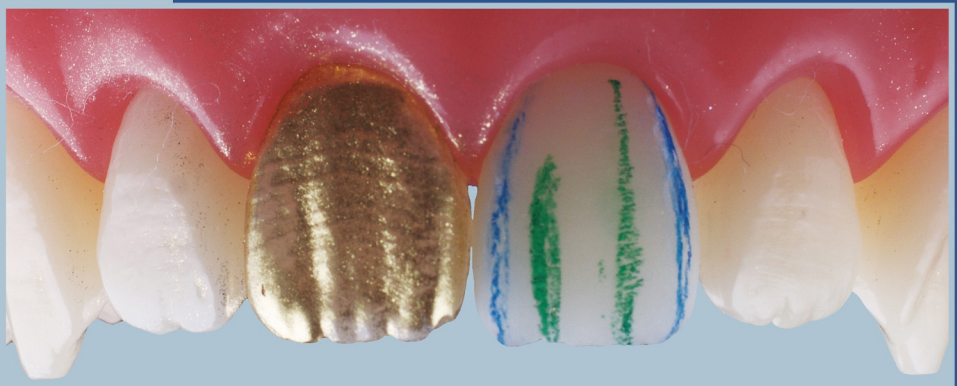

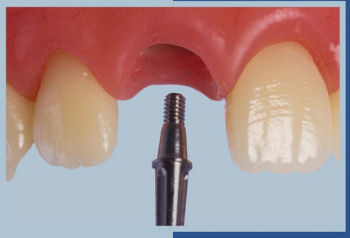

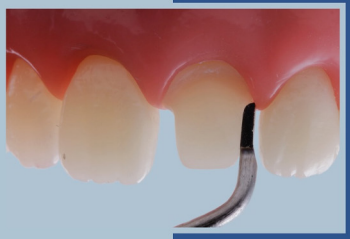

Procedures in Implantology, Prosthodontics and Surgery

André Antonio Pelegrine
Marcelo Lucchesi Teixeira
Marcelo Sperandio
Peter Karyen Moy

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and Peter Karyen Moy

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To the love of my life, Renata, and my beloved children, Iara and Enzo. I also wish to dedicate this textbook to my parents, Rino and Dalva, my best ethics teachers. Thank you for all your support and love.

André Antonio Pelegrine

I want to dedicate this book to my family, who supported me all along my journey. To my parents Moacir (*in memoriam*) and Marlí, and also to my sister Márcia.

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Marcelo Sperandio

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Peter Karyen Moy

TABLE OF CONTENTS

About the Authors ix

Acknowledgements xi

Preface xii

Presentation xiii

Part 1: Surgical Procedures 1

Chapter 1 6
Implant Placement Surgery

Chapter 2 40
Socket Augmentation

Chapter 3 53
Soft Tissue Management

Chapter 4 97
Alveolar Ridge Reconstruction

Chapter 5 128
Maxillary Sinus Floor Augmentation

Part 2: Procedures for Teeth-Supported Prostheses 145

Chapter 6 146
Semi-Adjustable Articulator Mounting and Bite Guards

Chapter 7 168
Teeth Preparations for Restorative Purposes

Chapter 8 201
Restoration of Endodontically-Treated Teeth

Chapter 9 225
Direct Provisional Restorations

Chapter 10 258
Impressions

Chapter 11 282
Framework Try-In

Chapter 12 292
Ceramic Adjustment

Chapter 13 306
Occlusal Adjustment for Tooth-Supported and Implant-Supported Partial Prostheses

Chapter 14 332
Effective Luting

Chapter 15 347
Ceramic Veneers

Part 3: Procedures for Implant-Supported Prostheses 371

Chapter 16 374
Single Unit Restorations

Chapter 17 397
Implant-Supported Fixed Partial Dentures

Chapter 18 419
Complete Dentures

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PREFACE

A textbook within the field of Oral Rehabilitation should have comprehensive contents including all aspects of Oral Rehabilitation, surgical and prosthetic techniques, and periodontal treatments. The authors in the present textbook most surely guarantee a thorough penetration of the actual topics. The step-by-step presentation of the different techniques is actually the best way to make them understandable. I recommend this textbook to all people that have an interest in Oral Rehabilitation.

Karl-Erik Kahnberg
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PRESENTATION

The professional formation in dentistry has some peculiarities that differ from other areas; one of them is motor skills. It is necessary to practice the procedures as much as possible to obtain better results in the clinical environment. Another concern relates to the clinical sequence of different procedures, which may vary according to the clinical situation and to the material's brand.

In this context, this book was planned to fill these demands. So, its design is focused on a step-by-step approach, but it is only based on this issue. As professors accustomed to working on the formation of skills, we think that it is mandatory to not only explain the procedure itself but also the reasons and the goals for each step. According to this approach, students and professionals can understand the rationale and work with specific aims for each procedure. The book is designed with models in order to show the ideal technique for each step, which is not possible in clinical situations. This didactic approach aims to prepare both the student and the professional so they can apply their knowledge according to any clinical situation.

The project of this book was based on a demand faced by our routine as professors. Our team, EPPIC (a Portuguese acronym for Campinas' Periodontics, Implantology, and Prosthodontic Team), is based at the Faculdade São Leopoldo Mandic in the city of Campinas, Brazil. Faculdade São Leopoldo Mandic is one of the most important dental schools in Brazil. Our experience involves graduate and postgraduate courses in the oral rehabilitation field. The EPPIC team has a scientific partnership with other institutions, and we are glad that Dr. Peter Moy (UCLA) accepted our invitation to join us in this project.

We hope you enjoy your reading and congratulate you on your concerns about improving your knowledge and skills.

André Antonio Pelegrine and Marcelo Lucchesi Teixeira

PART 1

SURGICAL PROCEDURES

The first part of this manual relates to the clinical protocols adopted by our team, EPPIC (a Portuguese acronym for Campinas' Periodontics, Implantology, and Prosthodontic Team), to assist in surgical preparation prior to dental rehabilitation. It is fundamentally important to emphasize that surgery is only a tool in the armamentarium of dental rehabilitation, where the prosthetic rehabilitation represents the "grand finale". This does not undermine the importance of the surgical phase as, on the contrary, it is the foundation for implant restorations, which includes soft tissue management with an emphasis on "pink esthetics". Timing is paramount in surgical and prosthodontic specialties in order to optimize treatment.

Part 1 describes the step-by-step surgical techniques adopted by EPPIC and aims to highlight hard tissue management as well as demystify soft tissue management in a structured and easily applied manner.

The surgical instrumentation necessary for implant placement are listed below. They are addressed as macro and micro surgical instruments (Fig. 1). An example of an implant installation kit is also provided (Fig. 2). Additional instrumentation are used for maxillary sinus floor augmentation (Fig. 3a, b), atraumatic extraction (Fig. 4), the support of soft tissue flap after bone grafting using the Barbell Technique™ (Fig. 5), for fixation/stabilization of bone blocks, and the installation of a mini implant for orthodontic traction (Fig. 6). The surgical motor and piezo units used during implant placement and grafting procedures are also shown (Figs. 7 and 8, respectively).

Figure 1: Micro and macro instruments used routinely in surgery.

(Gauze; disposable blunt needle; disposable syringe; stainless steel bowl; Minnesota cheek retractor; sutures; iris scissors; local anesthetic syringe; dental mirror size 5; periodontal probe; straight round scalpel handle; straight round scalpel handle for microblades; tissue dissector; freer elevator; angled tunneling instrument; papillae dissector; disk-shaped elevator; Kirkland scalpel; Stricker dissector; soft tissue spatula; Adson forceps; curved Adson forceps; Castroviejo needle holder).

Figure 2: Implant kit used in this textbook.

a b

Figure 3: Sinus membrane elevation instruments used in this textbook. (a) Curettes. (b) Summers Osteotomes.

Figure 4: Atraumatic extraction kit used in this textbook.

Figure 5: Barbell Technique™ surgical kit

Figure 6: Bone block fixation kit (also used for the installation of orthodontic mini implants).

Figure 7: Surgical motor used for osteotomy and implant placement

Figure 8: Piezo unit used for osteotomy, flap raising, and sinus floor lifting.

CHAPTER 1

IMPLANT PLACEMENT SURGERY

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Thiago Altro de Oliveira
Fernando Biolcati Chiantia
Marcelo Sperandio
Peter Karyen Moy

INTRODUCTION

The advent of implant dentistry has revolutionized the way we treat patients. To achieve the ideal implant positioning, the surgeon must place the dental implant from the perspective of three-dimensions: mesial/distal, apical/coronal, and buccal/lingual or palatal. When three-dimensional implant placement is not performed or achieved with due care, the results may lead to biological, mechanical, and esthetic problems. Implant selection can create another issue since each case poses its own specific prosthetic requirements, and these demands must be addressed by the selected implant system. Much has been discussed with regard to the surface treatments of dental implants, but the question of macro-engineering (the shape, thread design, and dimensions of the implant) should also be thoroughly examined. The EPPIC team (a Portuguese acronym for the Campinas' Periodontics, Implantology, and Prosthodontic Team) does not adopt a standard implant design for all cases; instead, we select the implant based on the available alveolar ridge to be operated on; for example, in situations where there is a fresh socket (or low bone density) tapered implants are preferred whereas straight-wall implants are acceptable for dense and healed alveolar bones.

In many clinical situations, especially when placing implants in the esthetic region, specific surgical procedures should be considered to reconstruct or maintain the alveolar bone prior to or concomitantly with implant installation. This is why biomaterials are occasionally brought into the spotlight in this chapter, though later chapters will dissect each subject in detail, such as socket augmentation (Chapter 2), soft tissue management

(Chapter 3), alveolar ridge reconstruction (Chapter 4), and maxillary sinus floor augmentation (Chapter 5).

The current trend, especially in the esthetic region, has been the use of prosthetic connections based on the concepts of platform switching (or shifting); we will, therefore, adopt such a philosophical approach for implant placement in this chapter. One of the advantages is the increased distance between implants, or between tooth and implant, when using the platform switching concept over using conventional abutment connections.

Our team determines implant positioning based on the requirements of the definitive prosthetic crown, which is known as reverse planning. It uses surgical templates generated from the design of definitive prosthetic prototypes. This approach was used for all the cases shown in this textbook.

Chapter 1 describes the techniques recommended for installing single and multiple implants, which always seek to establish elaborate surgical templates that take both the biomechanical and esthetic aspects of the future prosthesis into account. Orthodontic mini implants are also described since they require the same meticulous placement and angulations.

PLACEMENT OF A SINGLE IMPLANT INTO A FRESH EXTRACTION SOCKET

Surgical considerations

• ***Implant Design (macro-engineering):*** For immediate installation (fresh socket) tapered implants are recommended. In this chapter, immediate implant placement into a fresh socket was simulated using a tapered implant with a Morse taper-type prosthetic connection.

• ***Drilling speed:*** When using conical implants, most systems recommend a drilling speed ranging between 500 and 1000 rpm aided by a 20:1 speed-reducing contra-angle coupled to an electric motor.

• ***Immediate loading:*** In esthetic regions, whenever possible, immediate loading should be considered a potential option. Such an approach optimizes the maintenance of gingival architecture thus maximizing esthetics. Since this concept is a more advanced technique, a delayed loading approach was selected for this section to illustrate the implant installation procedure itself.

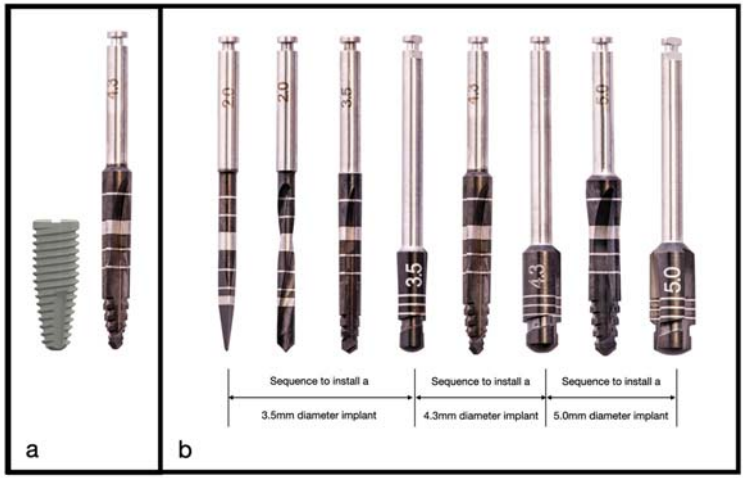


Figure 1.1: (a) Comparison between the implant length and the drill markings. Note that, for the implant system used in this textbook, the end of the top of the wide silver band coincides with a depth of 13 millimeter. (b) Enlarging the diameter drilling sequence to place a tapered implant.

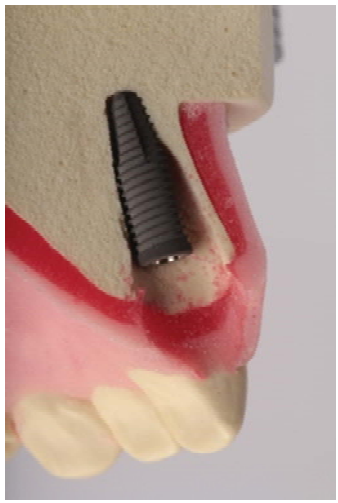


Figure 1.2: Sagittal diagram of the ideal position of the implant in a fresh extraction socket of an anterior tooth.

1. Tooth luxation using a periotome

Technique: Following local anesthesia and intrasulcular incision, a periotome is used to generate rotational movements in the mesio- and disto-buccal, as well as the mesio- and disto-palatal planes. Luxation is ascertained visually by observing the movement of the tooth.

Objective: Luxate the tooth to be extracted causing as little trauma as possible to the supporting tissues.

Rationale: Achieve exodontia lowering the risk of fracturing the buccal bone plate, which is usually thinner in esthetic regions.

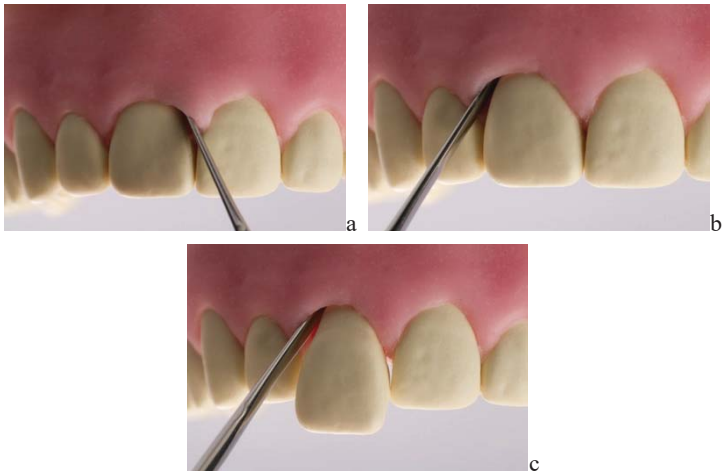


Figure 1.3: Use of a periotome in the mesial (a) and distal (b-c) positions.

2. Tooth removal and socket assessment

Technique: Once the luxation of the tooth has wedged the tooth from the socket, the tooth is removed with hemostat or extraction forceps and the fresh socket is inspected for the integrity of the bony walls.

Objective: Ensuring the maintenance of the four walls (buccal, palatal, mesial, and distal) will increase the predictability of the esthetic outcome.

Rationale: If the bone is damaged during extraction (most commonly the buccal wall), an occlusive membrane for guided bone regeneration (GBR)

must be placed to prevent soft tissue overgrowth towards the inner aspect of the socket.


a

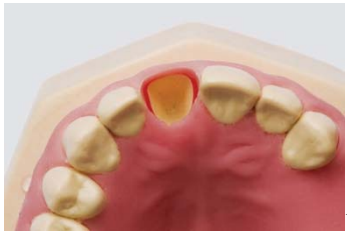

b

Figure 1.4: Tooth removal with tweezers (a) and verification of the integrity of the bone walls (b).

3. Surgical guide try-in

Technique: Upon completion of the treatment planning supported by adequate radiographic examination, study casts, and diagnostic wax-ups, the radiographic guide is converted to a surgical template. The surgical template should be tried-in clinically prior to surgery to ensure proper fit.

Clinical Tip: If a fully static-guided surgery is planned, a static surgical template must be digitally printed.

Objective: To ensure correct positioning of the implant from a three-dimensional perspective.

Rationale: Skipping the surgical template step may lead to inappropriate positioning of the implant, which, in turn, may subsequently lead to a negative impact on both function and esthetics.

Figure 1.5: Acrylic surgical template in position.

4. First drilling step (use of a spear-pointed drill)

Technique: A channel is prepared into the dense palatal wall of the fresh socket; the spear-pointed drill or #8 round drill can be used depending on the surgeon's preference. The drill is placed at a right angle into the palatal bone plate and then straightened vertically, always under constant irrigation. The surgical template can then be tried in with the drill in place.

Objective: The use of a spear-pointed drill or #8 round drill as a first preparation tool enables positioning the implant more palatally by engaging the dense cortical bone of the palate.

Rationale: Palatal positioning of the implant ensures the maintenance of a gap between the implant and the buccal bone plate. When this gap is filled with slow resorbable biomaterial, dimensional changes to the socket are minimized.

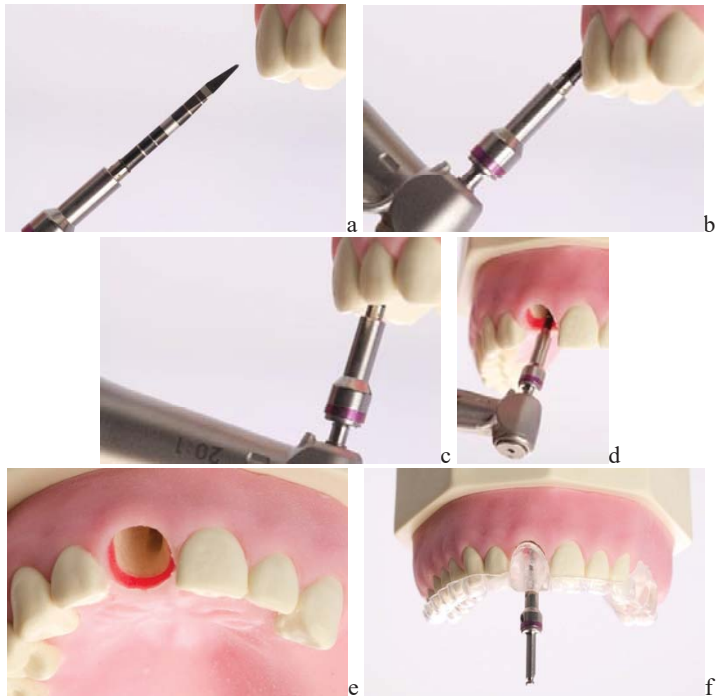


Figure 1.6: (a-b) First inclination of the spear drill to engage the palatal bone. (c-d) Drill verticalization. (e) Occlusal view of the bone osteotomy creating a channel for

the subsequent twist drills to follow. (f) Confirmation of the correct inclination with the aid of the surgical template.

5. Second drilling step (use of a 2.0 mm twist drill)

Technique: Guided by the channel made using the spear-pointed drill or #8 round drill, the next twist (typically 2 mm in diameter) is used for the total length of the selected implant (this drill has demarcations that match different implant lengths), using the buccal bone wall as a reference point. During the drilling procedure, the surgeon should always remember that the drill must be used under constant irrigation to avoid overheating the recipient bone bed. The parallel pin and the surgical template are then placed together to ascertain adequate three-dimensional implant positioning.

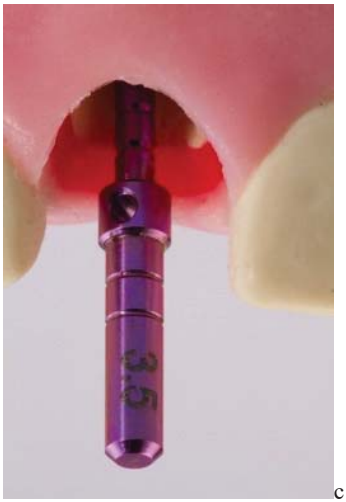
Clinical Tip: Morse-taper implants with platform switching capabilities may be inserted below the bone crest. Therefore, it is necessary to advance the drilling 1 to 2 mm deeper than the actual length of the implant.

Objective: The 2 mm twist drill creates the channel establishing the final position of the implant and paves the way to smoothly advance to larger diameter tapered drills.

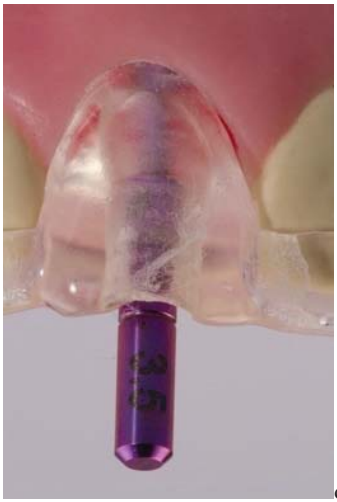
Rationale: The use of a tapered drill without prior preparation with a 2-mm twist drill tends to force drilling towards the buccal bone wall jeopardizes the gap needed between the implant and the buccal bone plate.

a

b



c



d

Figure 1.7: 2 mm twist drill with the markings corresponding to different lengths (a). The direction of drill is the same as that established by the spear-pointed drill (b). Three-dimensional evaluation of the drill position with the parallel pin (c) and coupled with the surgical template (d).

6. Tapered drill

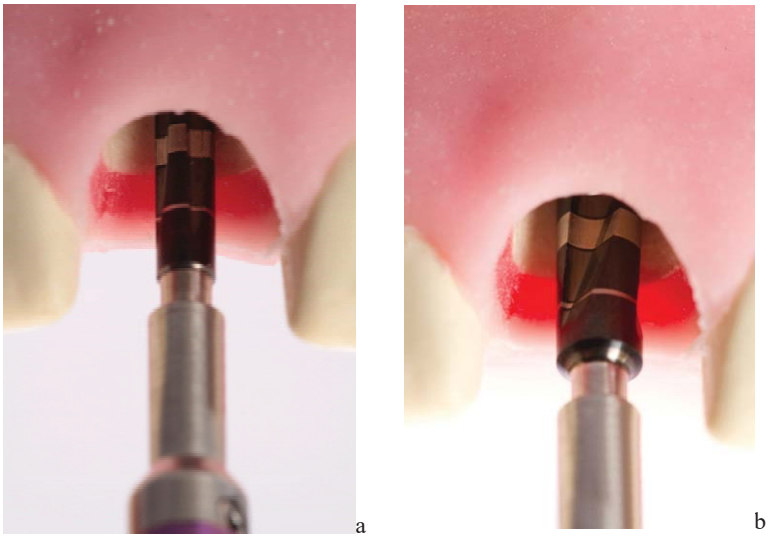
Technique: With the direction of the drills within the surgical socket now established, the sequence of tapered drills is applied, which should adhere to the proper working length determined in the previous step and follow the depth markings on the drill.

It should begin with the next largest diameter twist drill and then be sequentially enlarged until it is the appropriate diameter to accommodate the implant, which is always under constant irrigation.

Clinical Tip: In the case of low-density bone, using sequentially enlarging diameter twist drills may result in overpreparing the recipient site and an inability to establish initial implant stability; therefore, when dealing with low-density (soft) bone, the preparation of the bone bed should stop one drill before that recommended by the manufacturer. In the case of large sockets (greater than the diameter of the selected implant), as well as in cases where there is very thin cortical bone, the countersink drill should not be used.

Objective: The use of tapered drills permits the installation of tapered-body implants.

Rationale: In fresh sockets, from a macro-engineering point of view, tapered implants are the best option.



a b

Figure 1.8: Use a conical drill 2.8 mm (a) and 3.5 mm drill (b) in the predetermined direction and at a height of 13 mm.

7. Implant pick-up from package

Technique: After opening the implant package and engaging the implant insertion tool connected to the contra-angle, the implant snaps into the connection tip of the insertion tool.

Objective: Installing the implant using a rotatory speed-controlled contra-angle.

Rationale: The threaded area of the implant must not be touched because it may become contaminated, thereby potentially jeopardizing osseointegration.


a


b

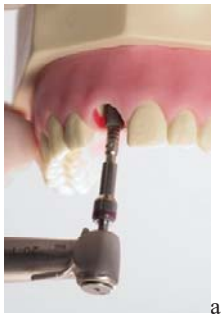
Figure 1.9: Using the implant insertion tool connected to the contra-angle (a) to engage the implant and carry to the recipient site for insertion (b).

8. Implant placement

Technique: Once the implant has been attached to the contra-angle insertion tool, the implant is inserted into the bone osteotomy at a speed of 30 rpm, without the use of irrigation. The installation is finalized with a surgical ratchet to position the neck of the implant between 1–2 mm below the buccal bone crest.

Objective: Permit implant placement with maximum accuracy, safety, and efficacy.

Rationale: Implant placement using a contra-angle minimizes the risk of deviating from the insertion axis. Finishing with a ratchet ensures safety, an accurate torque, and optimized visual access to ascertain the correct positioning of the implant.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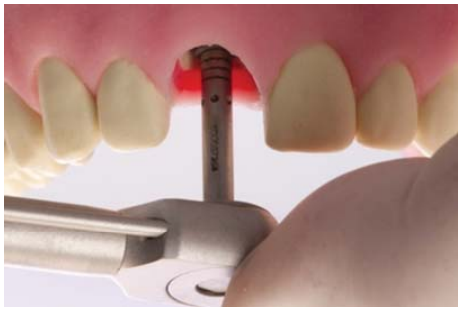

b

Figure 1.10: Using the implant carrier and contra-angle for the initial implant placement (a). The end of the implant installation should be performed with a hand-held torque wrench (b).

9. Filling the gaps

Technique: In the case of delayed loading, a cover screw is connected to the placed implant. In cases of immediate loading, an abutment is connected instead of the cover screw. The gap remaining between the implant and the buccal wall should be filled with slow resorption bone substitute biomaterial.

Clinical Tip: When filling the gap, care must be taken not to overly pack the biomaterial. Vigorous condensation may end up sealing the interconnecting pores within the biomaterial, which are necessary for the revascularization and osteoconduction of the newly formed bone.

Objective: To minimize postoperative dimensional loss of the alveolar bone, which would normally occur following exodontia.

Rationale: The use of a slow resorption biomaterial, such as bovine hydroxyapatite, alters bone remodeling patterns, minimizes dimensional changes, and provides continued support of gingival tissue thus maintaining gingival esthetics.

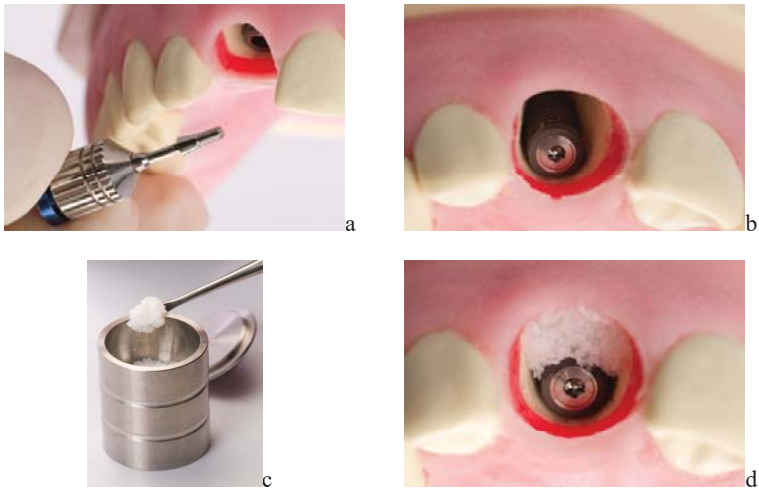


Figure 1.11: The cover-screw on the screwdriver tip is carried into position (a). The gap remaining between the socket walls and the implant (b). Xenograft after hydration in saline (c) and after filling the gap (d).

10. Sealing the socket

Technique: A socket seal can be achieved using an autologous free gingival graft, an acellular dermal matrix, or a collagen matrix (see Chapter 2 for further details on socket augmentation techniques).

Clinical Tip: Before positioning the socket sealing material, it is important to remove the crevicular gingival epithelium using either a scalpel or a diamond bur. As the epithelial tissue is avascular, such a maneuver optimizes the vascular flow of blood carrying nutrients to the soft tissue graft.

Objective: Protect the grafted area.

Rationale: The use of socket plugs minimizes the loss of biomaterial, protects the wound against bacterial contamination, and can contribute to establishing a thicker layer of gum tissue, which can have a positive impact on esthetics.

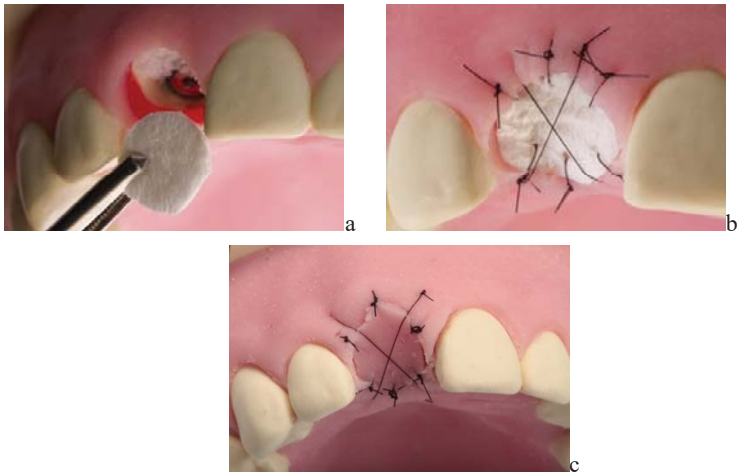


Figure 1.12: (a) Porcine collagen matrix cut into the socket size. (b) Graft sutured into position using nylon, prolene, or vicryl 5.0 sutures. (c) Sealing the surgical site using autologous free gingival graft to protect the socket.

PLACEMENT OF MULTIPLE IMPLANTS INTO HEALED SOCKETS

Surgical considerations

• ***Implant design (macro-engineering):*** The surgeon has the option of using a tapered or cylindrical implant in placements in healed sockets where the bone density is better than at a fresh extraction socket. In this chapter, a straight-wall implant with a Morse taper prosthetic connection is shown to simulate the installation of multiple implants in healed sockets. However, it is important to state that, even in healed sockets, if the bone density is low, tapered implants can be recommended.

• ***Drilling speed:*** when using straight-wall implants, most systems recommend drilling speeds between 800 and 1,200 rpm using a 20:1 speed-reducing contra-angle coupled with an electric motor.

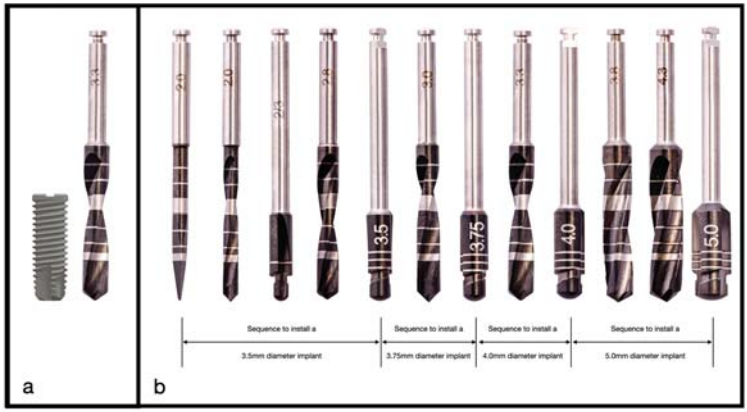


Figure 1.13: (a) Comparative scheme of the length of the implant and the drill markings. Note that, for the implant system used in this textbook, the end of the wide silver band coincides with the 13th millimeter. (b) Drilling sequence for the installation of a straight-wall implant.

1. Surgical template try-in

Technique: Upon completion of treatment planning, a surgical template is made; this is supported by adequate radiographic examination, study casts, and diagnostic wax-ups, which must be tried-in clinically to test the fit before surgery.

Clinical Tip: If a fully guided surgery is planned, a static surgical template must be printed.

Objective: To ensure correct implant positioning on a three-dimensional basis.

Rationale: Skipping the surgical template step may result in implant positioning errors, which in turn could impact both function and esthetics negatively with the definitive prosthesis.

Figure 1.14: Acrylic Surgical Template seated in place.

2. Incisions

Technique: After ensuring adequate local anesthesia, an incision is performed on the crest, extending from the mesial aspect of the most posterior tooth to the distal aspect of the most anterior tooth.

Clinical Tip: This needs to be a full incision, i.e., the blade must touch bone. Adequate incision can be confirmed using a dissector instrument.

Objective: Full incisions allow a full flap to be raised.

Rationale: Full incisions allow the subsequent detachment of a mucoperiosteal flap, granting access to the underlying alveolar bone, which is essential to prepare the surgical site for subsequent implant placement.


a


b


c

Figure 1.15: (a) Scalpel blade 15C for incision of the bone crest. (b) Scalpel blade 15C in sulcular incision around tooth 13. (c) Scalpel blade 15C in sulcular incision around tooth 17.

3. Flap reflection

Technique: Following the incisions, full thickness flap detachment is started using a periosteal elevator.

Clinical Tip: Flap detachment is facilitated enormously if started at the anterior end and progressed posteriorly.

Objective: Provide adequate access to the bone surface for preparation.

Rationale: Raising a mucoperiosteal flap provides access to the bone for preparation of the surgical site for subsequent implant placement.

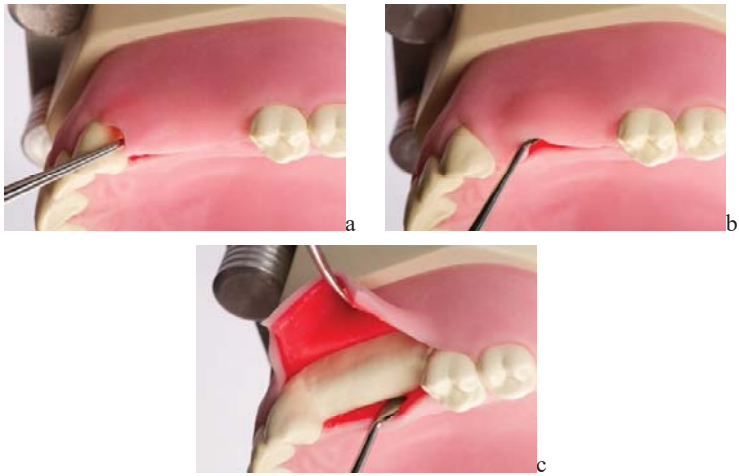


Figure 1.16: (a) Use of periosteal elevator to raise a full-thickness flap near tooth #14 region. (b) Using the periosteal elevator to lift the flap, working towards the posterior region. (c) Appearance after lifting the buccal and palatal flaps.

4. First drilling

Technique: Once the flap has been raised, the surgical template is then tried in to provide a visualization of the prosthetic contours for the accurate use of twist drills and positioning the osteotomy for each implant. This step should be carried out using a spear, pointed tip drill, or a round drill (#6 or #8) under constant irrigation.

Objective: The use of a spear or a round drill as a first preparation tool allows the accurate positioning of reference points on the dense bone crest and avoids chatter or the drill as it hits the dense bone.

Rationale: The points marked on the bone crest will be the landmarks for subsequently increasing the diameters of the drills by respecting the principles of reverse planning and understanding the demands of the definitive restoration.


a


b

Figure 1.17: Using the spear drill at the beginning of the preparation of the surgical socket, in both the anterior (a) and posterior implant sites (b).

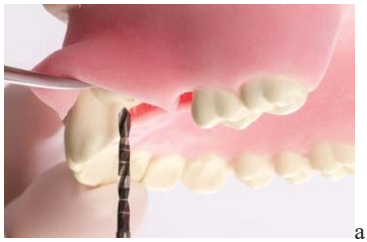
5. Second drilling step

Technique: From the reference points made with the spear or round drill, a larger diameter twist (commonly a 2 mm diameter) drill is used under constant irrigation. The drill is used to the desired length of the selected implant. Parallel pins and the surgical template are then tried in together to ensure appropriate three-dimensional positioning.

Clinical Tip: Implants with Morse taper connection and platform switching may be inserted below the bone crest. Therefore, it is necessary to advance drilling by 1–2 mm beyond the length established for the implant.

Objective: To determine the final working length for drilling to allow implant placement and ascertain parallelism.

Rationale: Achieving adequate parallelism, distance between the implants, and between the tooth and the implant, as well as establishing the drilling depth, will facilitate the subsequent preparation steps with other drills, which should aim solely at widening the osteotomy.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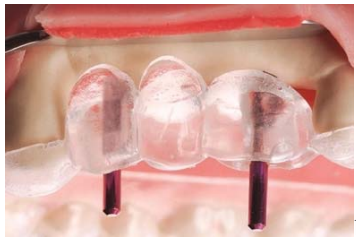
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Figure 1.18: (a) Using the 2 mm diameter twist drill. (b) Checking parallelism with the direction indicators provided by the implant system.

6. Preparation using the pilot 2/3 drill

Technique: Through the perforation made by the previous small diameter drill, a pilot drill is used to enlarge the diameter of the osteotomy to the next twist drill size.

Objective: To facilitate the use of subsequent twist drills.

Rationale: The use of a pilot drill is important to create a smooth transition to wider diameter drills in the manufacturer's recommended drilling sequence, such as a 3 mm diameter twist drill. The direct transition from a 2 mm to a 3 mm diameter drill without an intermediate step drill would mean a 50% increase in diameter, which may result in inefficient drilling and an osteotomy that is too wide.


a

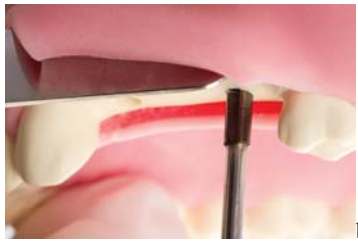
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Figure 1.19: 2/3 pilot twist drill used to allow further osteotomy with a 2.8 mm or 3 mm diameter twist drills in both the anterior (a) and posterior regions (b).

7. Preparation with wider diameter drills

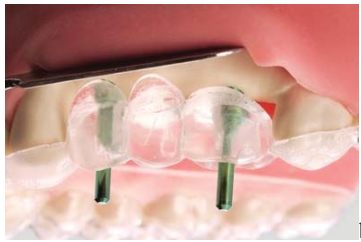
Technique: After using the pilot drill, wider diameter drills are used to the depth established with the first twist drill. The parallel pins and surgical template are once again used to verify the three-dimensional positioning.

Clinical Tip: If some angulation correction is required for implant(s) installation, it is important to do so using the smaller diameter twist drills so as not to overprepare the osteotomy thus making it more difficult to establish an initial primary stability with the implant.

Purpose: To enable the installation of the implant(s) with the predetermined diameter.

Rationale: To establish primary stability, the osteotomy should be made with a diameter slightly narrower than that of the implant. This is accomplished using a final twist drill diameter that is typically smaller than the diameter of the implant. This differential diameter size between the last twist drill used and the implant diameter should not be excessive because otherwise the implant will not be fully seated into the osteotomy due to underpreparing the recipient site. It is important to always follow the manufacturer's recommendations.

a



b

Figure 1.20: (a) Using the final twist drill (3.3 mm diameter) to allow a 4 mm diameter implant to be placed. (b) Surgical template and paralleling pins in place.

8. Final pilot drill preparation

Technique: Following the preparation with the twist drills, it may be necessary to use a countersink pilot drill to finish the drilling procedures. The countersink drill is necessary when there is dense cortical bone at the alveolar crest. Using the countersink will permit the complete seating of the implant neck/shoulder to the desired 1–2mm subcrestal position.

Clinical Tip: When bone density low or there is an absence of dense cortical bone, the use of a countersink drill is not necessary.

Objective: To adapt the osteotomy preparation to accommodate the shape of the implant platform.

Rationale: In situations where the preparation depth exceeds the length of the implant (implant platform below the bone crest level), the final pilot drill becomes essential, since the cervical portion of the implant may not adequately adapt to the bone bed otherwise. This is especially true in cases of deeper preparations in dense bone regions. It is important to insert the pilot drill to the pre-established length (e.g., implant bone level, 1 or 2 mm below the bone).

Figure 1.21: Pilot drill for a 4.0 mm diameter implant.

9. Implant pick-up from a package

Technique: After opening the implant package and seating the implant carrier into the contra-angle, the implant snaps into the connection area of the carrier.

Objective: Install the implant using a rotatory, speed-controlled contra-angle.

Rationale: The threaded (body) area of the implant must not be touched to avoid contamination which may potentially jeopardize osseointegration.


a


b

Figure 1.22: (a–b) Using the implant mounting key on a contra-angle to connect the implant.

10. Implant installation

Technique: Once the implant has been picked up with the contra-angle insertion tool, the implant is screwed in between one half to two thirds of the way into the osteotomy at a speed of 30 rpm, without the use of irrigation. Irrigation is not used for this step since the insertion of the implant does not generate heat and to also avoid rinsing out the blood clot which contain nutrients that initiate osseointegration. The installation is finalized with a handheld surgical wrench to position the cervical end of the implant about 1 mm below the buccal bone crest, taking care to align the implant connection area with the buccal surface of the crown, i.e., one of the dots marked on the implant insertion tool must be pointing towards the buccal aspect of the future crown.

Objective: Install the implant with maximum safety, ideal positioning, and minimal trauma.

Rationale: Starting implant installation with a speed reducing contra-angle minimizes the risk of deviation from the insertion axis and maximizes control. Completing implant placement with a hand-held surgical wrench ascertains safety and enables torque monitoring up to the final twist.


a


b

Figure 1.23: (a) After using the contra-angle implant carrier, the implant installation is completed with a surgical wrench. (b) Use of a wrench and an appropriate carrier to complete the implant placement. Note the cervical implant positioning 1 mm below the buccal bone crest.

11. Adaptation of the cover screw and suturing

Technique: Once the implant is in place, a cover screw is attached into the implant and the surgical wound is sutured to achieve primary closure.

Clinical Tip: In the case of an infrabony implant placement, a taller cover screw or even a healing abutment may be used instead of a conventional cover screw (flush with the platform).

Objective: Allow healing by primary intention.

Rationale: Adequate joining of the surgical wound edges optimizes healing. Care must be taken to ensure that the suture knots are placed away from the incision line to minimize the problems related to biofilm accumulation and ultimately scar formation. The use of monofilament (non-resorbable) sutures may aid in hindering plaque or bacterial build-up.

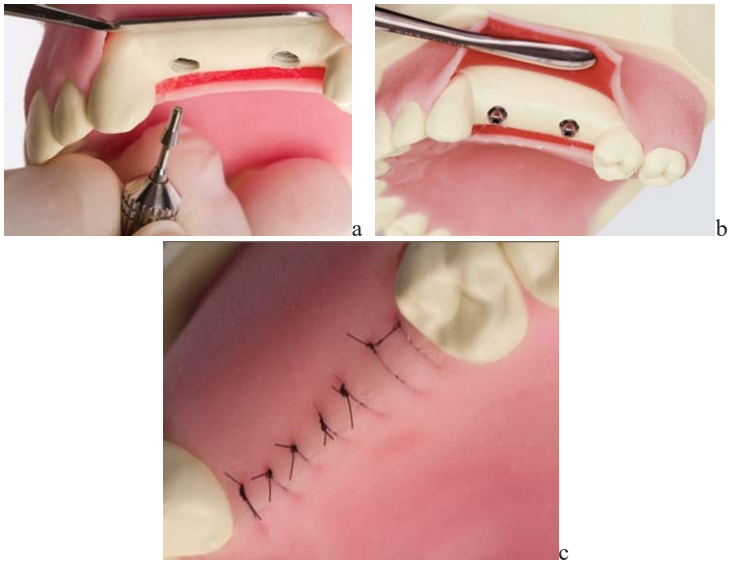


Figure 1.24: (a) 1.2 mm driver to screw the cover screw into the implant. (b) A slightly larger cover screw can be installed in cases where the implant has been installed below bone level. (c) Simple interrupted sutures. Care should be taken to leave the suture knots off the incision line.

ORTHODONTIC MINI IMPLANTS

(Primary sites for implant placement in the maxilla and mandible)

The placement and positioning of mini implants will vary according to the demands of the planned orthodontic traction. The mini implant is a point of anchorage for orthodontic brackets and the positioning in the jaws is determined by the type of movement to be executed.

The use of temporary anchorage devices should allow the planned tooth movements to be performed respecting the biomechanical control of movement. Correct positioning of the mini implant supports and ensures the successful completion of the orthodontic treatment. Therefore, the dentist planning the orthodontic treatment and its mechanics should identify the position and the number of mini implants to provide adequate traction.

Table 1.1: Positioning possibilities of mini implants taking the orthodontic application into account.

	Maxilla	Mandible
Posterior anchorage	Between the 1st molar and the 2nd premolar	Between the 1st molar and the 2nd premolar
Anterior Intrusion	Between lateral incisor and canine	Between lateral incisor and canine—submucosal placement
Posterior intrusion	Between the 1st molar and the 2nd premolar on the buccal and palatal	Not Applicable
Distalization of Molars	Between the 1st molar and the 2nd premolar	Between the 1st molar and the 2nd premolar
Verticalization of Molars	Between the 1st molar and the 2nd premolar	Between the 1st molar and the 2nd premolar

MINI IMPLANTS AS TEMPORARY ORTHODONTIC ANCHORAGE DEVICES

1. Selection criteria for mini implants: diameter and transmucosal profile

Table 1.2: Options for mini implant selection.

Type of mini implant	1.3 mm diameter	1.6 mm diameter	Low collar	Medium collar
Indication	Placement between the roots on the buccal of the mandible and the palate of the maxilla	Placement between the roots on the buccal aspect of the maxilla	0 mm thick mucosa	1 mm thick mucosa

Technique: A gingival needle adapted with an endodontic rubber stop is inserted at the mucogingival junction level.

Objective: To determine the thickness of the gingival tissue.

Rationale: This technique is used to select the height of the mini implant collar.

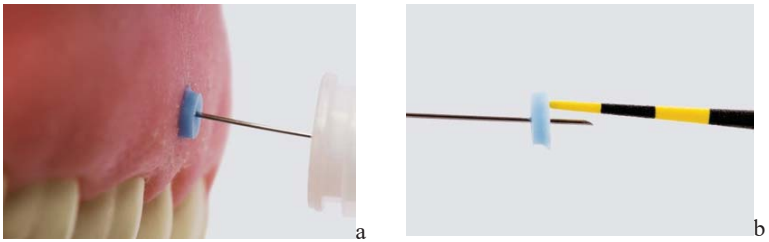


Figure 1.25: (a–b) Using a needle and an endodontic stop to determine the thickness of the muco-gingival junction.

2. Selecting the mini implant's diameter and site

Technique: Radiographic and CT images are used to check the availability of space between the roots before mini implant placement.

Objective: To ensure that the mini implant will not hit the periodontal ligament or the adjacent roots of teeth at the placement site.

Rationale: The choice of the mini implant's diameter should take not only the load which it will be exposed to but also the space available for installation into account.

Table 1.3: Calculation of the inter-radicular distance needed for the installation of mini implants.

Periodontal ligament	0.5 mm
Safety zone	1.0 mm
Diameter of the mini implant	1.3 or 1.6 mm
Interdental space needed	2.8 or 3.1 mm

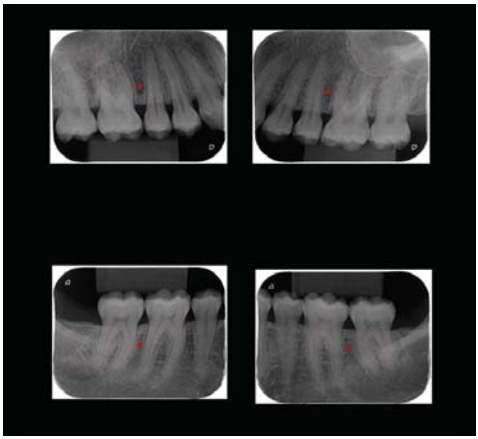


Figure 1.26: Periapical radiographs illustrating the ideal space between the roots for the installation of mini implants in the maxilla and the mandible.

3. Establishing the position for the mini implant on the alveolar ridge

Technique: The muco-gingival junction, which is the transition zone where the color changes from light red to pink and the texture of the soft tissue changes from smooth to stippled, is visually located.

Objective: To ensure that mini implants are placed in the attached gingiva.

Rationale: The placement of mini implants in the zone of the attached gingiva prevents hyperplasia, which often occurs when mini implants are placed in the mucosa.

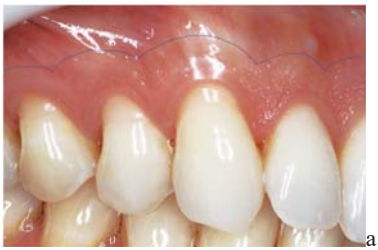

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Figure 1.27: (a) Clinical picture outlining the location of the mucogingival junction on the buccal of the right maxilla. (b) A similar area on the demonstration model showing the location of the mucogingival junction.

4. Use of a periodontal probe to measure and identify the location for mini implant placement.

Technique: With a periodontal probe, the distance between the mucogingival junction and the tip of the interdental papilla is measured in the mouth, guided by the radiographic findings, which should identify the ideal interradicular location for mini implant placement.

Objective: To record the distance and guide the mucosal perforation at an intermediate point between the roots of the teeth adjacent to the mini implant.

Rationale: The vertical position of the probe is used to help visualize the inclination of the long axis of the roots thus allowing mini implant installation with a safety margin.


a

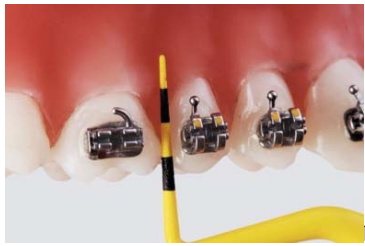
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Figure 1.28: (a) A periodontal probe is used to assess the slope of the roots of the teeth near the site for the mini implant placement. (b) A periodontal probe is used to measure the distance between the muco-gingival junction and the center of the orthodontic brackets.

5. Chairside fabrication of a guide for the surgical placement of mini implants

Technique: Use a rectangular stainless-steel wire bent in an L-shape with a loop on the mucogingival junction end, which is the position previously established with the periodontal probe.

Objective: To guide drilling through the mucosa in horizontal and vertical directions.

Rationale: The system of guides made from orthodontic wires facilitates the initial drilling and reduces estimation errors in terms of the horizontal and vertical planes when placing mini implants.


a


b

Figure 1.29: (a) Stainless steel wire bent into a loop shape with an average height of 8 mm. (b) Stainless steel wire guide attached to the orthodontic bracket with the loop positioned below the mucogingival junction and between the roots.

6. Demarcation of the drilling point in the mucosa

Technique: A perforation is made in the mucosa at the established point using a dental probe.

Objective: To penetrate through the soft tissues and facilitate the drilling of the cortical bone.

Rationale: Initial puncturing of the mucosa leaves a bleeding spot, which helps to identify the correct point for drilling the cortical bone.

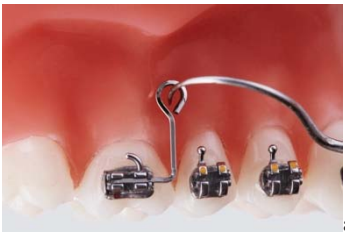
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Figure 1.30: (a) Drilling the mucosa using the guide fabricated with a steel wire and adapted to the braces. (b) Drilling in patients without an orthodontic appliance is performed after careful measurements using the periodontal probe, which is pressed against the gingiva and mucosa marking the drilling point.

7. Drilling the cortical bone

Technique: The cortical bone is perforated using a manual spear tip driver and semi-rotation movements with hand and digital pressure.

Objective: To create an initial pathway with tactile sensation to direct the subsequent rotatory bone drills.

Rationale: Creating a pathway manually prior to power drilling the bone makes the process more predictable, thus minimizing the risk of positioning errors and injuring adjacent teeth.


a


b


c

Figure 1.31: Installation kit. (a) spear-shaped manual driver. (b) Manual driver at the intended mini implant location. (c) Hand and finger support for cortical drilling, ensuring a secure grip.

8. Drilling

Technique: The drill size is determined based on the diameter of the implant and must be the same length as the threaded part of the selected mini implant. A 20:1 speed-reducing contra-angle is used coupled to an electric motor at a speed of 200 rpm. The angulation of the drill for perforation may vary from 0° to 30°, depending on the intended orthodontic treatment plan.

Clinical Tip: In cases of low bone density, electric power drilling is unnecessary since the screw thread favors penetration upon rotation and pressure. Therefore, in such scenarios, one can screw the mini implant directly after the site is adequately anesthetized and positioning has been established with the hand driver.

Objective: To create a path of insertion for the mini implant to be used as a guide for the installation.

Rationale: Drilling reduces the application of force against bone. This is needed to install the mini implant, which increases their primary stability.


a


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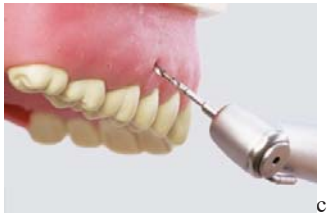
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Figure 1.32: (a) Drills used in contra-angle handpiece. (b) Contra-angle position used for drilling at 0 degrees. (c) Contra-angle positioning for drilling at 30 degrees.

9. Mini implant pick-up from the package

Technique: Connect the implant insertion tool into the contra-angle and then attach the insertion tip into the mini implant directly while it is still contained in the sterile package. There are two connectors: one for each of the two mini implant diameters.

Objective: To enable the use of a contra-angle handpiece as a carrier for mini implant placement.

Rationale: The threaded area of the mini implant should not be touched to reduce the risk of contamination.


a


b

Figure 1.33: (a-b) Connecting the mini implant with the specific handpiece adapter for each diameter.

10. Installation of the mini implant (initial)

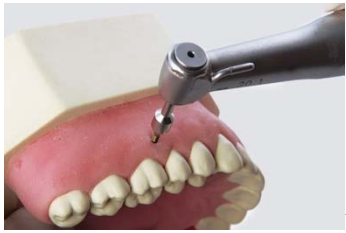
First phase: Rotatory instrument

Technique: The mini implant is positioned in the perforation site and installed at 30 rpm until the threaded portion of the mini implant is no longer visualized.

Objective: To place the mini implant with speed control.

Rationale: The initial installation of the mini implant with a rotatory device ensures control and accurate positioning based on the requirements for orthodontic traction.

a



b

Figure 1.34: (a) Positioning the mini implant connected to the handpiece. (b) Mini implant installed with a rotary instrument until the body of the mini implant (the threads) is below the gingival tissue.

11. Installation of the mini implant (final)

Second phase: Manual instrumentation

Technique: Using the respective mini implant manual hand-held driver under constant clockwise hand pressure, the mini implant is inserted until the transmucosal collar is in contact with the patient's mucosa.

Objective: Complete installation of the mini implant.

Rationale: The final seating using a hand-held driver is a safety step to prevent over-seating of the mini implant and to avoid the overcompression of soft tissue.

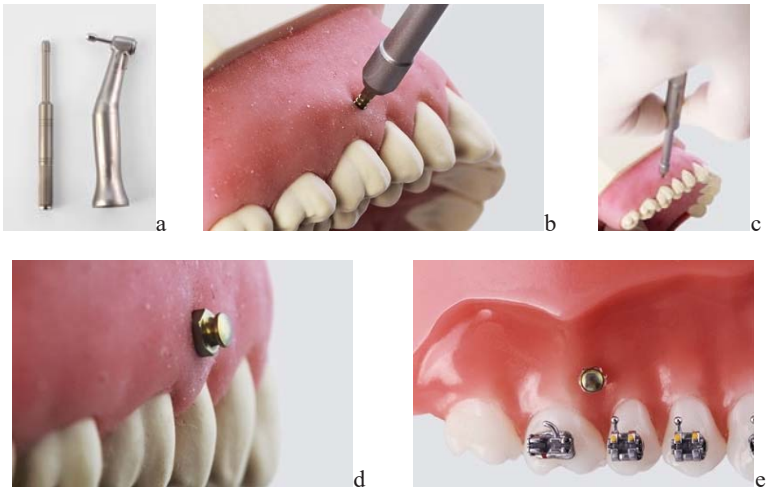


Figure 1.35: (a) Manual and contra-angle mini implant drivers. (b-c) Completing the mini implant installation with the manual driver. Note the correct grip of the hand-held driver. (d-e) Proper appearance on the completion of the mini implant installation.

12. Evaluation of the primary stability of mini implants

Technique: Aided by a pair of tweezers or cotton pliers, gentle movement is applied to the mini implant searching for signs of displacement in various directions.

Objective: To ascertain the mini implant's stability.

Rationale: Primary stability is achieved by the threaded portion of the mini implant's intimate contact with bone. Lack of primary stability in the mini implant prevents it from being used for orthodontic anchorage, which is paramount for orthodontic mechanics.

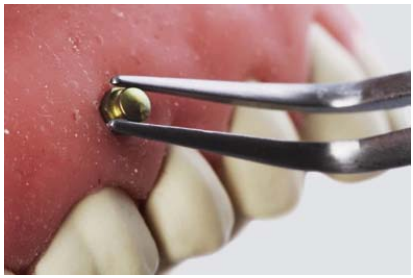


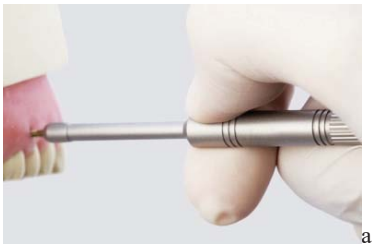
Figure 1.36: After installing the mini implant, its primary stability is tested with clinical tweezers.

13. Removal of mini implants

Technique: The hand-held driver, which was initially used for seating the mini implant, is adapted to the mini implant head and rotated counter-clockwise.

Objective: To remove the mini implant on the completion of orthodontic treatment.

Rationale: Temporary anchor devices are removed once the biomechanical objectives of the tooth movements have been achieved.



a

b

Figure 1.37: (a) Positioning the driver for removing the mini implant. (b) Mini implant removed but still connected to the driver.

CHAPTER 2

SOCKET AUGMENTATION

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INTRODUCTION

It is well documented that, following the exodontia of anterior teeth, where the buccal bone plate is usually thin, or the traumatic removal of teeth, a significant loss of alveolar ridge volume occurs, especially in the buccal (labial)-palatal direction. In terms of prosthetic rehabilitation, whether implant-supported or not, the loss of buccal root prominence significantly alters the contours of the alveolar ridge. This may have important esthetic implications, especially if the patient has a high smile line. Therefore, attempts to minimize the dimensional changes following exodontia should be made at the time of exodontia, particularly in areas with a high esthetic demand.

Traditionally, slow resorption biomaterials are used to prevent volume loss on the buccal aspect of the socket. There are two methods to apply this concept of maintenance of ridge contours by augmenting the socket:

1. With immediate implant placement

2. Without immediate implant placement

The decision to immediately place the implant or delay the placement should be made based on the availability of residual bone forming the socket and whether the remaining bone will provide adequate support to achieve primary stability versus the patient's desire for a quick solution to the loss of a tooth in the esthetic area of the mouth. When the surgeon attempts to appease the demands of the patient with immediate implant placement into

a fresh extraction socket with insufficient bone support for the implant, compromised surgical and prosthetic outcomes will occur.

Another factor of great importance in the management of fresh extraction sockets is the risk of losing the buccal bone wall. In the anterior region, the buccal wall may be lost, as it is usually very thin. If the buccal bone wall is lost or missing, the principles of guided bone regeneration should be applied. Guided bone regeneration requires the placement of an occlusive membrane which affords full access to the bony defect; hence, a full thickness flap must be created which increases the invasiveness of the surgical procedure and may lead to further passive resorption of the buccal bone. Therefore, minimally traumatic extraction techniques should be used in order to reduce the risk of buccal bone wall fracture. Atraumatic techniques can be performed using flexible periotomes and/or specially designed mechanical extractors. Periotomes initiate the loosening of the root from the periodontal fibers and luxating the tooth. Extractors remove the tooth along its long axis, without significant risk of compressive forces applied to the buccal bone plate. Contraindications to using mechanical extractor for removal of teeth include divergent roots, root dilaceration, hypercementosis, ankylosis, and severely weakened roots (decayed and/or fractured).

This section addresses socket augmentation techniques with or without immediate placement of implants. The loss of the bone wall will also be discussed.

ALVEOLAR AUGMENTATION USING A MECHANICAL EXTRACTOR WITHOUT IMPLANT PLACEMENT

1. Intrasulcular incision

Technique: After local anesthesia, an intrasulcular incision is applied circumferentially around the entire tooth.

Objective: To sever the dental-gingival fibers.

Rationale: Intrasulcular incision disrupts both the junctional epithelium and the connective tissue attachment, assisting the subsequent luxation of the tooth.

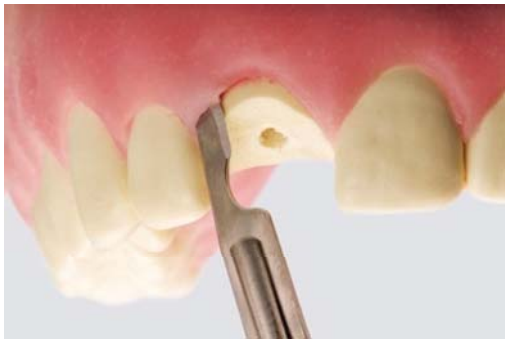


Figure 2.1: Scalpel blade (15C) used for intrasulcular incision.

2. Preparation of the nerve canal

Technique: Using the specific twist drill provided in the extractor system, perforation and widening the central aspect of the root is performed at a low speed.

Objective: To allow the delivery of the extractor system's intracanal screw.

Rationale: Adequate locking of the intracanal screw is required to ensure that the tensile force generated by the extractor is transferred to the body of the root, thus dislodging the root.

Figure 2.2: Preparation of the nerve canal with a twist drill for the extractor system.

3. Adaptation of the intracanal screw

Technique: Using the specific key and screw from the selected extractor system, the screw is engaged into the canal.

Objective: To allow the intracanal screw to lock into the nerve canal.

Rationale: Firm engagement of the intracanal screw is needed to transmit the traction force needed for exodontia.

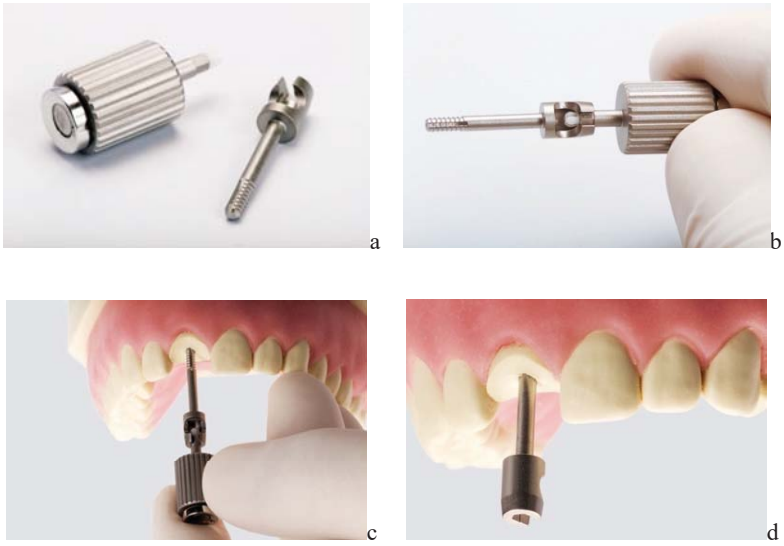


Figure 2.3: (a) Manual key and screw extractor before assembly. (b) Manual key and screw from the extractor system after assembly. (c) Manual digital key in position. (d) manual key removed and intracanal screw in position.

4. Adapting the steel cable and the extractor

Technique: With the screw properly engaged, the steel cable is attached both to the screw and the extraction platform. The system is then activated by rotating the handle knob clockwise.

Objective: To pull the tooth out of the socket with minimal trauma.

Rationale: Tooth extraction performed using this method greatly minimizes the compression exerted on the buccal bone plate, thereby decreasing the chances of fracturing it during the extraction procedure.


a


b


c


d

Figure 2.4: The extractor kit. (a) Note the presence of the rear handle that allows tooth traction when rotated clockwise. (b) Adapted extractor system. (c-d) Root being removed using the extractor system.

5. Use of biomaterial in the extraction socket

Technique: The slow resorption biomaterial must be hydrated in saline prior to adaptation into the fresh socket.

Clinical Tip: Hydration of Bio-Oss Collagen® prior to shaping facilitates the easier handling of the material. Trying to cut the biomaterial while it is dry could cause it to crumble.

Objective: To minimize the dimensional changes of the socket post-extraction.

Rationale: Using slow resorption bone graft biomaterial minimizes dimensional changes by supporting the buccal bone wall during the healing period.

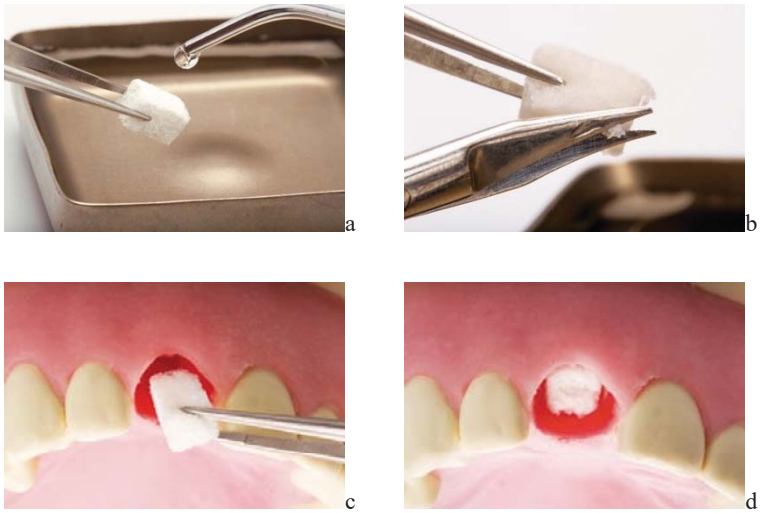


Figure 2.5: (a) Xenograft block (90% bovine bone and 10% porcine collagen) hydrated with saline. (b) Xenograft being shaped with scissors. (c-d) Xenograft being inserted into the fresh socket.

6. Socket seal

Technique: Socket seal can be achieved using an autologous free gingival graft (see Chapter 3), an acellular dermal matrix, or a collagen matrix.

Clinical Tip: Before positioning the autologous soft tissue graft, it is important to remove the epithelial layer from the superficial layer of gingiva either with a scalpel blade or a diamond bur. As the epithelial tissue is avascular, this maneuver optimizes the nutrition of the soft tissue graft during revascularization.

Objective: To protect the hard tissue graft delivered into the socket area.

Rationale: The use of a gingival graft minimizes the loss of biomaterial, protects the wound against bacterial contamination, and may contribute to establishing a thicker gingiva, thus enhancing esthetics.

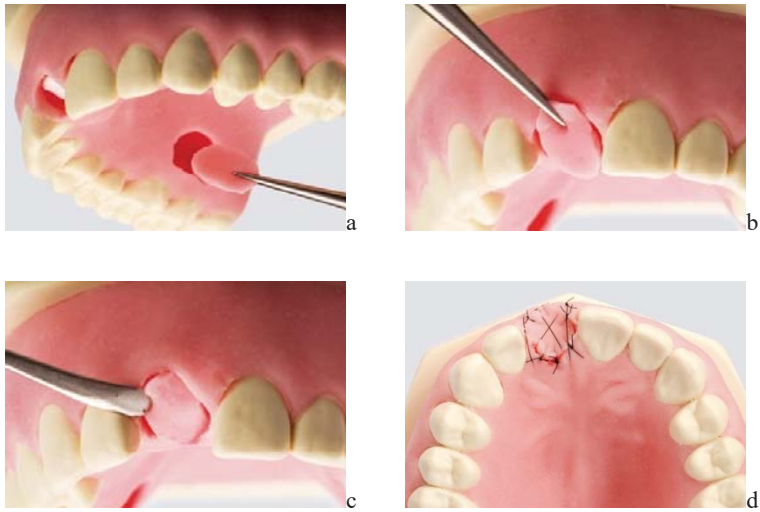


Figure 2.6: (a) Free gingival graft harvested from the palate. (b) Positioning the free gingival graft. (c-d) Gingival graft fitting and stabilization using interrupted sutures and a mattress X suture.

ALVEOLAR AUGMENTATION USING A PERIOTOME AND IMMEDIATE IMPLANT PLACEMENT

1. Luxation using a periotome

Technique: Following local anesthesia and intrasulcular incision, a periotome is used to generate rotational movements in the mesial and distal line angles along both the buccal and palatal positions of the tooth. Luxation and movement can be ascertained visually.

Clinical Tip: In anterior areas, it is recommended to use straight periotome, whereas angled periotomes are preferable in posterior regions.

Objective: Luxate the tooth to be extracted creating as minimal trauma as possible to the supporting hard and soft tissues.

Rationale: Achieve atraumatic exodontia, thereby lowering the risk of fracturing the buccal bone plate, which is usually thinner in the esthetic regions.

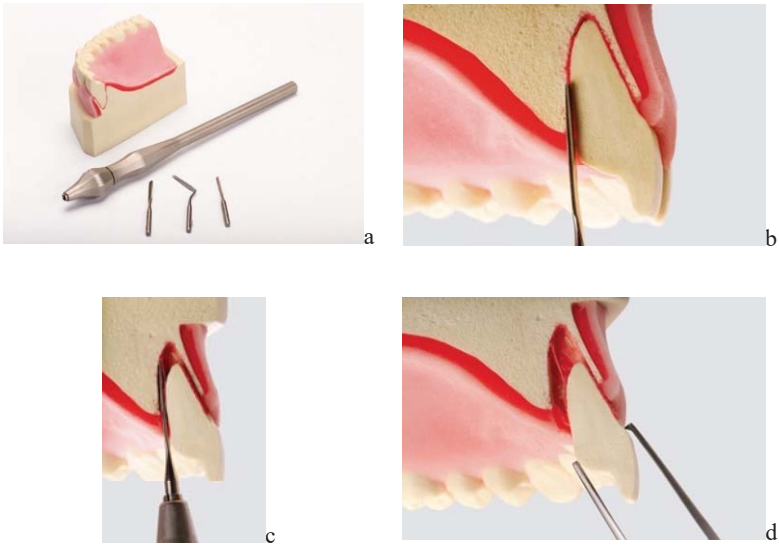


Figure 2.7: (a) Periotome with different detachable tips. The straight blade is usually preferred for anterior teeth. (b) Periotome positioning within the periodontal ligament (b). (c-d) Periotome enabling minimally traumatic extraction.

2. Ideal position of the implant and gap filling

Technique: Following exodontia, the socket should be curetted and prepared to receive an implant. The palatal positioning of the implant for the future crown results in a gap between the implant and the buccal bone plate. This gap must be filled with bone biomaterial that resorbs slowly to minimize dimensional changes to the socket.

Clinical Tip: Connecting a cover screw to the implant prior to inserting a fine-grained biomaterial, even if it is to be changed to a healing abutment later on, will prevent graft particles from falling inside the implant. A cover screw is usually smaller and less bulbous than a healing abutment, and so using a healing abutment may hinder the delivery of the material into the gap.

Objective: Place the implant to properly support the prosthesis while minimizing alveolar dimensional changes.

Rationale: To maintain alveolar ridge contours, thereby optimizing the esthetics and function.

a b c

Figure 2.8: (a) Appearance of a fresh socket after curettage. (b) Tapered implant installation leaving a labial gap. (c) Filling the labial gap with fine-grained xenograft.

3. Socket seal

Technique: Once the biomaterial is in place, the cover screw is removed and a larger component is installed (taller cover screw or a healing abutment). If the implant was installed flush with the buccal bone plate, the cover screw can be maintained. A free gingival graft is then adapted over the region covering the socket.

Clinical Tip: Only keep the cover screw in place if the implant was installed flush with the bone level. Otherwise, replace the cover screw with a larger, taller component as bone may form over the cover screw during healing, making it very difficult to remove when uncovering the implant and forcing the removal of bone that is needed for long term support of the gingival tissue.

Objective: To protect the grafted area.

Rationale: The use of a gingival graft minimizes loss of biomaterial, protects the wound against bacterial contamination, and may help to maintain thicker gingival tissue, thus optimizing esthetics and resistance to gingival recession.

Figure 2.9: After filling the gap, the cover screw is removed, a healing abutment (or a larger screw cover) is fitted, and a free gingival graft cap is placed into position.

ALVEOLAR AUGMENTATION WITH IMMEDIATE IMPLANT PLACEMENT AND WITH THE ABSENCE OF THE BUCCAL BONE PLATE

1. Implant placement

Technique: Following exodontia, the socket should be curetted and prepared to receive an implant. Palatal positioning of the implant for the future crown results in a large gap between the implant and the gingival tissue since the buccal bone plate is not present. A cover screw must be placed over the implant in preparation for performing guided bone regeneration.

Objective: To position the implant in the best location to support the future prosthetic crown, regardless of the status of the buccal bone wall.

Rationale: Correct positioning of the implant in relation to the future crown will translate into better esthetic outcomes, especially with regard to the emergence contours of the future prosthesis. Getting the pink esthetics with natural soft tissue correct is highly dependent on performing this step properly.

a b c

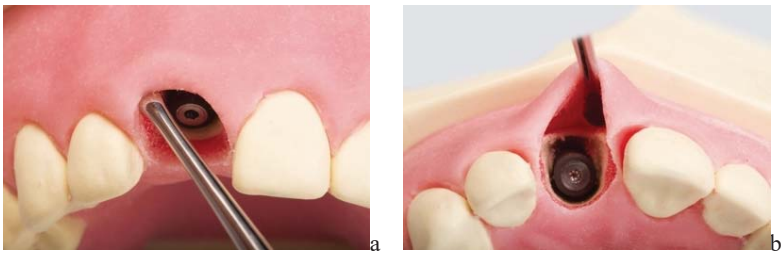
Figure 2.10: (a) Appearance of the fresh socket illustrating the loss of the buccal bone plate. (b) Implant placement in socket with loss of the buccal bone plate. (c) Connecting the cover screw.

2. Flap reflection for membrane positioning

Technique: After the implant has been placed, a full thickness flap is raised using a small periosteal elevator. Dissection should continue until 3 mm of stable buccal bone structure can be visualized.

Objective: To allow the insertion of a resorbable occlusive membrane.

Rationale: The use of an occlusive membrane is mandatory in cases of buccal bone loss, as it prevents the interference through downgrowth of the gingival soft tissue.



a b

Figure 2.11: (a) Flap detachment using a delicate instrument. (b) View of a 3-mm bony defect buccally.

3. Preparation and adaptation of the resorbable occlusive membrane

Technique: A resorbable membrane is trimmed to create the correct shape, which will be supported by the remaining stable buccal bone and cover the

biomaterials used for grafting. Care must be taken during the installation of the membrane so that it does not fold upon itself or become damaged (tearing). The membrane should be positioned with fine tweezers until it is snuggly tucked under the base of the raised flap.

Clinical Tip: Do not hydrate the membrane prior to insertion. This facilitates trimming and sizing the membrane. Gradual hydration will occur *in situ*, which should help to adapt the membrane to cover the defect.

Objective: Prevent contact between the graft biomaterial and the surrounding soft tissue epithelium.

Rationale: The use of a membrane is mandatory in cases of buccal bone loss, as it prevents the downgrowth of epithelial cells. The epithelial cells form soft tissue faster than bone cells (osteoblasts) form bone.

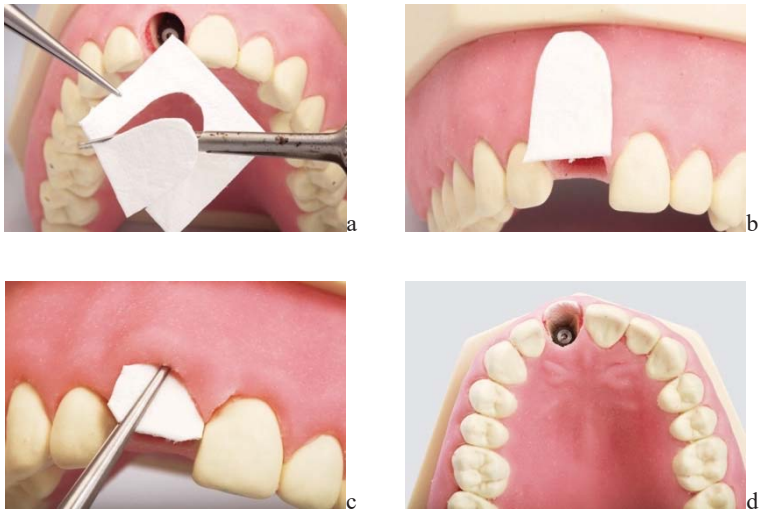


Figure 2.12: (a-b) Collagen membrane being trimmed and shaped. (c-d) Collagen membrane placement.

4. Biomaterial insertion and socket seal

Technique: After positioning the occlusive membrane, the bone grafting biomaterial should be inserted up to the height of the implant platform. The occlusive membrane is then folded towards the palate to completely cover

the implant. Soft tissue closure of the socket is performed using autologous free gingival, an acellular dermal matrix, or a collagen matrix material for grafting (see Chapter 3).

Clinical Tip: Before positioning the soft tissue graft, it is important to remove the epithelium from the superficial surface of the gingival tissue (epithelium) using either a scalpel blade or a diamond bur in order to expose the connective tissue layer; this optimizes graft revascularization because the epithelial layer is avascular.

Objective: To protect the grafted area.

Rationale: The use of a gingival graft minimizes loss of biomaterial, protects the wound against bacterial contamination, and may contribute towards an improved quality of gingival tissue, thus achieving a better outcome for the esthetic aspect of treatment.

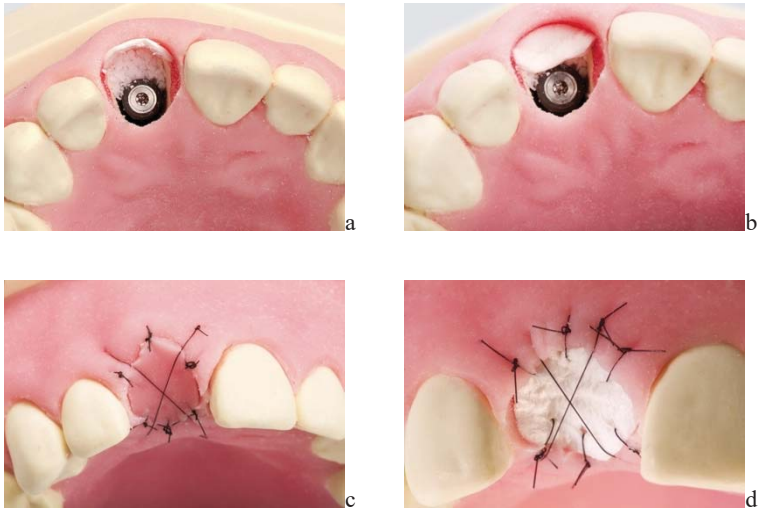


Figure 2.13: (a) Fill the gap with fine-grained xenograft. (b) The collagen membrane is folded over the xenograft. (c-d) Positioning and suturing of either a free gingival graft or a collagen matrix.

CHAPTER 3

SOFT TISSUE MANAGEMENT

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INTRODUCTION

Soft tissue management is a topic of utmost importance nowadays, especially with regards to esthetics. Over the last two decades, we have learned to place more value on the so-called pink esthetics, i.e., the esthetics of the soft tissues around both a tooth, natural or restored, and implant-supported prosthesis. Tissue management and manipulation in clinical situations is not only important for esthetic outcomes but also for functional ones. In terms of functional improvements in implantology, increasing the zone of keratinized gingiva does not only improves the characteristics of the tissue around the implants but it also facilitates hygiene maintenance and the prevention of marginal gingival recession. Since this textbook is to serve as a practical step-by-step manual of key clinical techniques in implantology, the authors strongly suggest reading other academic sources that have focused on specific specialty subjects for more detailed information on the indications and limitations of these procedures.

For our discussion on soft tissue management, the procedures will be divided into two main areas: reconstructive management and resective management. The first relates to soft tissue grafting procedures and the latter to tissue removal, such as clinical crown lengthening. From an esthetic point of view, crown lengthening is indicated when the anterior teeth appear shortened, especially in a patient presenting with a smile line ranging from average to high. It is clear that in a manual made up of photographs of plastic models, this particular aspect of soft tissue management is limited at best.

This chapter addresses the most commonly used techniques for soft tissue manipulation in everyday practice.

RECONSTRUCTIVE TECHNIQUES

Reconstructive management of soft tissue

Introduction

The need to increase and/or modify the characteristics of the soft tissues around the teeth as much as around implants often requires soft tissue grafting. In such clinical situations, one must choose between a graft containing both epithelium and connective tissue or only connective tissue. Decision-making should therefore take the need for keratinized gingiva into account. In which case, the first option would be the most appropriate; this is traditionally known as a free gingival graft (FGG). An FGG, however, creates issues that clinicians and patients should be aware of. The clinical issues involve the donor site healing through secondary intent (longer and typically more painful) and the risk of gingival color differences between the adjacent tissue sites with the recipient bed after healing. An FGG may also be used when sealing of a fresh socket is desirable. When such demands are not needed, then a connective tissue graft (CTG) should suffice; this is where only the connective tissue is harvested (be it free or pedicle/modified roll), leaving the epithelium behind to heal by primary intention at the donor site. In addition, connective tissue grafts should not yield differences in gingival color at the recipient site. A third clinical scenario is one presenting with deficient soft tissue both in terms of height and in thickness. In such situations, the graft of choice should be a combination (mixed graft), which features the connective tissue as a major component (to promote a gain in thickness) as well as a secondary portion containing epithelium + connective tissue (FGG) to promote a gain in height. In situations where there are concerns regarding the harvesting of autologous soft tissue grafts, an acellular dermal matrix or a collagen matrix could be an alternative, with allogeneic and xenogeneic donor materials commercially available. The techniques involved in obtaining soft tissue grafts will be addressed first and then the reconstructive techniques themselves.

Techniques for Harvesting Soft Tissue Grafts

Table 3.1 – Characteristics of soft tissue graft materials

Graft type	Vascularization potential/ harvesting method	Source	Indication(s)	Tissue(s) component(s)
Free gingival graft	++/free	Autologous (Palate* or tuberosity*)	Attached gingiva augmentation and fresh socket seal	Connective and epithelial (same area in both)
Connective tissue graft (Classic)	+++/free	Autologous (Palate** or tuberosity**)	Root coverage and alveolar ridge augmentation (thickness)	Connective
Modified roll technique	++++/pediculate	Autologous (Palate**)	Alveolar ridge augmentation (thickness)	Connective
Mixed graft	++/free	Autologous (Palate* or Tuberosity**)	Both height and thickness augmentation of the alveolar ridge	Connective (> volume) and epithelial (thin strip)
Acellular dermal matrix or collagen matrix	+/free	Homologous (Human) or Xenogeneic (Animal)	Root coverage and augmentation of attached gingiva	Dermis/collagen

* Healing by second intention of the donor site.
** Healing by first intention of the donor site.

CONNECTIVE TISSUE GRAFT HARVEST

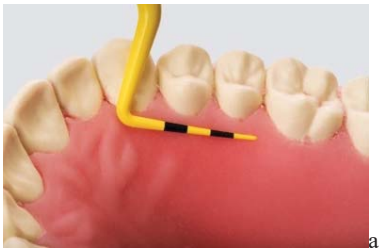
1. Initial linear incision

Technique: After local anesthesia, a full linear incision (scalpel blade touching bone) is made in the palate, around the region of the premolars and approximately 2 to 3 mm from the gingival margin. The length of the incision depends on the size of the graft needed to cover the recipient site.

Clinical Tip: Due to the tissue's elasticity and tendency to shrink, it is necessary to extend the incision by 1 mm on either side in relation to the length and width of the graft, e.g., if the graft is to be 14 mm, the incisions must be 16 mm long.

Objective: To enable flap reflection and dissection.

Rationale: The position of the incision near the gingival margin is recommended to minimize the risk of injury to the palatine artery.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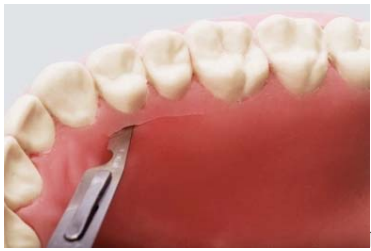
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Figure 3.1: (a-b) Full thickness linear incision in the palate, 2 mm from the gingival margin extending from the mesial aspect of the first molar to the distal aspect of second premolar. A 15C scalpel blade was used.

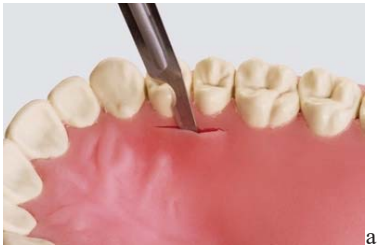
2. Additional incisions

Technique: A split-thickness flap is prepared at a depth that is sufficient to the needs of the recipient bed, while respecting the anatomical limits. The split-thickness flap is characterized by a division line within the connective tissue, which will ensure that a layer of connective tissue remains adhered to the epithelium, whereas the deeper layer will in turn supply the periosteum. Subsequently, three full incisions are made internally: a vertical mesially, a vertical distally, and a horizontal apically, thus releasing the

connective-periosteal freeing the submucosal layer and permitting the harvesting of the graft.

Objective: To delineate the margins of the graft to be removed.

Rationale: Maintaining a band of connective tissue attached to the epithelium is essential to prevent necrosis of the donor site.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c


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Figure 3.2: (a) Flap dissection from the palatal aspect. Three full-thickness incisions being performed internally to the flap: (b) a vertical incision distally, (c) a vertical incision mesially, and (d) a horizontal incision apically.

3. Removing the graft

Technique: Once the incisions have been made, the connective tissue graft is detached using a periosteal elevator.

Clinical Tip: If the recipient site demand does not require too thick a graft, the periosteum can be preserved and only a thin strip of connective tissue is harvested from the donor site.

Objective: Obtain tissue for soft tissue reconstructive surgery, such as root coverage or tissue augmentation at the peri-implant site.

Rationale: In cosmetic procedures, the use of connective tissue grafts increases tissue volume, promotes greater coverage, and decreases the risk of relapse.


a


b

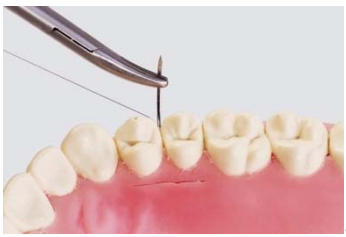
Figure 3.3: (a) Detaching the periosteum to harvest the connective tissue graft. (b) Removal of the donor tissue graft.

4. Suture

Technique: Following graft harvesting, the edges of the wound must be brought together as close as possible. In addition to simple sutures, "square-X" sutures can also be applied.

Objective: To promote adequate stabilization of the surgical wound.

Rationale: Close adaptation of the edges allows healing to occur by primary intention. The use of "square-X" sutures brings the tissue edges together, thereby minimizing the risk of dehiscence.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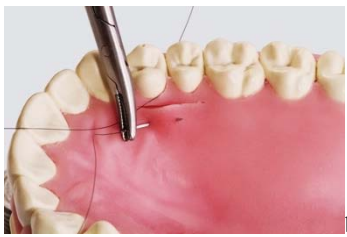
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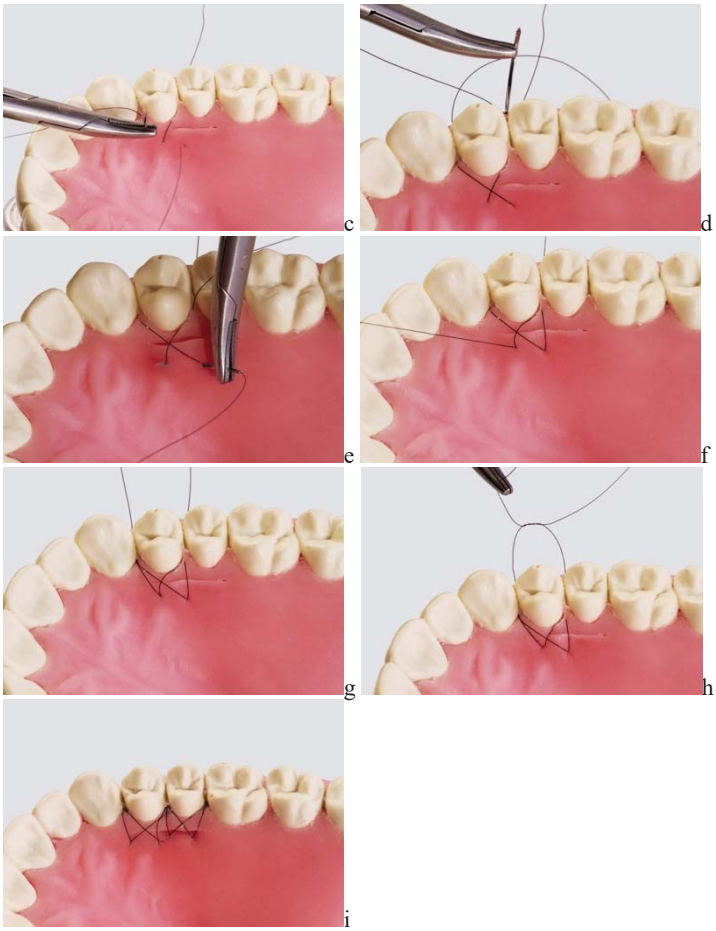


Figure 3.4: (a) The needle is passed from buccal to palatal, below the contact point between the premolars, and then (b) horizontally on the palate at the level of the first premolar. (c) The needle is taken once again under the contact point but is now between the first premolar and the canine in the shape of an "X". (d) The needle is then taken from buccal to palatal, below the contact point between the premolars and then (e and f) horizontally on the palate at the level of the first premolar. (g) The needle is taken through below the contact point but is now between the first premolar and the canine, forming a square. (h) The knots are placed buccally. (i) The same sequence is followed for the second premolar.

MIXED GRAFT HARVESTING FROM THE PALATE

1. Initial linear incisions

Technique: After local anesthesia, a full thickness linear incision is made (scalpel blade touching the bone) in the palate at the height of the premolars and about 2 to 3 mm from the gingival margin. The length of the incision depends on the size of the graft needed to cover the recipient site. Parallel to the first incision, a second, split thickness incision is made, but partially (not touching bone), and at a distance based on the recipient site's needs. The distance between incisions (thickness) must be calculated according to the need for a gain in height in the recipient site.

Clinical Tip: Due to the tissue's elasticity and tendency to shrink, it is necessary to extend the incision by 1 mm on either side in relation to the length and width of the graft, e.g., if the graft is to be 14 mm, the incisions must be 16 mm long.

Objective: To establish the length of the graft to be harvested.

Rationale: A mixed graft features a thin strip of epithelium with a large connective tissue component. This is ideal in cases where there is need to gain both thickness and height in the deficient ridge.

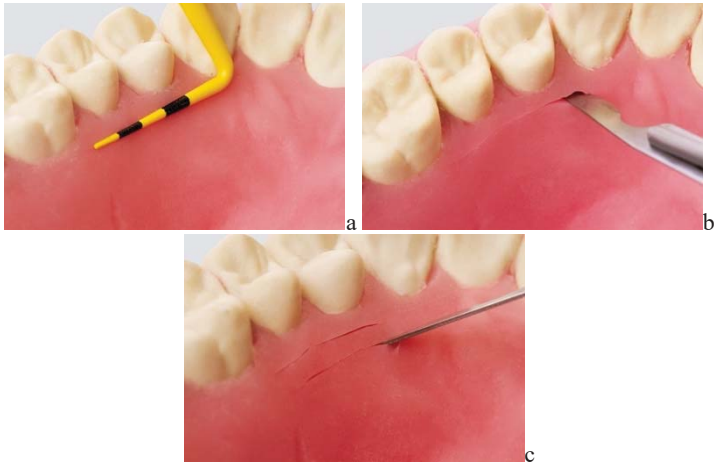


Figure 3.5: (a-b) Full-thickness linear incision in the palate, 2 mm from the gingival margin extending from the mesial aspect of the first molar to the first premolar. (c) Thereafter, a second incision (partial thickness) is made parallel to the first incision. A 15C scalpel blade was used.

2. Additional incisions and graft removal

Technique: A split-thickness flap is prepared on the palatal aspect using a second incision (apically) to a depth sufficient to meet the needs of the recipient site (usually involving the periosteum). Subsequently, three additional full-thickness incisions are made internally: a vertical mesially, a vertical distally, and a horizontal apically. This enables the release of a donor tissue graft that includes a strip of epithelial tissue. Upon completion of the incisions, a periosteal elevator is used to detach and remove the connective tissue.

Objective: Obtain both connective and epithelial tissues for grafting.

Rationale: In cosmetic procedures, the use of mixed grafts increases both tissue thickness and height, thereby promoting greater reconstruction in sites in need of additional volume.

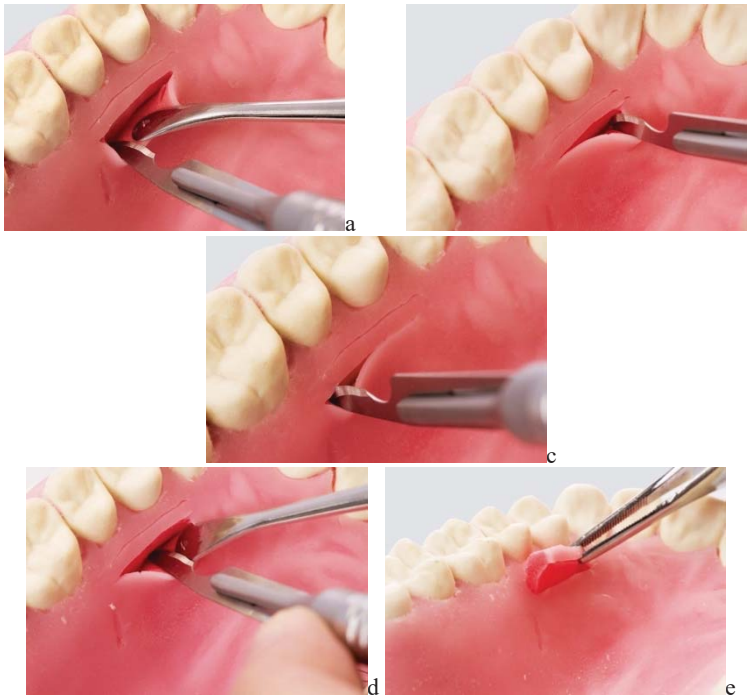


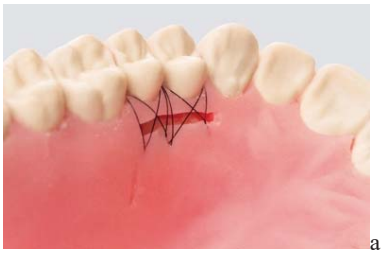
Figure 3.6: (a) Flap splitting (palatal aspect) with full thickness horizontal incision and partial thickness vertical incision on distal. 3 full incisions made internally to the flap: (b) a vertical incision mesially, (c) another vertical incision distally, and (d) a horizontal incision apically. (e) Graft removal.

3. Sutures for the donor site

Technique: Once the graft has been harvested, the edges of the wound must be brought together as closely as possible. In addition to simple sutures, a suspensory suture called “square-X” can also be used to achieve this.

Objective: To gain the highest possible stabilization and protection for the donor site wound.

Rationale: Reapproximating the edges of the wound without contact will provide the smoothest healing by secondary intention. The shorter the distance between the edges the better the postoperative recovery. “Square-X” sutures bring the edges closer together thereby minimizing the risk of dehiscence and complicated healing.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b

Figure 3.7: (a-b) Suspensory sutures placed according to Figure 3.3.

MIXED GRAFT REMOVAL FROM TUBEROSITY

1. Incisions and removal of the graft

Technique: The procedures involved in mixed grafting from the tuberosity are similar to those for the mixed graft removal from the palate, and only the donor site anatomy is different. In the tuberosity, the initial incisions are made parallel to the long axis of the posterior arch and towards the distal aspect of the second molar.

Objective: To obtain a soft tissue graft for alveolar ridge augmentation both in terms of thickness and height.

Rationale: To optimize the esthetic outcome in areas needing alveolar ridge soft tissue gain in thickness and height.

Figure 3.8: (a) Full linear incision in the region of the tuberosity. (b) A second full incision is made parallel to the first. A 12D scalpel blade is used. (c) After the internal flap division, (d) the mixed donor graft is removed.

2. Suture

Technique: Unlike the mixed graft harvesting technique from the palate, tissue coadaptation and primary closure in the tuberosity region can be achieved with simple sutures.

Objective: To promote the adequate protection and stabilization of the surgical wound for healing by primary intention.

Rationale: The use of simple sutures facilitates and speeds up the surgical procedure.

Figure 3.9: Single interrupted sutures.

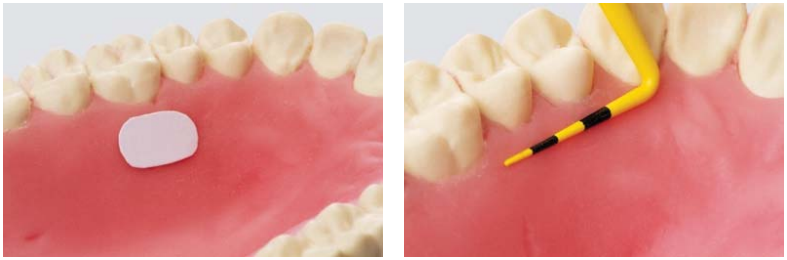
FREE GINGIVAL GRAFT HARVEST

1. Fabricating a sizing template

Technique: The template can be made in two ways: direct or indirect. The direct method involves a cutout using sterile suture packaging in the shape of the recipient area to be grafted. The indirect technique is performed by measuring the recipient site with a periodontal probe and outlining the desired size of the graft needed on the donor area.

Objective: To be as precise as possible to harvest the appropriate volume of tissue needed from the donor site and to minimize the trauma and recovery time to the donor site, especially since the donor site will need to heal by secondary intention.

Rationale: To facilitate the procedure and reduce postoperative discomfort.



a b

Figure 3.10: (a) A sizing template is positioned over the area to be used as the donor site using the direct method. (b) Note indirect method of sizing the donor graft to be harvested using a periodontal probe to measure the graft extension.

2. Incision and graft removal

Technique: After local anesthesia, a partial incision is made (not touching the bone) in the palate, 3 mm away from the gingival margin of the premolars and first molars, with an average depth of 2 mm. The sizing template will define the length of the incision. Removal of the flap is achieved by changing the inclination of the scalpel blade (from perpendicular to practically parallel with the epithelial layer) aided by fine-tip tweezers, so that the deeper layer of connective tissue remains attached to the periosteum.

Objective: To design and harvest grafts for sealing sockets or increasing keratinized gingiva.

Rationale: Maintaining a layer of connective tissue at the donor site will decrease postoperative discomfort.

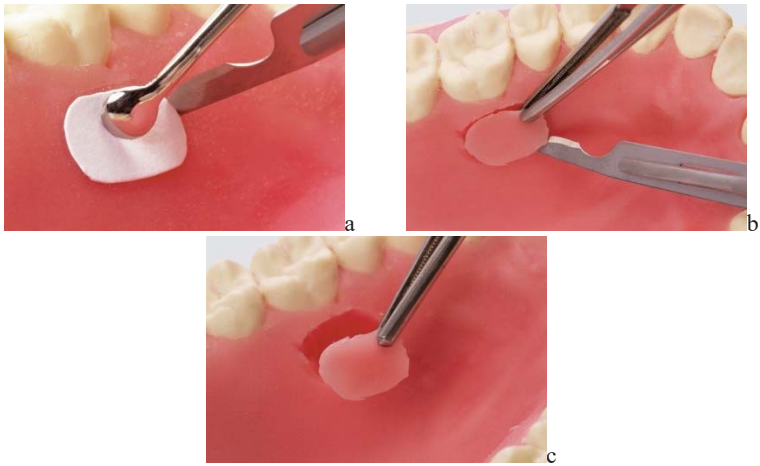


Figure 3.11: (a) Partial incision around the sizing template. (b) A 15 C blade scalpel is used for the graft dissection. (c) Graft removed.

3. Suture

Technique: Due to the extent of donor tissue loss, the goal of the suture is only to retain the blood clot. Criss-cross sutures are used to accomplish this task. Surgical dressings or lab-made palatal splints may also be considered for this purpose.

Objective: Maintenance of a blood clot to heal by secondary intention.

Rationale: Loss of the clot hinders the healing process and increases discomfort.

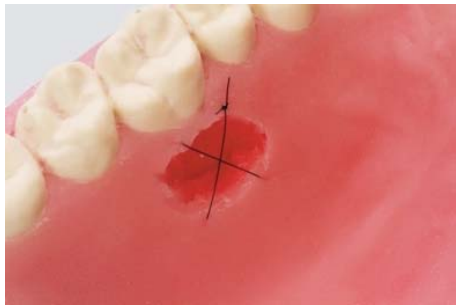


Figure 3.12: Suture in a figure of “X".

KERATINIZED GINGIVA AUGMENTATION

1. Incision and split-thickness flap at the recipient site

Type of graft used: Autologous free gingival graft or acellular dermal matrix

Technique: This technique can be performed in either of two ways: keeping the flap by positioning it apically or removing it. Regardless of the technique used, the first step is the incision. The first incision is partial thickness (not touching the periosteum) and linear along the area requiring keratinized gingiva. Subsequently, two lateral incisions are performed (mesially and distally) perpendicular to the first incision. When a decision is made to remove the flap, a new linear incision is made parallel to the first but more apically, thereby allowing the graft to be excised.

Objective: To create a suitable recipient site for free gingival graft.

Rationale: An open (bleeding) wound is critical for graft nutrition.

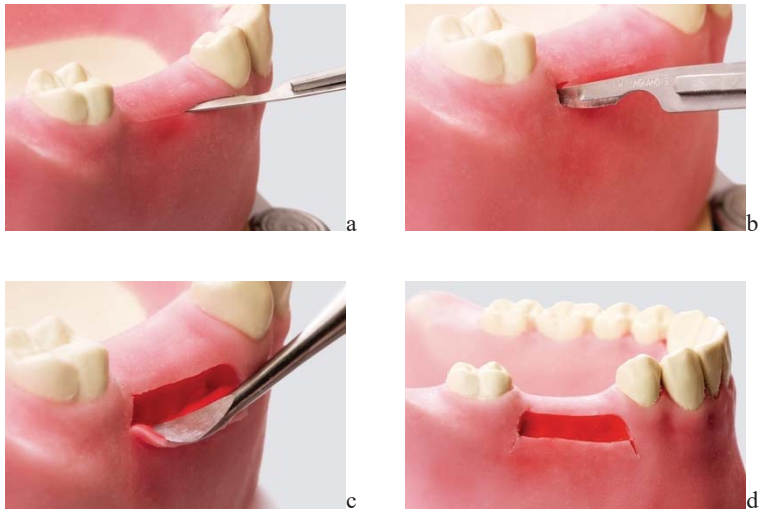


Figure 3.13: Partial thickness incisions (horizontal and vertical). (a-b) A 15C scalpel blade is used. (c-d) Preparation of the recipient site by removing tissue (mucosa) or apical positioning of the flap.

2. Graft delivery and suture

Technique: After preparing the recipient bed, a free gingival graft using autologous donor material or an acellular dermal matrix or a collagen matrix is positioned onto the created bed. Graft stabilization is achieved by means of simple sutures fixing the graft to wound edges of the recipient bed.

Objective: To stabilize the graft and promote healing through revascularization thus gaining keratinized tissue.

Rationale: A tooth or an implant-supported appliance with minimal keratinized tissue is more susceptible to inflammation and recession. In the case of implants, the presence of a suitable strip of keratinized tissue also optimizes comfort.

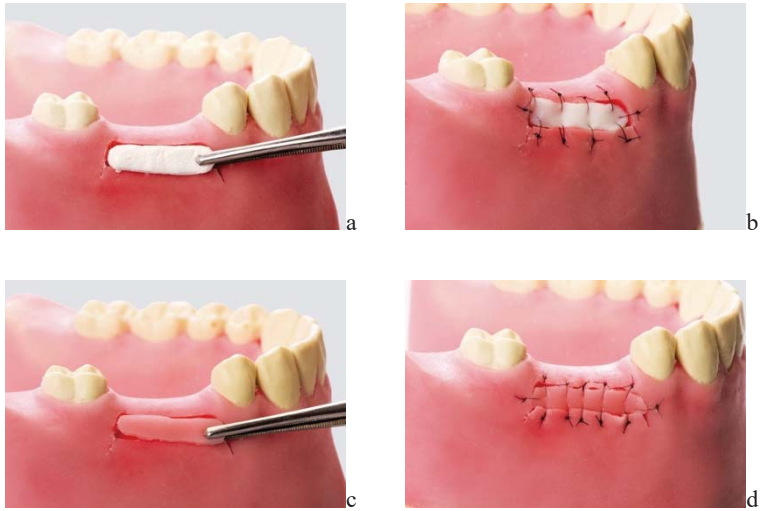


Figure 3.14: (a-b) Porcine collagen matrix being stabilized with simple sutures. (c-d) Free autologous gingival graft stabilized with simple sutures.

SINGLE ROOT COVERAGE TECHNIQUE

1. Preparation of the root surface

Type of graft used: Autologous connective tissue, acellular dermal matrix, or collagen matrix

Technique: Once adequate local anesthesia has been achieved, scaling and root planing are performed (periodontal set burs can also be used for this purpose). Moisture control is important, so gauze swabs may be used when the root surface is conditioned with 24% EDTA gel for two minutes. The surface is then rinsed thoroughly with saline.

Objective: To create a suitable root surface for grafting.

Rationale: Decontamination and removal of the smear layer favor cell adhesion via hemidesmosomes.

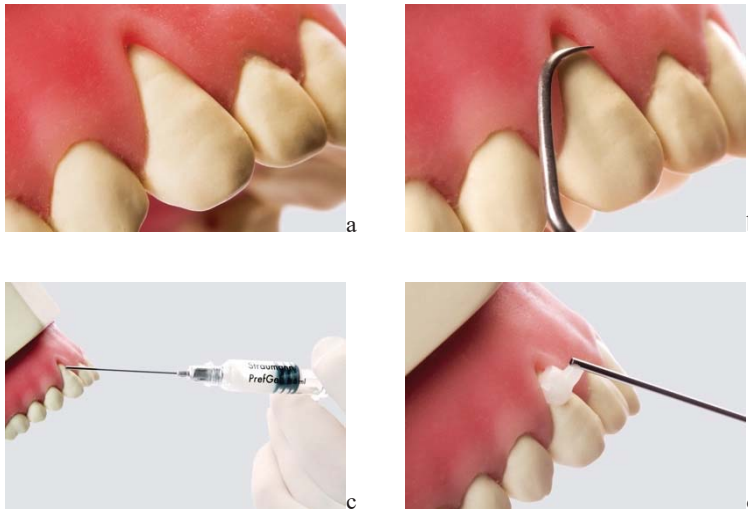


Figure 3.15: (a) Single root recession in the canine. (b) Scaling and root planing with Mini-Gracey curette. (c-d) 24% EDTA gel application for 2 minutes.

2. Incision to obtain a split-thickness flap

Technique: Following local anesthesia, a sulcular incision is performed so as to obtain a split-thickness flap on the buccal aspect until the dissection is past the mucogingival junction. This split flap should ensure that the periosteum of the cortical bone remains covered.

Clinical Tip: In the case of single/or narrow recession defects, a microscalpel blade can greatly facilitate flap separation.

Objective: To create a suitable receptor site (pocket) for the graft.

Rationale: Extending dissection beyond the mucogingival junction reaches the elastic fibers that will allow coronal traction of the gingival margin, which in turn should facilitate graft coverage.

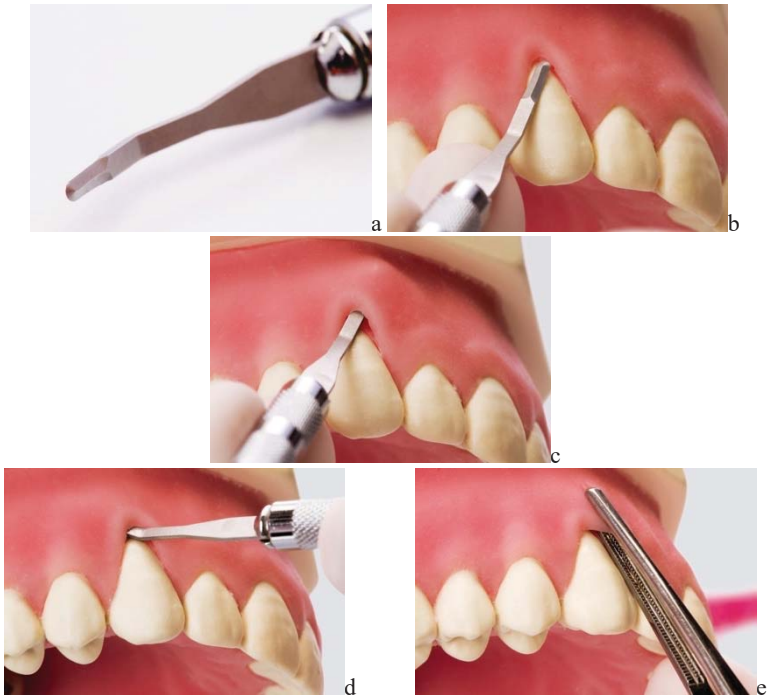


Figure 3.16: (a-b) Microblade 6962 adapted to the scalpel handle and used for the initial sulcular incision. (c-d) Microblade 6962 being used for flap division just over the height of the mucogingival junction. (e) Flap passivity being tested with tissue tweezers.

3. Insertion of the graft and suture

Technique: Once the recipient bed (root) is conditioned, an autologous connective tissue graft (or an acellular dermal matrix or a collagen matrix) is positioned over it. The graft insertion and positioning are carried out using a fine-tip pair of tweezers and supporting instruments. Maintaining the position of the graft is achieved through sutures, which must pass through the gingival margins (positioned as coronally as possible) and the graft itself using suspensory sutures.

Objective: To promote the coronal traction and positioning of the flap, while keeping the donor graft in position.

Rationale: The presence of connective tissue favors tissue stability in the area, thereby increasing its chance of success.

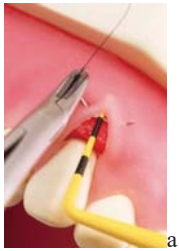

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Figure 3.17: (a) Overview of the needle entry and exit points for the suspensory suture. (b) Finalized brace suture. The knots are placed palatally.

ROOT COVERAGE TECHNIQUE FOR MULTIPLE TEETH

1. Preparation of the root surface

Type of graft used: Connective tissue or acellular dermal matrix or collagen matrix

Technique: Scaling and root planing are performed (periontal set burs can also be used for this purpose). Moisture control is important, so gauze swabs may be used while the root surface is conditioned using 24% EDTA gel for two minutes. The surface is then rinsed thoroughly with saline.

Objective: To create a suitable root surface to receive the graft.

Rationale: Decontamination and removal of the smear layer allows flap adhesion via hemidesmosomes.

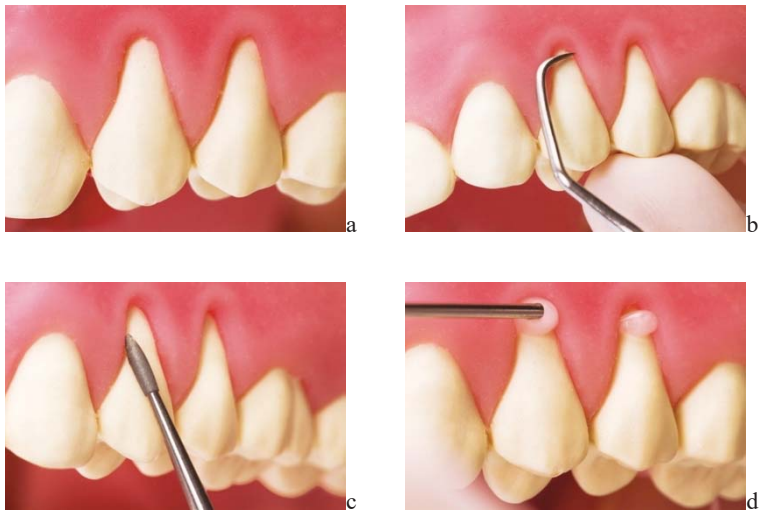


Figure 3.18: (a) Gingival recession on two adjacent teeth. (b) Scaling and root planing using a Mini-Gracey curette. (c) Use of a fine grit diamond bur for polishing and (d) EDTA gel application for 2 minutes.

2. Incision of the interdental papilla

Technique: Once local anesthesia has been achieved, partial oblique incisions are performed in the base of the papillae adjacent to the recession areas. As a result, the papillae should be de-epithelialized.

Objective: To create a surgical papilla that allows flap advancement.

Rationale: As the epithelial tissue is avascular, its removal exposes a well-vascularized bed of connective tissue.

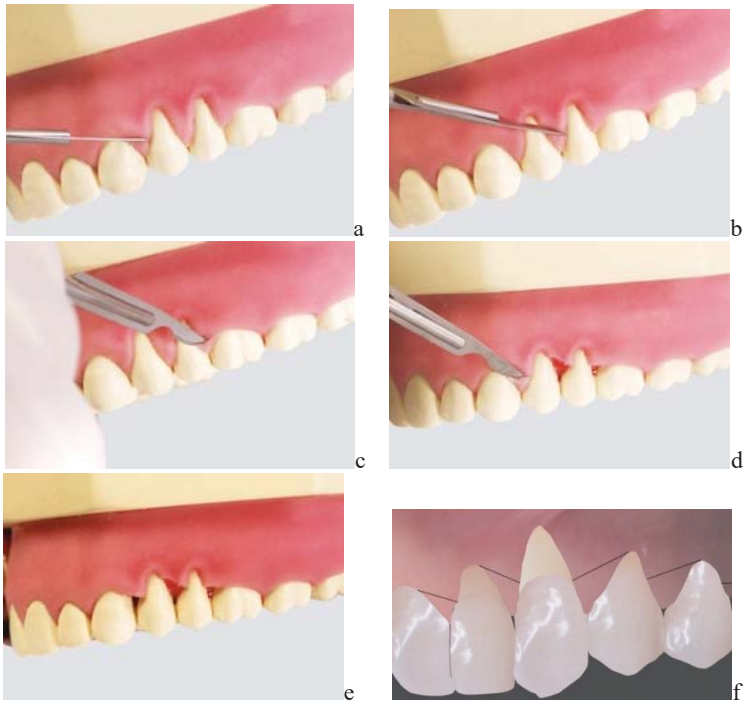


Figure 3.19: (a) Partial oblique incisions at the base of the interdental papillae. (b–c) A 15C scalpel blade or microblade 6962 is used. (d–e) Epithelium removed. (f) Representative sketch of the incisions.

3. Split-thickness flap

Technique: Once the sulcular incisions have been made, a split-thickness flap is prepared buccally, extending beyond the muco-gingival junction but leaving the periosteum attached to the buccal bone plate.

Clinical Tip: By dividing the flap apically beyond the mucogingival junction, it will become more mobile, thus favoring root and graft coverage and the coronal repositioning of the flap.

Objective: To create a suitable recipient site for the graft.

Rationale: A partial thickness flap enables dual blood supply to the graft: one coming from the flap and the other from the periosteum that was left on the bone.

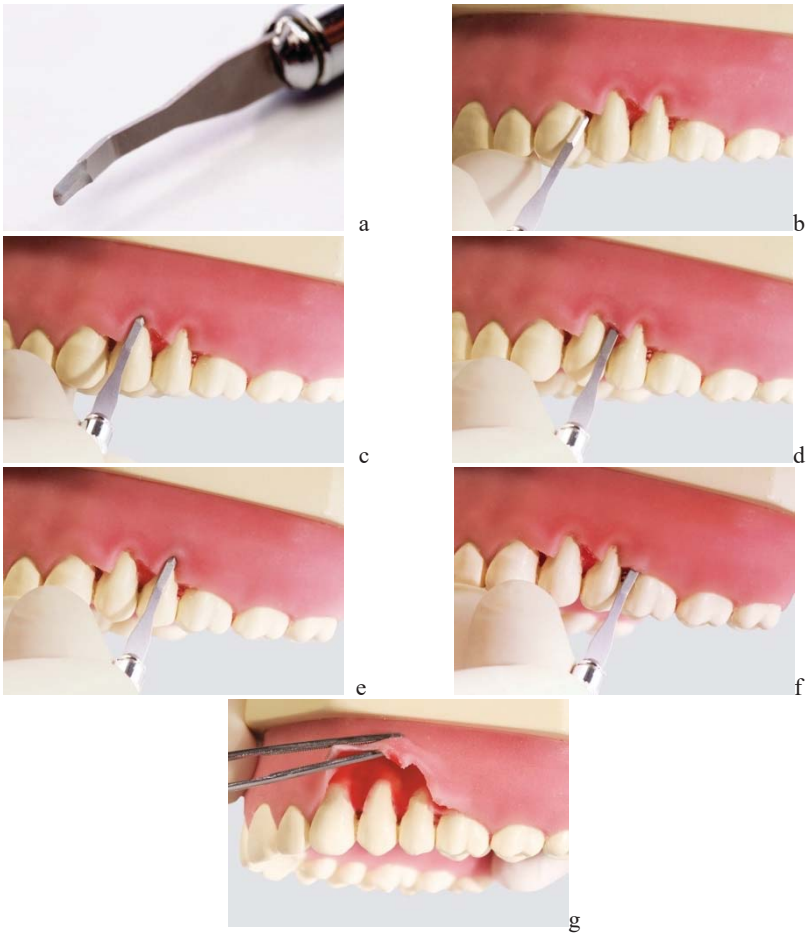


Figure 3.2: (a–f) Partial thickness flap made with a microblade adapted to a scalpel handle at the height of the teeth 23, 24, 25, and 26. (g) Appearance after the flap division.

4. Assessing the need for grafting and suturing the graft

Technique: After ensuring that the flap is freely mobile, the need for a tissue graft should be reassessed. If the indication exists, then the flap should be sutured over the denuded papillae. If grafting proves unnecessary, the edges of the wound should be brought together using single interrupted or suspensory sutures.

Clinical Tip: If the gingival tissue is very thin and/or poor quality (lacking keratinized tissue), a connective tissue graft should be placed into position.

Objective: To increase the thickness and keratinization of the soft tissue.

Rationale: Following the integration of the graft and consequent increase in tissue volume, the recurrence of gingival recession is minimized. The connective tissue graft also favors keratinization by autoinduction.

Figure 3.21: Example of connective tissue graft sutures passed through the previously denuded papillae.

5. Internal vertical mattress sutures

Technique: The re-adaptation of the soft tissue flap should begin with internal vertical mattress sutures (one for each papilla). The needle must pass through the base of the buccal papilla (in the direction of the epithelium-connective tissue) beneath the interdental contact point and through the papilla on the palatal aspect (in the direction of the connective tissue-epithelium). Subsequently, the inverse route should be taken, passing the needle through the tip of the papilla from the epithelium to connective tissue (palatally) and through the connective tissue to the epithelium on the buccal aspect.

Objective: Co-adapt the surgical wound edges and reposition the flap coronally.

Rationale: Internal vertical mattress sutures retain and add stability to the repositioned flap.

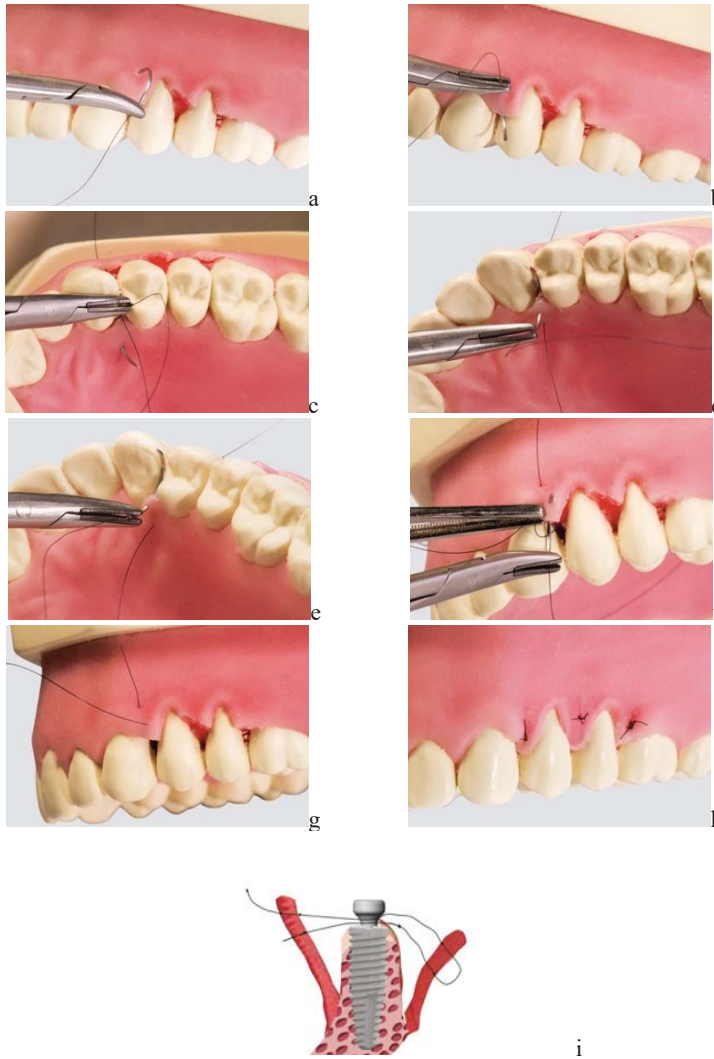


Figure 3.22: (a-b) Needle going through the base of the buccal papilla in the epithelium—connective tissue direction. (c) Needle going through the base of the palatal papilla in the connective tissue—epithelium direction. (d-e) Needle going through the tip of the palatal papilla in the epithelium—connective tissue direction. (f) The needle going through the tip of the buccal papilla in the connective tissue—epithelium direction. (g–h) Finalizing with knots. (i) Representation of the internal vertical mattress sutures used in re-adapting papillae around implants.

6. Suspensory sutures

Technique: Following completion of the sutures in the papillae, a suspensory suture should be placed for each tooth involved in the root coverage procedure. The needle must go through the buccal flap horizontally 4 to 5 mm away from the gingival margin. The suture thread can be pushed through the contact point (similar to passing dental floss) to enable suturing on the palatal aspect.

Clinical Tip: If the contact point is too tight, the suture thread will probably break. In such situations the needle should be used to direct the thread through below the contact point in a manner similar to that of a floss threader.

Objective: To enable coronal positioning of the flap.

Rationale: Suspensory sutures enable anchorage of the gingival flap around the tooth, which helps to maintain the flap in a more coronal position against the tooth and more apically against the buccal flap.

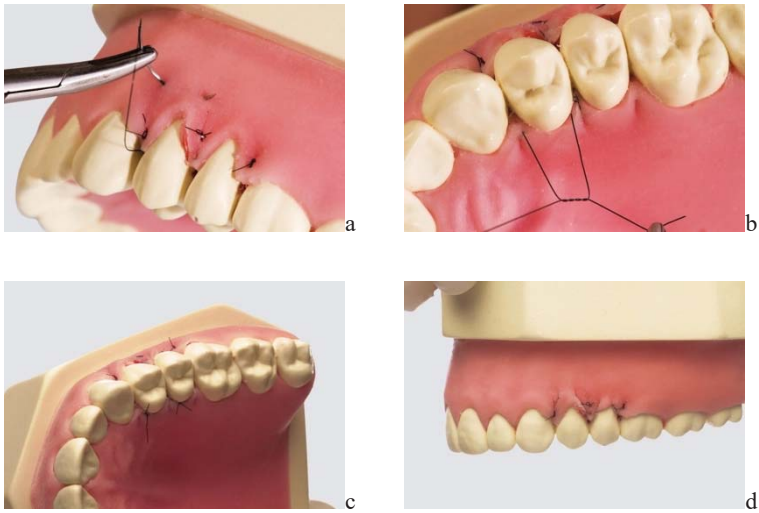


Figure 3.23: (a) The needle is inserted horizontally through the flap buccally, 4 mm from the gingival margin. (b) The suture thread is then taken through the palatal papillae (both mesially and distally) where the knots are tied. (c) Occlusal and (d) frontal views upon completion of the sutures.

RIDGE THICKNESS AUGMENTATION WITH CONNECTIVE TISSUE GRAFT

1. Incision and flat splitting

Type of graft used: Connective tissue.

Technique: Following local anesthetic application, a partial incision is performed (not touching the bone) along the crest of the alveolar ridge, and extending between the remaining teeth, without reaching the base of the papilla (typically 2 mm away, but this distance may vary depending on the gingival phenotype and location within the arch). Subsequently, a split flap (partial thickness) is made on the buccal aspect, extending beyond the mucogingival junction and keeping the periosteum attached to the buccal bone plate. An important factor to remember is that graft size should always be overestimated, since some graft loss/contraction is to be expected during the healing process.

 ***Clinical Tip:*** By dividing the flap beyond the mucogingival junction level, the flap will gain mobility, which favors graft coverage and coronal repositioning.

Objective: To create a suitable recipient bed for the soft tissue.

Rationale: A partial thickness flap enables dual blood supply to the graft: one coming from the flap and another from the periosteum that was left on the bone.

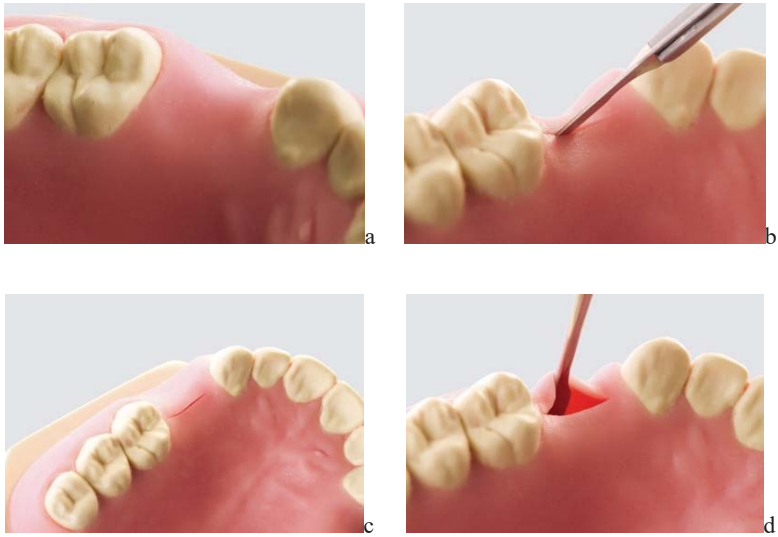


Figure 3.24: Partial incision on the alveolar crest in area where a gain in soft tissue thickness is indicated (Seibert Class 1). (a–b) A scalpel blade 15C is used to create the incision. (c–d) The flap is divided (partial thickness) until just beyond the mucogingival junction.

2. Graft insertion and suturing

Technique: The connective tissue graft is positioned on the recipient bed using tweezers and delicate supporting instruments. Subsequently, a horizontal mattress suture is passed through both the flap and the graft to stabilize the graft. Single interrupted sutures are then placed for primary wound closure.

Clinical Tip: This type of procedure is mostly indicated in situations of bone loss creating a lack of gingival thickness (Seibert Class 1). Cases that demand gains in both thickness and height (e.g., Seibert Class 3) should benefit from a mixed grafting approach (connective + epithelium).

Objective: To increase soft tissue volume, especially in the horizontal direction.

Rationale: Immobilization and stabilization of the graft are essential for volumetric increases in the desired areas.

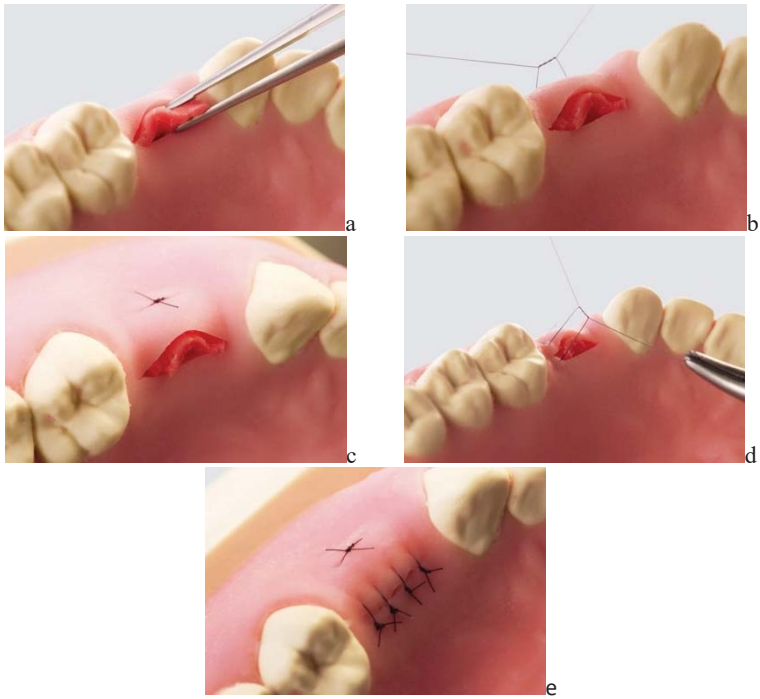


Figure 3.25: (a) The connective tissue graft is positioned within the recipient site. (b–c) Horizontal mattress suture used to stabilize the graft. (d–e) Simple sutures used for primary closure of the surgical wound margins.

ALVEOLAR RIDGE AUGMENTATION USING A MODIFIED ROLL TECHNIQUE

1. Incisions

Type of graft used: Connective tissue

Technique: After local anesthesia is achieved, a partial incision is made (not touching the bone) along the alveolar ridge slightly palatally, thereby preserving the bases of the papillae. Subsequently, a split flap is prepared palatally leaving the epithelium with a thin layer of connective tissue so as to allow a thicker connective tissue layer over the periosteum to a sufficient depth to meet the needs of the recipient bed. Three total incisions (touching the bone) are then performed internally to the palatal flap: one vertical mesially, one vertical distally, and one horizontal apically.

Objective: To create a pedicle which will later be rolled up onto the buccal aspect.

Rationale: Internal incisions will allow graft harvesting from an area very close to the recipient bed, which minimizes postoperative morbidity.

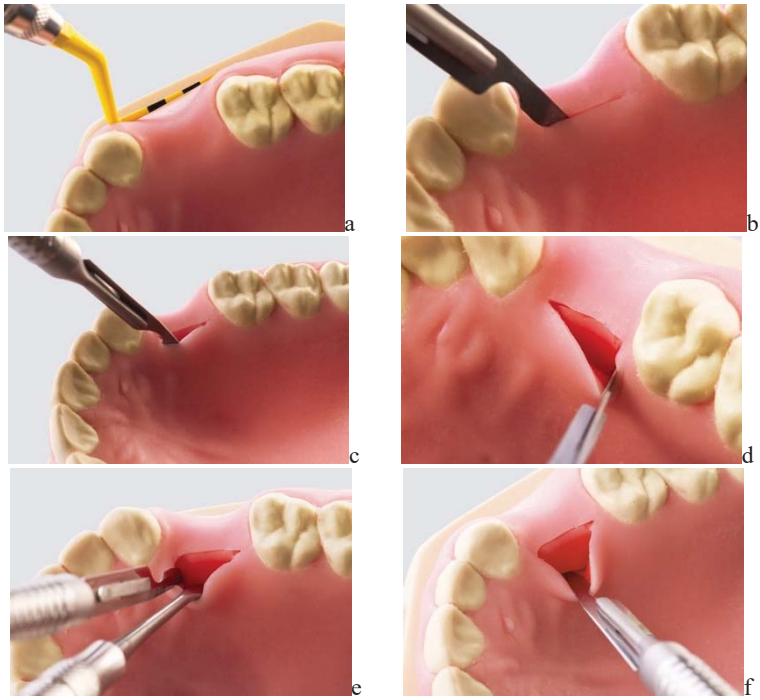


Figure 3.26: Partial incision on the crest in a site where a gain in soft tissue thickness is needed (Seibert Class 1). (a–b) A 15C scalpel blade is used. (c) Flap division on the palatal aspect. (d–f) Three incisions to bone are made inside the flap: 1 vertical mesially, 1 vertical distally, and 1 horizontal apically.

2. Graft detachment and "rolling"

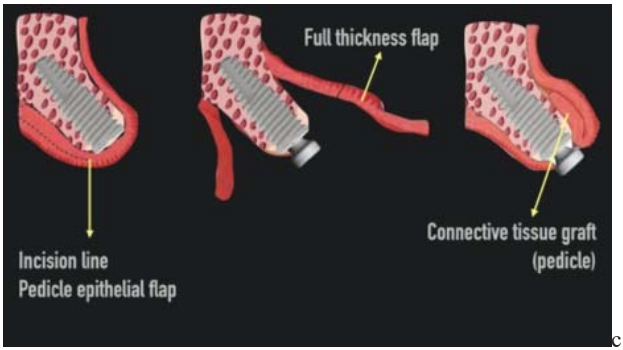
Technique: After the completion of the incisions, both the connective tissue graft and the recipient bed buccally are raised using a periosteal elevator. The pedicled graft is then rolled under the buccal flap, increasing volume on the buccal aspect.

Objective: To gain tissue volume (thickness) using a pedicled graft.

Rationale: Keeping the graft pedicled maintains vascularization to the graft keeping it vital and optimizing healing.


a


b



c

Figure 3.27: (a) Maintaining the pedicled graft attached to the buccal flap maintains blood supply, thus vitality to the graft. (b) Soft tissue graft folded in buccally. (c) Diagrammatic illustration of the "modified roll" technique.

3. Sutures

Technique: After positioning the graft, horizontal mattress sutures are placed into position, which must pass through both the flap and the graft in order to stabilize them. Simple sutures are subsequently placed to allow for primary closure of the wound edges.

Objective: To immobilize the graft and reapproximate the edges of the surgical wound.

Rationale: Graft immobilization allows volumetric increase in the required areas and readapting the wound edges will encourage healing by primary intention.

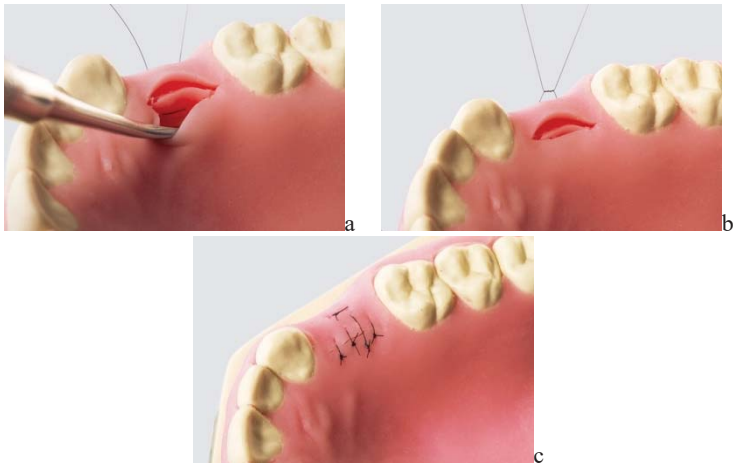


Figure 3.28: (a–b) Horizontal mattress suture fixing the graft against the flap. (c) Simple interrupted sutures securing the edges of the wound.

ALVEOLAR RIDGE AUGMENTATION IN BOTH THICKNESS AND HEIGHT USING A MIXED GRAFT

1. Incision and flap splitting

Type of graft used: Mixed

Technique: Following local anesthesia, a split thickness incision is performed (not touching the bone) at the crest of the alveolar ridge, which is extended between the remaining teeth, keeping the bases of the papillae. Subsequently, the flap is divided on the buccal aspect. This flap should be designed as split-thickness, keeping the periosteum attached to the bone plate and extended apically beyond the muco-gingival junction.

Clinical Tip: By dividing the flap beyond the mucogingival junction, flap mobility is increased, which favors graft coverage and coronal repositioning.

Objective: To create a suitable recipient bed for the soft tissue graft.

Rationale: A partial thickness flap promotes dual blood supply to the graft, one coming from the submucosal layer of the flap and the other from the periosteum that was left attached to the bone.

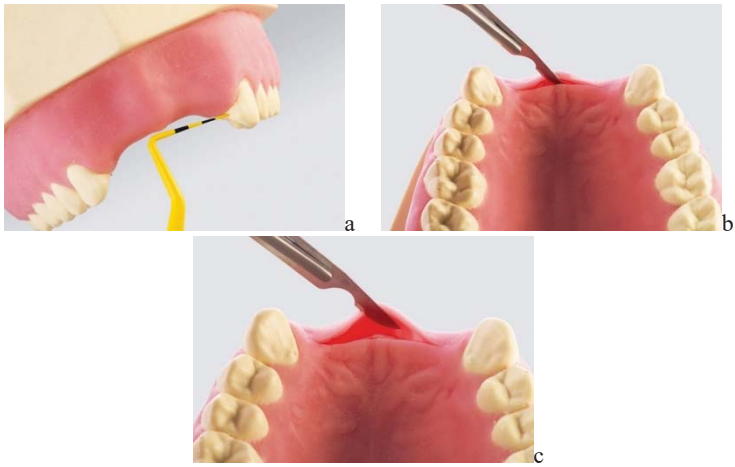


Figure 3.29: A partial incision on the crest where alveolar height and thickness gains are needed (Seibert Class 3). (a–b) A 15C scalpel blade is used. (c) The flap is divided until just beyond the mucogingival junction.

2. Graft insertion and sutures

Technique: The mixed graft is positioned so that the connective tissue portion is inserted into the buccal pouch created by the split thickness incision and the epithelial lining should remain exposed superficially at the level of the incision. Once the graft is positioned, a horizontal mattress suture is passed through both the flap and the graft to stabilize the graft. Primary wound closure is achieved using simple interrupted sutures to close the edges of the incision and to gain primary closure over the graft.

Clinical Tip: This specific grafting procedure is often indicated to create an adequate volume of soft tissue to enable appropriate coverage of a future bone graft and the impact this grafting technique has on gingival esthetics is clearly observable.

Objective: To increase soft tissue volume both horizontally and vertically.

Rationale: Graft immobilization optimizes volumetric gain in the deficient area.

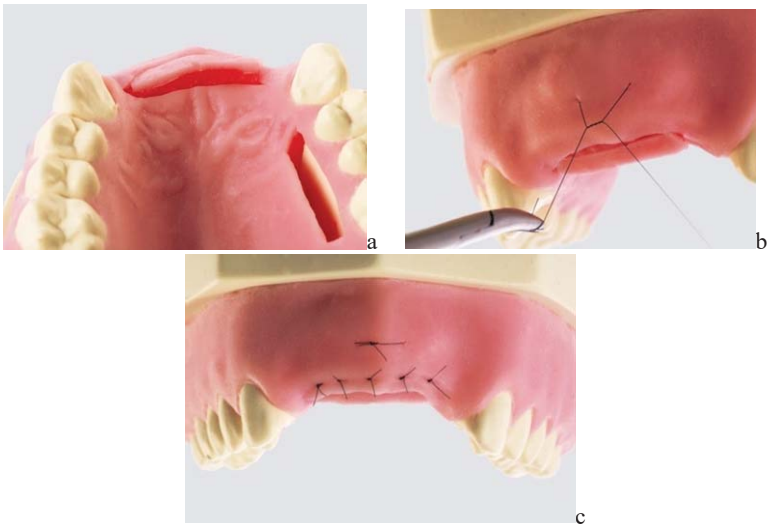


Figure 3.30: (a) The mixed graft is positioned in the recipient site, with its connective component inwards and the epithelial component towards the surface. (b) A horizontal mattress suture is used to stabilize the graft. (c) Single auxiliary sutures.

RESECTIVE TECHNIQUES

Resective management of soft tissue

Introduction

In situations where there is excess tissue volume, either around the teeth or around the implants, resective techniques should be considered if the excess tissue has a negative impact on esthetic and/or biological stability. In such scenarios and when a resective surgical procedure is planned, the surgeon must respect the concept of biological width and the adverse clinical outcomes when it is violated. Based on these biological principles, it is imperative to assess the benefits gained from performing a bone resective procedure. Once the decision is made to perform a resective procedure, the second decision is whether the resection should involve soft tissue alone or whether it should be extended to include hard tissue removal. This second decision is made based on the need for approximately 3 mm of distance between the gingival margin (thickness of soft tissue) and the bone crest.

TECHNIQUE FOR CLINICAL CROWN LENGTHENING WITHOUT BONE REMOVAL

1. Diagnosis

Technique: Following local anesthesia, a periodontal probe is placed into the gingival sulcus (buccal face) until it touches the bone crest. Periodontal probing of the sulcus is also the standard maneuver to determine the height of the cementoenamel junction. Subsequently, Chu's esthetic gauges are used to assess whether there is harmony between height and width of the crown. Such measurements should be performed on all teeth in the esthetic region (usually from 15–25).

 ***Clinical Tip:*** As the biological width on average is 2.5 mm, if probing detects the cementoenamel junction at 2.5 mm from the alveolar bone crest, surgery can be performed without an osteotomy (removal of bone).

Objective: The use of a periodontal probe allows a risk assessment of both root exposure and the need for an osteotomy.

Rationale: The patient must be advised in advanced of performing the surgery of need for an osteotomy and/or the risk of postoperative root exposure (which in turn demands prosthetic intervention to prevent dentinal sensitivity.

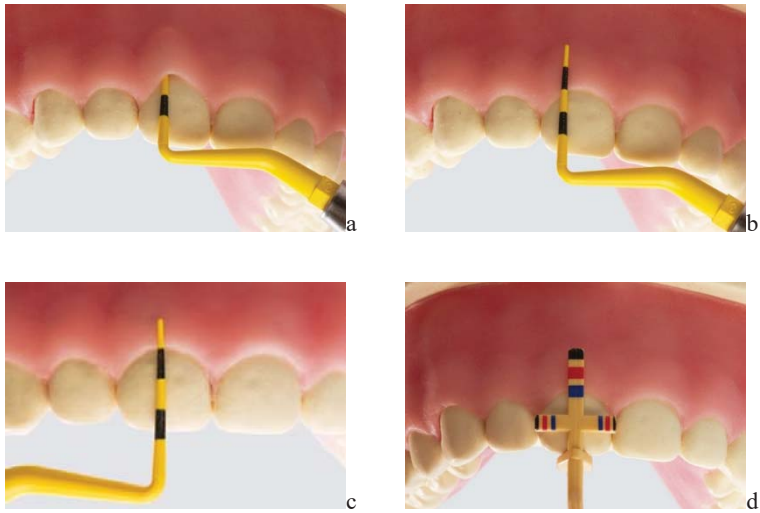


Figure 3.31: (a) Bone probing showing 6 mm between the buccal bone crest and the gingival margin. (b) The probing depth can be visualized by a probe, which is placed externally. (c) In this situation, probing the cementoenamel junction showed that it was located 3mm subgingivally. (d) The use of a Chu calibrator shows that the width (beginning of the black band) does not match the height of the crown (the end of the blue band). Ideally, the height should also be located at the beginning of the black band.

2. Demarcation and incisions

Technique: A periodontal probe is used to demarcate the location of the cementoenamel junction by puncturing through the gingival tissue, based on previous probing measurements. The probe must be pressed at a right angle against the gingival tissue until it is pierced through. Inverted bevel incisions are subsequently performed along the demarcation line, followed by intrasulcular incisions. This step should be repeated for all teeth involved in the esthetic region.

Objective: To remove excess gingival tissue at the cementoenamel junction level.

Rationale: The inverted bevel incision allows gingival resection with concomitant flap thinning. This is important because a tapered gingival margin is ideal from an esthetic point of view.

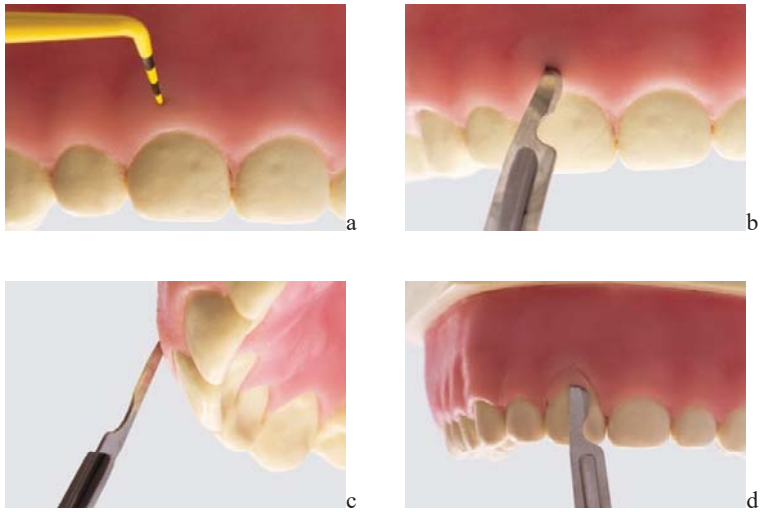


Figure 3.32: (a) Demarcation of the cementoenamel junction height using a periodontal probe. Reverse beveled incision. (b–c) Note the positioning of the 15C scalpel blade at 45 degrees. (d) Sulcular incision to facilitate removal of the gingival marginal "cuffs". Note the positioning of the 15C scalpel blade parallel to the long axis of the tooth.

3. Removal of gingival "collars"

Technique: Upon completion of the incisions, a periodontal curette is used to remove the resulting "collars" of excess gingival tissue. This should be performed on all teeth selected for clinical crown lengthening.

Objective: Remove the gingival tissue at the level of the cementoenamel junction.

Rationale: The use of a periodontal curette allows pressure to be placed against the hard tooth surface, which, combined with traction movements, allow the removal of excess gingival tissue with precision (provided the depths of the incisions were adequately made).

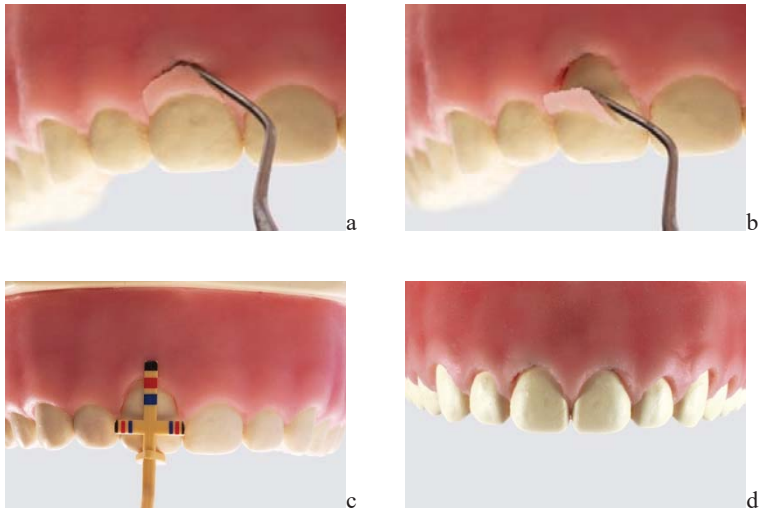


Figure 3.33: (a) Removal of the gingival "cuffs" with a periodontal curette. (b) Appearance after the removal of the cuffs from tooth 11. (c) Note that, in spite of the optimal gingival removal of marginal gingival tissue (up to the cementoenamel junction), the black mark on the probe was not reached. Should this happen, tooth restoration is essential (possibly veneers) to manage the potential for root exposure. (d) Appearance after clinical crown lengthening of the maxillary anterior teeth.

TECHNIQUE FOR CLINICAL CROWN LENGTHENING WITH BONE REMOVAL (OSTEOTOMY)

This adds a fourth step to the previously described technique, “clinical crown lengthening without bone removal” (Steps 1, 2, and 3 are the same).

4. Flap detachment and osteotomy

Technique: After removing all “collars” of gingiva, a full thickness flap is elevated to allow an osteotomy of the buccal bone crests with a chisel or a piezo unit.

Clinical Tip: If the use of burs is not necessary to remove large bony outgrowths, as a microflap can be reflected without needing to incise the interdental papillae and consequently sparing the need for sutures.

Objective: To respect the dimensions of the biological width.

Rationale: An osteotomy allows the maintenance of an adequate biological space as it prevents recurrence of the clinically short crown due to an excessive bone structure.


a


b

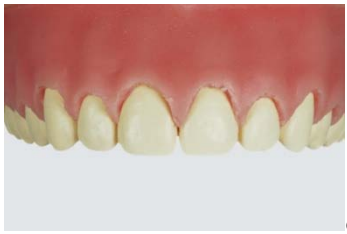

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Figure 3.34: (a–b) Use of a Fedi chisel for a buccal osteotomy. (c) Appearance after clinical crown lengthening of the upper anterior teeth with osteotomy.

TECHNIQUES FOR THE EXPOSURE OF IMPLANTS (SECOND-STAGE IMPLANT SURGERY)

Introduction

Surgical procedures for accessing implants are only necessary in situations where the implant (with its respective cover screw) is buried under the soft tissue. Prior to exposing the implant, one should assess whether there is adequate soft tissue volume adjacent to the implant. If there is insufficient volume or poor quality, consideration should be given to augmenting the soft tissues with the surgical exposure of the implant.

TECHNIQUES TO EXPOSE IMPLANTS

Two surgical techniques have been used for exposure of buried implants: using the circular scalpel and the open flap technique.

Implant exposure (Stage 2) technique using the circular scalpel: Tissue punch (This technique should only be used when there is sufficient width of keratinized gingiva covering the alveolar ridge.)

1. Demarcation and incision

Technique: Once adequate anesthesia has been achieved, a periodontal probe is used to identify the location of the implant cover screw. The probe pierces the soft tissue and presses until the tip touches the cover screw. Tactile sensitivity should allow relative accuracy in pinpointing implant/cover screw location. A circular scalpel/tissue punch is then positioned, pressed, and rotated to incise through the soft tissue.

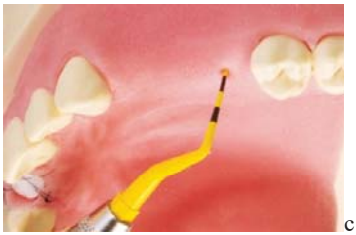
Clinical Tip: Implant reopening aided by a tissue punch can only be considered when good quantity and quality of soft tissue is available. Otherwise, it may risk creating an esthetic problem.

Objective: Using a circular scalpel allows implant access quickly and atraumatically.

Rationale: The use of a circular scalpel requires no surgical flap. It is, however, essential to locate the cover screw accurately with a periodontal probe to avoid the risk of removing soft tissue outside the cover screw perimeter.


a


b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e


f

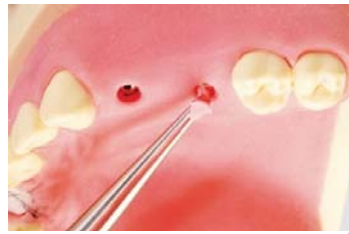
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Figure 3.35: (a) Circular scalpel and periodontal probe used for reopening. (b–c) Use of periodontal probe to locate the cover screw. (d–e) Tip of the circular scalpel being adapted to cover screw hexagon. (f) With rotation movements, the gingival tissue is removed. (g) Note that the gingival tissue will not always stay inside the circular scalpel and, in such cases, the excised tissue should be removed with tweezers.

2. Adaptation of healing abutments

Technique: Once the gingival tissue has been removed exposing the implant, the cover screw is removed, the healing abutment is installed.

Objective: To maintain the soft tissue open channel giving access to the implant.

Rationale: Install a healing abutment at the gingival level or supra-gingivally enabling soft tissues to heal without closing the access to the implant. This greatly facilitates the future installation of definitive abutments and crowns when progressing with implant rehabilitation.

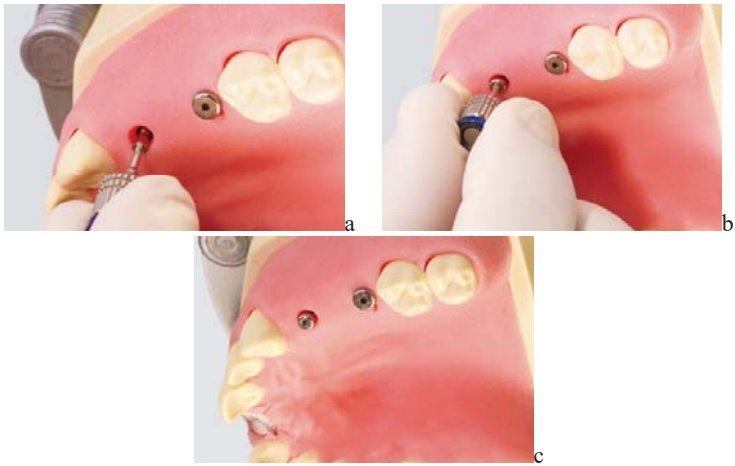

Figure 3.36: (a–c) Cover screw removal and healing abutments fitted, using a 1.2-mm manual driver.

Implant exposure (Stage 2) technique using the open flap technique to expose a buried implant (reopening via the management of the inter-implant papilla).

1. Preliminary incision: Flap design

Technique: Once local anesthesia has been achieved, a small distal releasing incision and a crestal incision are made, extending to the distal aspect of the most anterior tooth. The extent of the incision is based on the need to increase papillary height.

Clinical Tip: The incisions must be full thickness (touching the bone). Verification of the incisions may be performed using a periosteal dissector.

Objective: Full incisions allow full-thickness flap detachment.

Rationale: Full thickness incisions permit subsequent mucoperiosteal flap detachment, granting access to bone, which is desirable for cover screw access.

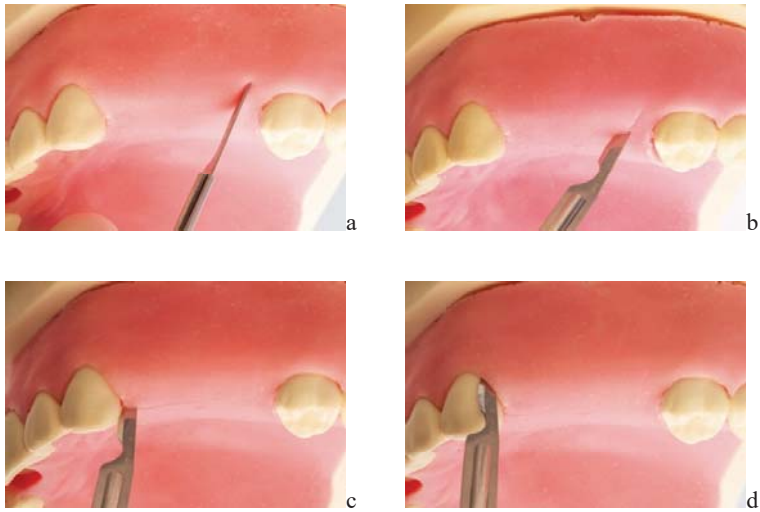

Figure 3.37: (a–b) Using a 15C scalpel blade to perform a short releasing incision distally, followed by the crestal incision. (c–d) Finishing the incision on the crest and, finally, sulcular incision around the more anterior tooth.

2. Flap detachment and adaptation of healing abutments

Technique: After the completion of the incisions, full-thickness flap is raised. The cover screw can be removed, and a healing abutment installed over each implant.

Clinical Tip: Flap raising may be greatly facilitated if performed from anterior to posterior.

Objective: To obtain adequate access to bone and the implant platform. Healing abutments maintain an opening for access to the implants through soft tissue.

Rationale: Installation of a healing abutment at the gingival level or supra-gingivally enables healing of the soft tissues without closing access to the implant, thus allowing the future installation of an abutment and rehabilitation.

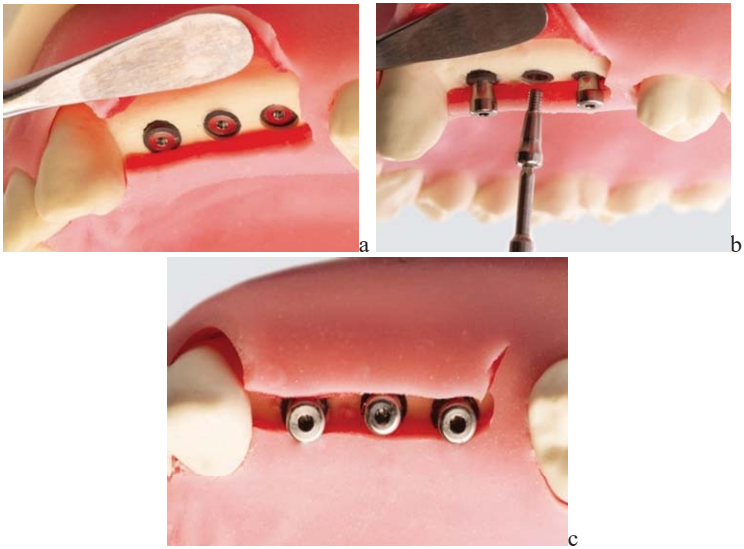

Figure 3.38: (a) Full flap detachment completion. (b–c) After re-opening, the cover screw is removed, and a healing abutment is fitted for each implant.

3. Tissue manipulation and suturing

Technique: After adapting the healing abutments, semicircular incisions are made around each implant pedicle created are turned towards the inter-implant spaces and between the tooth and implant.

Objective: To create the appearance of interdental papillae by rotating the pedicles into the inter-implant spaces.

Rationale: The pedicles permit soft tissue augmentation between implants and between tooth and implant, thereby improving gingival contours, thickness, and esthetics.

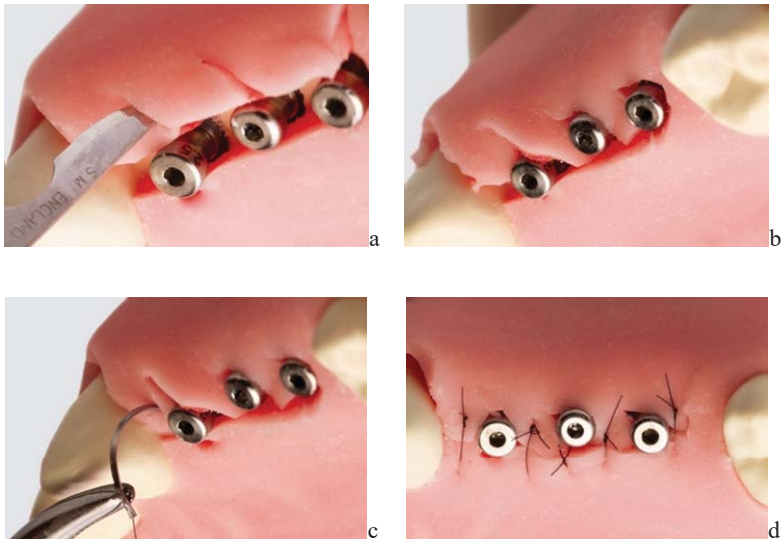

Figure 3.39: (a) Design and (b) rotation of the pedicles to the inter-implant areas as well as between the tooth and implant. (c–d) Sutures stabilizing the pedicles in the inter-implant areas as well as between the tooth and implant.

CHAPTER 4

ALVEOLAR RIDGE RECONSTRUCTION

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André Antonio Pelegrine

INTRODUCTION

The need for alveolar bone reconstruction prior to implant placement represents a major challenge for the surgical team. Autologous bone is the gold-standard as donor material due to its biologic properties. The donor site of the autograft can be from an intraoral site (mandibular ramus, chin, tuberosity, etc.) or extra-oral site (tibia, iliac bone, skullcap, etc.). Extra-oral donor sites are not in the scope of this work, but the main intra-oral donor sites (e.g., mandibular ramus and chin) are described. As autologous bone grafting may reflect high levels of postoperative morbidity, bone substitute biomaterials have developed, including xenogeneic (animal), allogenic (human), and alloplastic (synthetic). Therefore, the use of bone substitutes is also cited in this chapter.

The focus of this chapter is appositional bone reconstructions. Interpositional grafts are discussed in Chapter 5. For appositional vertical bone augmentation, the use of autografts is mandatory, but for horizontal bone augmentation the indication of the graft material may vary. Therefore, to make an adequate choice in horizontal bone augmentation, the following classification is suggested by the authors of this book.

Table: Horizontal alveolar change (HAC) classification

Classification	Amount of alveolar horizontal loss	Surgical approach (stages)	Presence of cancellous bone	Imperative need of autogenous graft or bone inductive proteins/live cell transplant	Material for augmentation	Maxilla aspect on CT	Mandible aspect on CT
HAC1	Small	Single	Yes	No	No		
HAC2	Small	Single	Yes	No	Osseoconductive biomatrial		
HAC3	Moderate	Two	Yes	No	Osseoconductive biomatrial		
HAC4	Large	Two	No	Yes	Autogenous or biomaterial with bone inductive proteins/live cell transplant		

Source: Pelegrine, AA, Romito, G, Villar, CC, Macedo, LGS, Teixeira, ML, Aloise, AC, and Moy, PK. Horizontal bone reconstruction on sites with different amounts of native bone: a retrospective study. Braz. Oral Res. 2018;32:e21. (Reprinted with permission)

Regardless of the graft material source, various surgical techniques have been proposed to recover lost bone tissue. Two major reconstructive techniques are strongly reported in the scientific literature: the use of bone blocks and the use of particulate bone grafts (usually coated with membranes). Coverage membranes prevent interference from adjacent soft tissue cells, thereby maximizing bone reconstruction, which is known as guided bone regeneration (GBR).

In this chapter, we will discuss the techniques for alveolar reconstruction with bone blocks or bone particles associated with GBR, which can be combined with a novel device designed for appositional bone augmentation purposes (Barbell Technique™). It is important to state that, when using the non-structured particulate bone grafts for appositional bone reconstruction, the usage of an inner structure, such as the Barbell Technique™ approach or a coverage with a reinforced barrier membrane, is desirable in the majority of cases. In this chapter, the Barbell Technique™ was selected for this purpose because it allows the use of a resorbable non rigid membrane, which is related with lower levels of complications when compared with non-resorbable membranes.

ALVEOLAR RIDGE AUGMENTATION USING BONE BLOCKS

1. Incision

Technique: Once adequate local anesthesia has been achieved, the surgical procedure begins with intrasulcular incisions around the teeth adjacent to the bone defect. Subsequently, a straight incision is made on the bony ridge, covering the distance between two adjacent teeth to the defect. Finally, a vertical releasing incision is performed distobuccally on the adjacent teeth extending beyond the muco-gingival junction. Confirmation of the incisions may be ascertained using a periosteal dissector.

 ***Clinical Tip:*** All incisions must “touch” the bone to allow detachment of a mucoperiosteal flap. Partial incisions hamper flap detachment and may contribute to lacerations.

Objective: To allow adequate flap detachment.

Rationale: Improperly executed incisions may result in difficulties raising the flap.

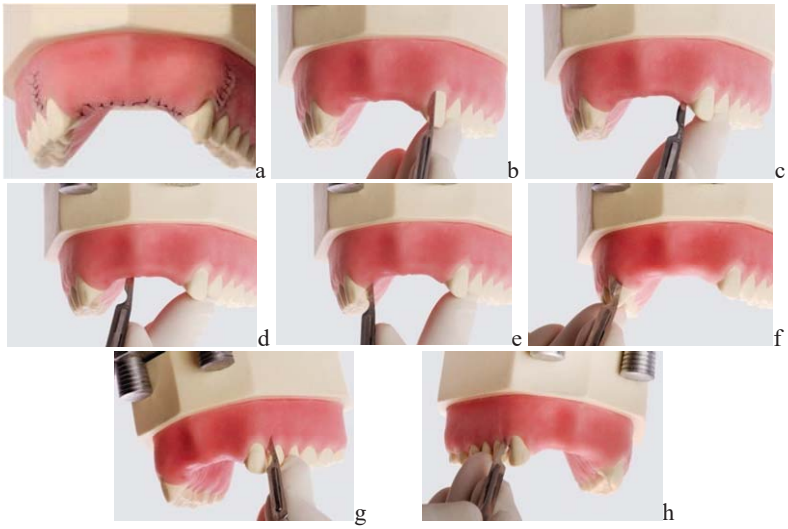


Figure 4.1: Bone loss in thickness (a). Sulcular incision in the tooth 23 (b). Beginning of incision on the crest (c). Extending the incision (d). Completion of the incision on the crest (e). Sulcular incision in the tooth 13 (f). Releasing the vertical incision involving the tooth 23 (g). Relieving the vertical incision involving the tooth 13 (h).

2. Flap detachment

Technique: A periosteal elevator is used to detach and raise the flap upon completion of the incisions. A piezo can also be used for this purpose (tip insert #SLTV-O, CVDentus).

Clinical Tip: Flap detachment must be initiated from the incision made on the bone crest as close as possible to the two teeth adjacent to the defect. This creates a detachment line that facilitates raising a full thickness flap.

Objective: Obtain adequate access to the bony defect in order to shape and fixate the bone blocks.

Rationale: Inadequate access may hinder subsequent surgical maneuvers and often results in lacerations or tearing soft tissue, which compromises the blood supply, placement of sutures, and esthetics.

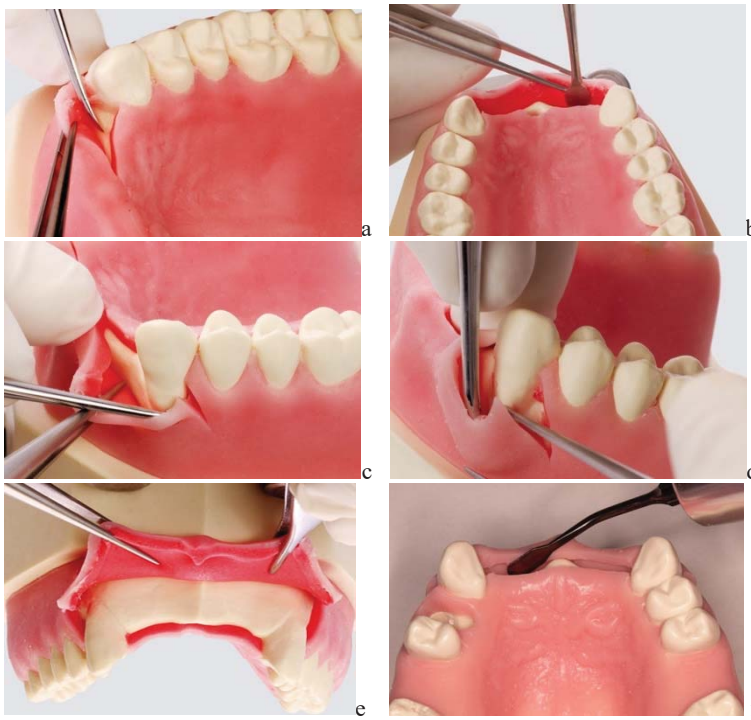


Figure 4.2: Beginning of gingival detachment around tooth 23 (a). Detachment of the anterior portion (b). Detachment around the releasing incision on the left side (c). Detachment around the releasing incision on the right side (d). Completion of flap elevation for surgical access (e). Detachment performed with piezo tip (f).

3. Decortication

Technique: The recipient site should be perforated in several places (decortication). This step can be accomplished either by using a surgical angulated handpiece (1:2 at 28000 rpm) or a contra-angle (20:1 at 1000 rpm) on an electric motor, but always under copious irrigation. A piezo can also be used for this purpose (tip insert #SR2, CVDentus).

Clinical Tip: For decortication, a spherical bur of small diameter, a spherical insert for piezo, or a thin spear point drill are recommended.

Objective: The creation of perforation holes in the cortical bone leads to greater chances of success for the bone grafting procedure.

Rationale: The perforation holes in the cortical bone allow the exposure of the bone marrow to enhance the nutrition of the grafting material.

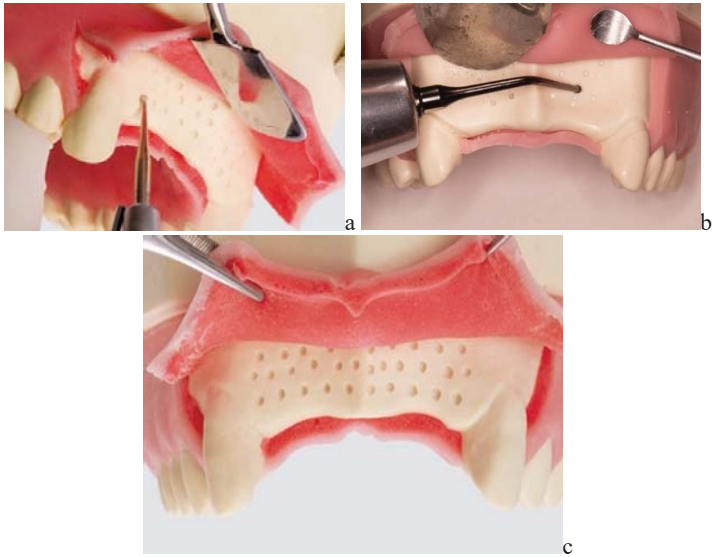


Figure 4.3: Decortication using a round bur (a). Decortication performed with piezo (b). Appearance after decortication (c).

4. Bone block shaping and adaptation

Technique: Once the block has been obtained (using autologous or bone substitute biomaterial), it is trimmed and sculpted into shape to optimize fit and close adaptation to the bony defect. For this purpose, diamond discs and laminated or diamond burs are used (28,000 rpm with a 1:2 surgical angled handpiece)—always under copious saline irrigation to shape the donor material.

Clinical Tip: A grasping forceps should be used to hold the block for cutting and shaping.

Objective: Close adaptation and stabilization of the donor block to the recipient bed increases the success rates of bone grafting procedures.

Rationale: Correct adaptation of the blocks minimizes the size of any gaps between donor material and recipient bed, allowing greater contact between them and, consequently, improved revascularization of the grafting material.

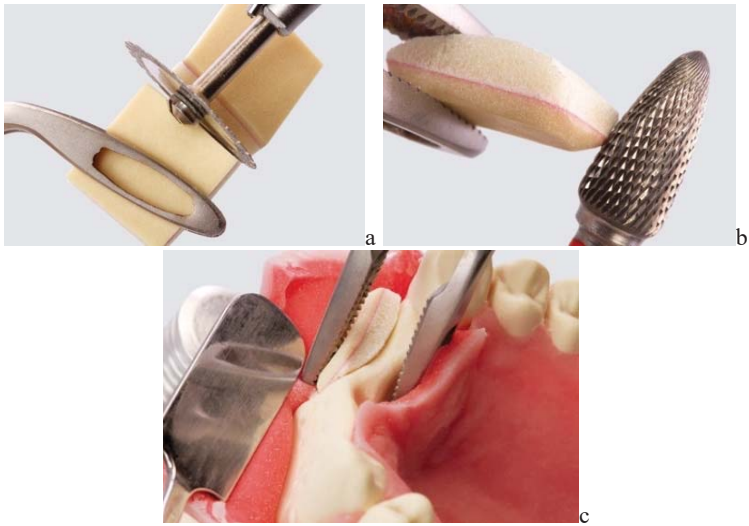


Figure 4.4: Block being shaped using a diamond disc (a). Block being shaped using a resin cutting bur (b). Block being adapted to the recipient bed (c).

5. Fixation of the block graft

Technique: Keeping the block in contact with the recipient bed using an Arnhold forceps, a perforation is made through the block and the recipient bed simultaneously in order to deliver stabilization or fixation screws. The drill used is selected based on the diameter of the fixation screw being used (1.5 or 2.0 mm). Drilling is carried out using the 20:1 contra-angle on an electric motor at a speed of 200 rpm and constant irrigation. The required number of screws per block depends on the size and accuracy of fit with the donor block against the defect. The fixation screw can be placed using a contra-angle at 30 rpm or inserted manually.

Objective: To stabilize the block graft in place.

Rationale: Block graft micromovements may result in fibrosis (formation of fibrous tissue during healing rather than bone tissue), which will lead to the failure of the graft.

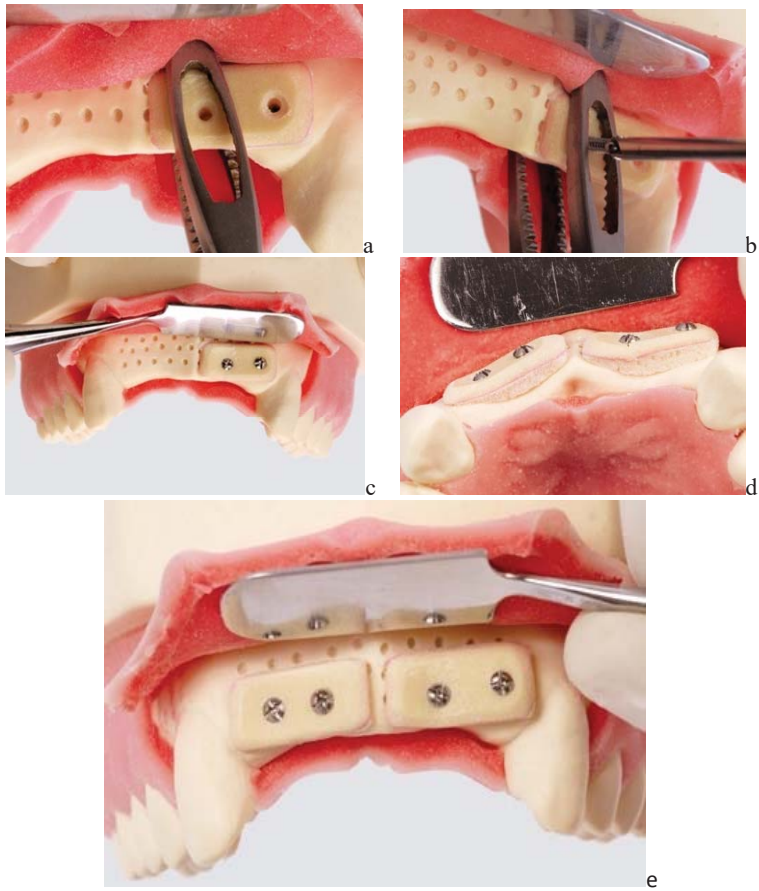


Figure 4.5: Blocks being adapted to the recipient bed (a). Block being fixed to the recipient bed (b). Completion of fixation of block to the recipient site (c). Two blocks adapted to the recipient bed (d–e).

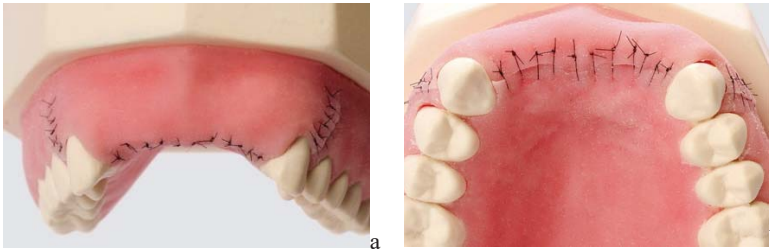
6. Suture

Technique: Closure of the surgical wound can be achieved through single interrupted sutures and horizontal mattress sutures. Normally, 4-0 or 5-0 sutures can be used.

💡***Clinical Tip:*** Keeping the knots off the surgical wound minimizes biofilm accumulation on the incision line.

Objective: To encourage healing by primary intention.

Rationale: Adequate re-approximation of the edges of the wound optimizes healing. The use of monofilament sutures also minimizes bacterial build-up.



a b

Figure 4.6: Completion of the suturing using single interrupted sutures. Frontal view (a). Occlusal view (b).

ALVEOLAR RIDGE AUGMENTATION USING GUIDED BONE REGENERATION (GBR)

1. Incision

Technique: Once local anesthesia has been achieved, the surgical procedure starts with intrasulcular incisions around the teeth adjacent to the bony defect. Subsequently, a straight incision is made along the alveolar ridge covering the distance between the two teeth adjacent to the defect. If necessary, for better access, the incisions can be extended via two releasing incisions created on the distal aspects of the adjacent teeth.

Clinical Tip: All incisions should "contact" the bone to allow full thickness mucoperiosteal flap detachment. Partial thickness incisions may hamper flap elevation and contribute to lacerations in the soft tissue flap.

Objective: To allow proper flap elevation.

Rationale: Inadequate incisions may result in greater difficulties with elevation of the flap.

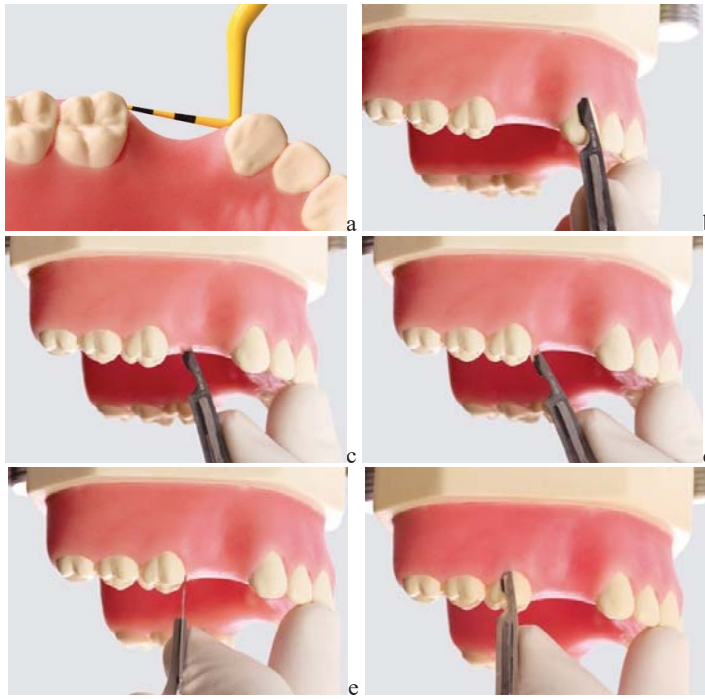


Figure 4.7: Buccal bone thickness loss (a). Sulcular incision around tooth 13 (b). Incision along the bone crest (c). Completion of the incision along the crest (d). Sulcular incision around tooth 16 (e). Sulcular incision around tooth 16 (f).

2. Flap dissection and elevation

Technique: Once the incisions have been completed, flap elevation should begin with the use of a periosteal elevator. A piezo tip can also be used for this purpose (insert #SLTV-O, CVDentus). The dissection must be initiated from the intrasulcular incision, distally to the most anterior tooth adjacent to the defect. This forms a plane that facilitates the elevation of a full thickness flap.

Objective: Obtain adequate access to the bony defect in order to adapt the graft material and use an occlusive membrane.

Rationale: Inadequate access may hinder surgical performance, limit visibility, and often result in soft tissue lacerations, thereby affecting vascular blood flow resulting in wound dehiscence.

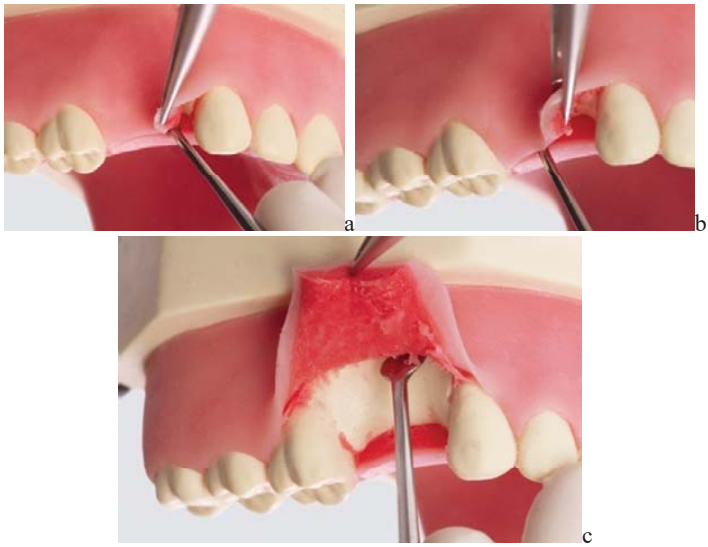


Figure 4.8: Beginning flap reflection in the intrasulcular space of tooth 13 (a). Dissection continued posteriorly (b). Completion of flap elevation with full surgical access (c).

3. Decortication

Technique: Once the recipient bed has been accessed, several perforations should be made into the cortical bone (decortication). This step can be accomplished by using a surgical handpiece, a contra-angle on an electric motor, or with a piezo (insert #SR2, CVDentus).

Clinical Tip: Decortication is best performed using spherical bur of small diameter or a thin spear point drill mounted either on an angled handpiece or a contra-angle.

Objective: Perforations into the cortical bone increase the chances of success of bone grafting procedures.

Rationale: Perforations made in the cortical bone exposes the bone marrow and bleeding points, bringing nutrition to the grafting material.


a


b

Figure 4.9: Decortication using a round bur (a). Appearance after decortication (b).

4. Adaptation of bone particles

Technique: Particulate donor bone may be autologous or bone substitute biomaterial. The grafting material should be delivered to the bony defect and adapted smoothly to the recipient bed but not condensed.

Clinical Tip: If the choice of graft is non-autologous biomaterial, hydrating the biomaterial in saline will provide much easier handling of the biomaterial.

Objective: Proper adaptation of bone particles to the recipient bed should result in improving the chances of graft success.

Rationale: The correct adaptation of the graft allows for greater contact and consequently optimized revascularization (blood flow) to grafting material. Strong compression (condensation) of grafting material reduces the porosities within and between the particles of graft material for osteoconduction.

Figure 4.10: Fine-grained xenogeneic biomaterial after hydration with saline (a). Fine-grained biomaterial being accommodated in layers (b). Appearance of the surgical site after biomaterial insertion into the bone defect (c).

5. Membrane adaptation

Technique: Trimming of the membrane is carried out to ensure full coverage of the graft material. Direct contact between the membrane and the root surface of the adjacent teeth should be avoided. A distance of about 1mm away from the adjacent teeth is suitable to minimize the possible exposure of the membrane.

Clinical Tip: To facilitate membrane trimming, a template can be made out of sterile suture packaging in the same way described for free gingival grafting (Chapter 3).

Purpose: To keep the graft material in position and protect the hard tissue graft from the downgrowth of epithelial cells derived from the adjacent soft tissue.

Rationale: The use of a suitable membrane reduces the risk of fibrous tissue forming in the area, as it prevents graft micromovements, as well as interference from adjacent soft tissue cells with a high proliferative potential that could fill the spaces meant for the formation of bone tissue.

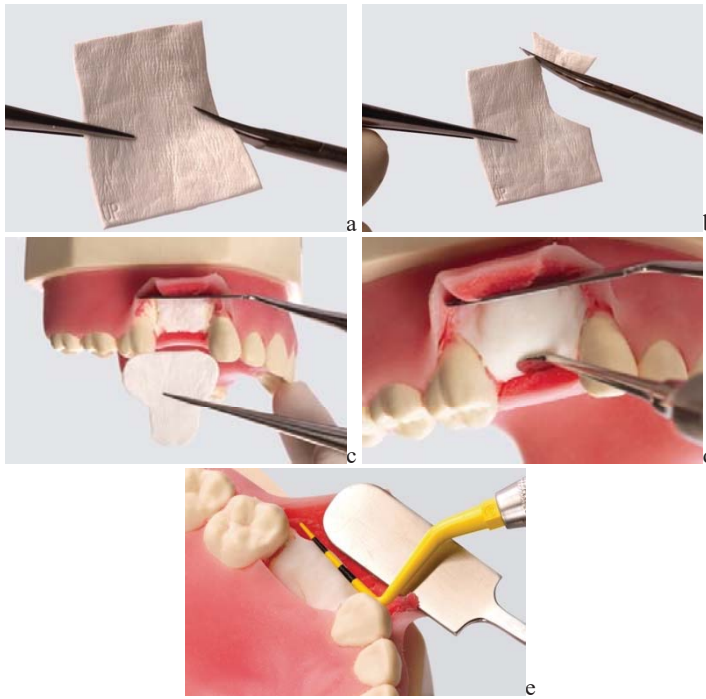


Figure 4.11: Xenogeneic membrane (Bio-Gide™) being customized. Note the presence of the word "Up" in lower left corner, indicating the side of the membrane to be positioned facing the flap (a–b). Porcine collagen membrane outline (c). Porcine collagen membrane adapted to the recipient site (d). Porcine collagen membrane adapted to the site (occlusal view) (e).

6. Suture

Technique: Re-approximation of the edges of the surgical wound can be achieved using single interrupted and horizontal mattress sutures. It is recommended to keep suture knots away from the edges of the surgical wound to minimize biofilm accumulation on the incision line. In this case, the occlusive membrane should **not** be sutured to the flap.

Objective: Encourage healing by primary intention.

Rationale: Adequate approximation of the edges of the wound optimizes healing. The use of monofilament sutures may also contribute to hindering bacterial build-up.

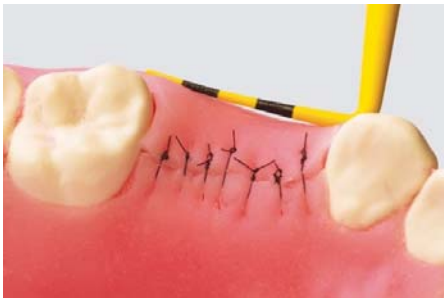


Figure 4.12: Suture after GBR procedure. Note the considerable thickness gain in the alveolar ridge.

ALVEOLAR RIDGE AUGMENTATION USING THE BARBELL TECHNIQUE™ (COMBINED WITH GBR)

1. Incision

Technique: Once adequate local anesthesia has been achieved, the surgical procedure begins with intrasulcular incisions around the teeth adjacent to the bone defect. Subsequently, a straight incision is made on the bony ridge, covering the distance between two adjacent teeth to the defect. Finally, a vertical relieving incision is performed distobuccally on the adjacent teeth extending beyond the muco-gingival junction. Confirmation that the incisions have been made down to bone may be ascertained by dragging the tip of a periosteal dissector along the incision line.

Clinical Tip: All incisions must "contact" the bone to allow detachment of a full mucoperiosteal flap. Partial thickness incisions hamper flap reflection and may contribute to lacerations or tearing of the soft tissue flap.

Objective: To allow adequate flap reflection.

Rationale: Improperly executed incisions may result in difficulties raising the flap.

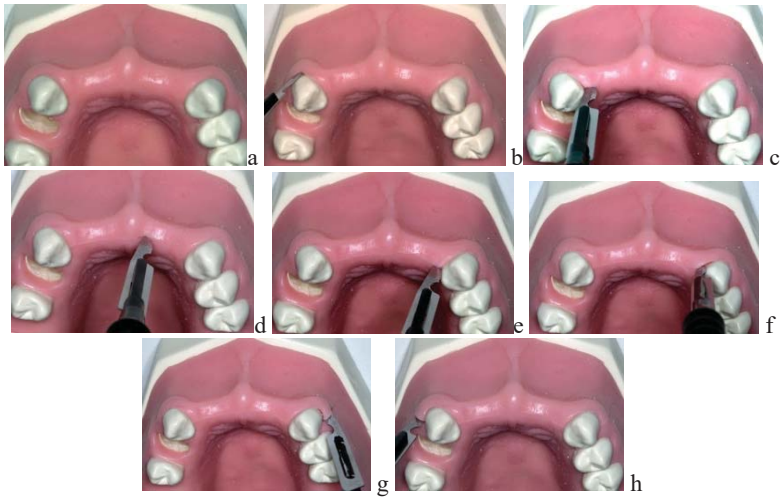


Figure 4.13: Bone loss in terms of thickness is evident (a). Sulcular incision in the tooth 23 (b). Beginning of incision on the crest (c). Extending the incision (d). Completion of the incision on the crest (e). Sulcular incision in the tooth 13 (f). Relieving vertical incision involving the tooth 23 (g). Relieving vertical incision involving the tooth 13 (h).

2. Flap dissection and reflection

Technique: A periosteal elevator is used to detach and raise the flap upon completion of the incisions. A piezo can also be used for this purpose (insert #SLTV-O, CVDentus).

Clinical Tip: Flap dissection and elevation must be initiated from the incision made on the bone crest as close as possible to the two teeth adjacent to the defect. This creates a dissection line that facilitates raising a full thickness flap.

Objective: Obtain adequate access to the bony defect in order to install the Barbell device.

Rationale: Inadequate access may hinder subsequent surgical maneuvers and often result in lacerations or tearing of soft tissue flap, compromising both the ability to achieve primary wound closure and esthetics.

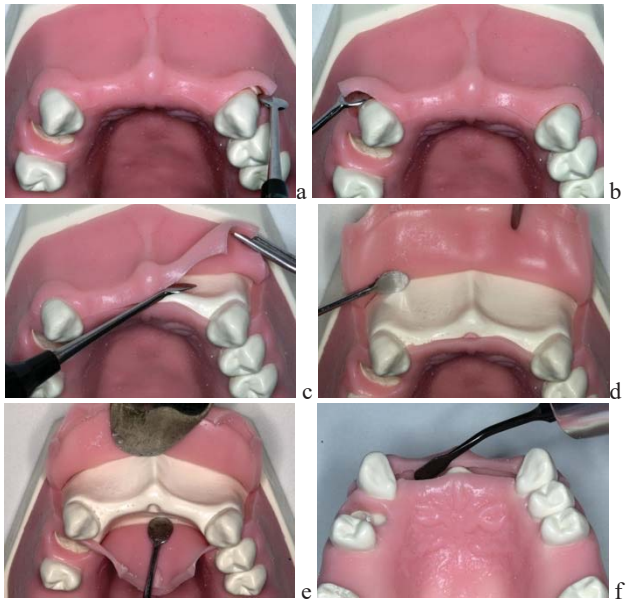


Figure 4.14: Beginning of gingival detachment around tooth 23 (a). Beginning of gingival detachment around tooth 13 (b). Detachment of the anterior portion (c). Completion of the surgical access at the buccal side (d). Completion of the surgical access at the palatal side (e). Detachment done with piezo (f).

3. Decortication

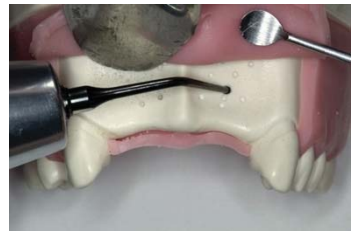
Technique: The recipient site should be perforated in several places (decortication). This step can be accomplished by using a surgical angulated handpiece (1:2 at 28000 rpm) or a contra-angle (20:1 at 1000 rpm) on an electric motor. Always use copious irrigation. A piezo can also be used for this purpose (insert #SR2, CVDentus).

Clinical Tip: For decortication, a spherical bur of small diameter or a thin spear point drill is recommended.

Objective: The creation of holes in the cortical bone leads to improved chances of success with the bone grafting procedure.

Rationale: The decortication of the cortical bone permits the exposure of the bone marrow to enhance blood flow, thereby bringing nutrients to the grafting material.


a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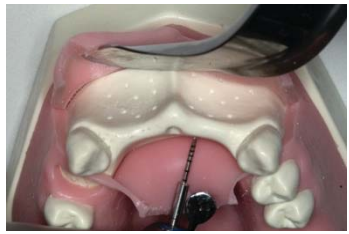

c

Figure 4.15: Decortication using a thin spear bur at the buccal side (a). Decortication done with piezo (b). Decortication using a thin spear bur at the palatal side (c).

4. Screw Installation

Technique: After determining the bone volume needed for reconstruction of the deficient ridge, a Barbell screw(s) with an adequate length (6, 8, or 10 mm) is selected. The recipient bed is perforated with one of the two diameter drills provided in the Barbell Technique™ kit (1.1 or 1.3 mm in diameter). Drilling is carried out using a 20:1 contra-angle on an electric motor at a speed of 200rpm and constant irrigation. The screw can be placed using a contra-angle at 30 rpm or inserted manually.

Clinical Tip: A 1.1 mm or 1.3 mm diameter drill is selected based on the density of the bone at the recipient bed (i.e., a 1.1 mm drill is used for soft bone and a 1.3mm drill for dense bone). The length and the position of the screw(s) may vary depending on the size and characteristics of the bone defect. Commonly, 10 mm screws are used for bidirectional horizontal augmentation, and 6 and 8 mm screws are used for unidirectional horizontal or vertical augmentation.

Objective: To stabilize the screw(s) and, consequently, to maintain the space over the defect by tenting the soft tissue.

Rationale: The use of screw(s) allows the determination of the magnitude of the bone volume to be reconstructed.

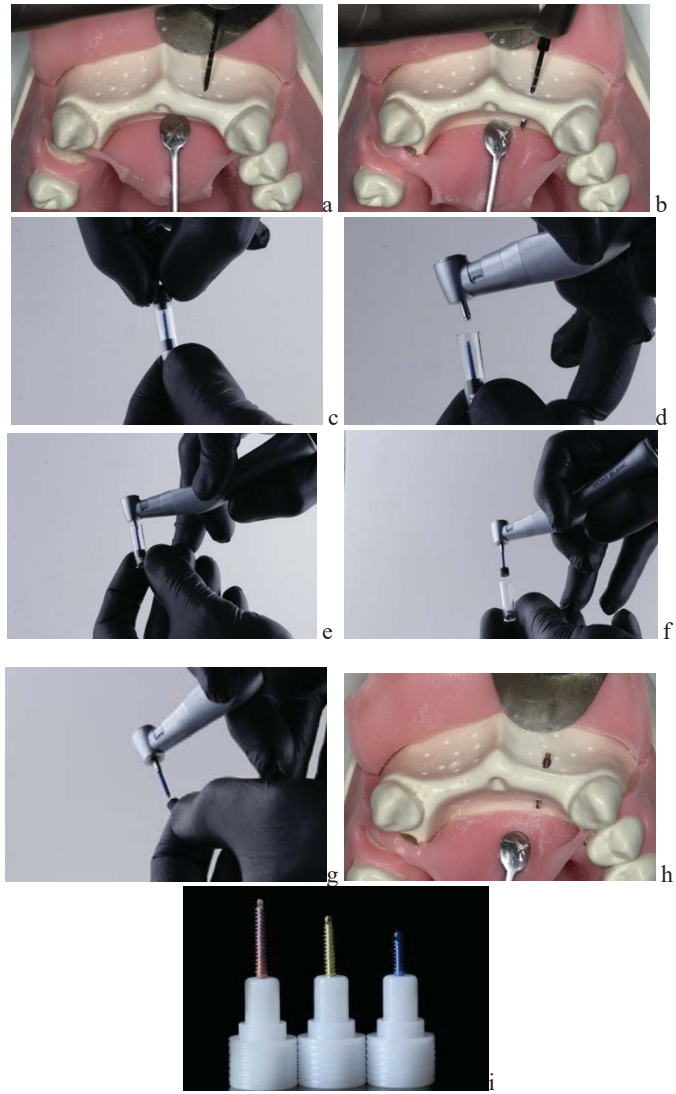


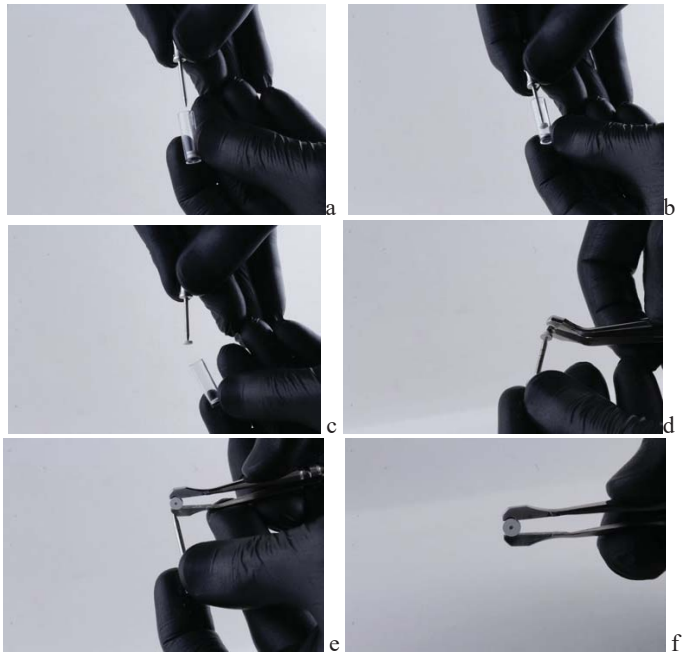
Figure 4.16:1.1 mm drill being used to prepare the bed for the screw placement (a). 1.1 mm drill transfixing the residual ridge (b). Barbell™ device inside the blister packaging (c). Screw being removed from the blister packaging and pick-up using the contra-angle attachment from the package (d–f). Base being removed from the screw (g). Screw transfixed through the ridge to allow a horizontal bidirectional bone augmentation (h). The three lengths available: 6 mm [blue], 8 mm [yellow] and 10 mm [red] (i).

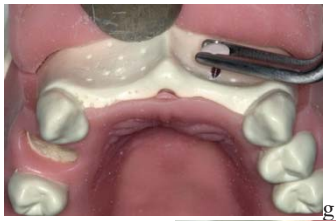
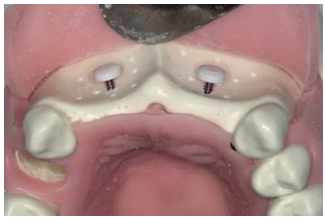
5. PEEK capsule installation

Technique: After the installation of screw(s), PEEK capsules are installed with the specific carrier provided in the Barbell Technique™ kit.

Objective: To connect the capsules to the tips of the Barbell screw, which is used to tent/support the soft tissue flap preventing its collapse.

Rationale: The use of Barbell device reduces the risk of soft tissue compression against bone graft and maintain a sufficient space for bone regeneration.




g

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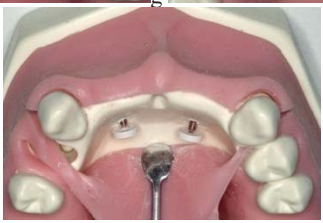

i

Figure 4.17: A specific carrier from the Barbell Technique™ kit is used to pick-up the caps located in the bottom of the blister packaging (a–c). A specific carrier from the Barbell Technique™ kit is used to pick-up the caps from the first carrier and to adapt the caps over the screw's head (d–g). Barbell Technique™ "screws" allow the placement of PEEK caps at both ends (h and i).

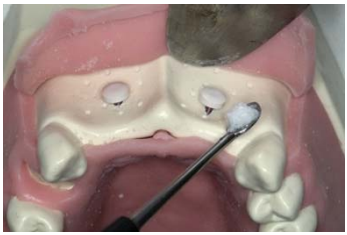
6. Delivery and adaptation of bone particles

Technique: Particulate donor bone may be autologous or bone substitute biomaterial. The grafting material should be delivered into the bony defect and adapted smoothly to the bed but not compacted or condensed.

Clinical Tip: If the choice of graft is bone substitute biomaterial, then hydrating it in saline prior to delivering it to the bony defect will make it much easier to handle.

Objective: Thorough adaptation of bone particles to the recipient bed can improve the likelihood of graft success.

Rationale: The correct adaptation of the graft allows for greater contact and consequently optimized blood flow to the donor grafting material. Dense compression (condensation) of grafting material decreases the potential for osteoconduction by reducing or eliminating the interconnection of pores, thus reducing the available space between the granules for bone formation to occur.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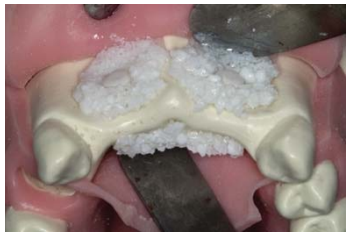

b

Figure 4.18: Fine-grained biomaterial placed (a). Appearance of the surgical site after biomaterial insertion into the bone defect, at both the buccal and palatal sides (b).

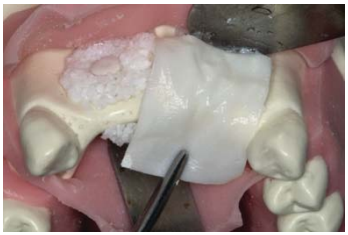
7. Membrane adaptation

Technique: Trimming of the membrane is carried out to ensure full coverage of the graft material and the Barbell device. Direct contact between the membrane and the root surface of the adjacent teeth should be avoided. A distance of about 1mm is suitable to minimize the possible exposure of the membrane.

Clinical Tip: To facilitate membrane trimming, a template can be made out of sterile suture packaging in the same way described for free gingival grafting (Chapter 3).

Purpose: To prevent downgrowth of epithelial cells from the overlying gingival tissue and minimizing the formation of soft tissue filling in the area where bone formation is desired.

Rationale: The use of a suitable occlusive membrane reduces the risk of fibrous connective tissue formation in the area as well as the interference from adjacent soft tissue cells with a high proliferative potential that could jeopardize the formation of bone tissue.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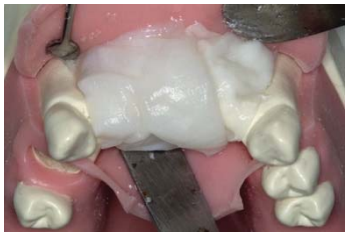

b

Figure 4.19: Porcine collagen membrane being adapted to the recipient site (a). Porcine collagen membrane adapted to the recipient site and covering all bone graft particles (b).

8. Suture

Technique: Re-approximation of the wound edges can be achieved using single interrupted and horizontal mattress sutures. It is recommended to keep the knots off the edges of the surgical wound to minimize biofilm accumulation on the incision line. In this case, the membrane should not be sutured to the flap.

Objective: Encourage healing by primary intention.

Rationale: Adequate approximation of the edges of the wound optimizes healing. The use of monofilament sutures may also contribute to hindering bacterial build-up.

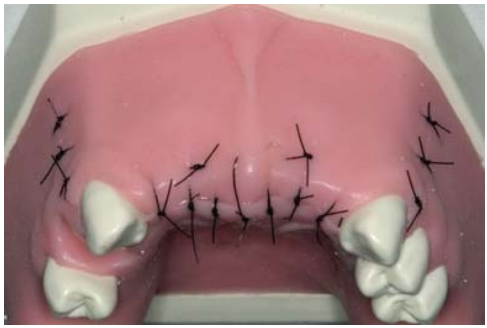


Figure 4.20: Completion of suturing using single interrupted and horizontal mattress sutures.

OTHER POSSIBLE USES OF THE BARBELL TECHNIQUE™ (COMBINED WITH GBR)

By using the same technique—the objective and rationale for each step already mentioned for Barbell Technique™—this concept can also be used for vertical bone augmentation and horizontal unidirectional bone augmentation. Commonly, 10 mm screws are indicated for bidirectional horizontal augmentation, and 6 mm and 8 mm screws are indicated for unidirectional horizontal or vertical augmentation. With regard to the horizontal augmentations, the PEEK capsule can be positioned below (shown in Fig. 4.19) or over the barrier membrane (if the surgeon intends to have better stabilization of the occlusive barrier membrane).

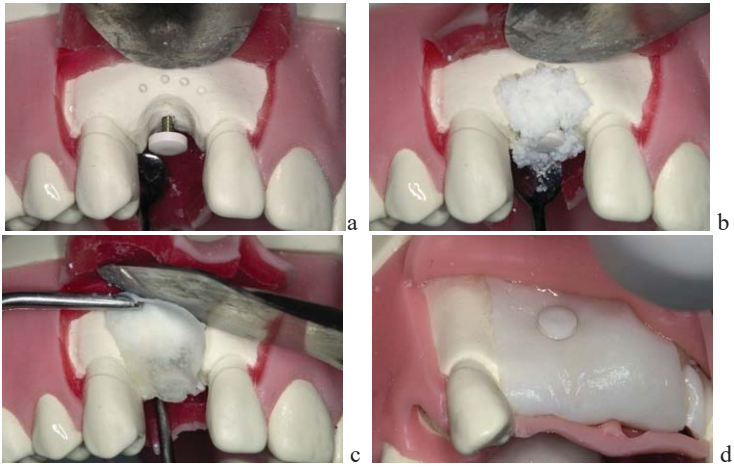


Figure 4.21: Barbell Technique™ being used for vertical bone augmentation purposes (a –c). Barbell Technique™ being used for unidirectional buccal bone augmentation purpose (note the use of a PEEK capsule to stabilize the occlusive barrier membrane) (d).

APPROACH TO DONOR SITE: CHIN

1. Incision

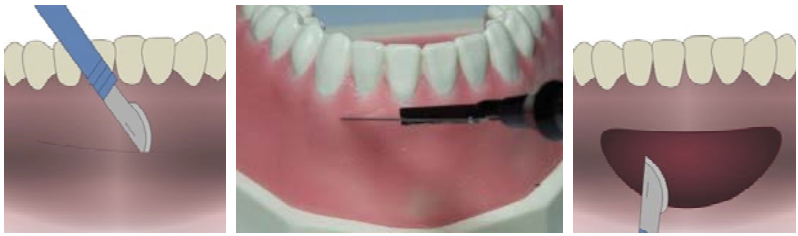
Technique: Once local anesthesia has been achieved, the surgical procedure is initiated by making a straight partial thickness, horizontal incision at least 5mm from (below) the gingival margin of the anterior teeth. The scalpel blade is placed at a 30^{0} angle to create a beveled superficial incision. Subsequently, the flap is divided using a 15C scalpel blade ensuring a

minimum of 2mm thickness of periosteum with a full thickness incision covering the same area as the partial incision.

Clinical Tip: The partial thickness incision should only penetrate the epithelium and the underlying connective tissue, thus preventing the blade from reaching bone. A full incision should otherwise contact the bone to ensure the incision is carried through the periosteum.

Objective: This incision pattern allows for ease of suturing in layers, minimizing the risk of both the suture not bringing the proper layers of tissue together and wound dehiscence.

Rationale: Inadequate incisions make suturing difficult and increase the risk of wound dehiscence, which in turn will compromise healing.



a b c

Figure 4.22: Straight partial horizontal incision is created, 5mm from the gingival margin of the anterior teeth (a–b). After the creation of a split thickness flap, the second straight incision is performed (c). This incision must be a full thickness incision touching the bone.

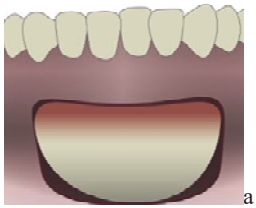
2. Flap dissection and reflection

Technique: After the incision, the elevation of a full thickness flap begins using a periosteal elevator. A piezo can also be used for this purpose (insert #SLTV-O, CVDentus).

Clinical Tip: Flap reflection should start just below the preserved periosteum, thus safeguarding the eventual suturing of the periosteum with the connective tissue.

Objective: To obtain adequate access to the donor site in order to provide a good view of the surgical field.

Rationale: Inadequate access may reduce the amount or size of the donor bone harvested and risk tearing the soft tissue flap, making it more difficult for achieving adequate primary wound closure.


a


b

Figure 4.23: Completion of the surgical access at the chin bone donor site (a–b).

3. Osteotomy and bone block harvest

Technique: Once access to the donor site is obtained, several small perforations are made very close to each other using the tip of a #701 fissure bur on a straight handpiece at 20000 rpm, which will outline the size of the block to be removed. A 5-mm distance must be maintained from the mental foramina, dental roots, and the base of the mandible as a margin for safety. After drilling, connect the perforation marks made through the cortical bone and remove the bone block using chisels. Depending on the size and shape of the deficiency at the receptor site, another option is to use trephine drills on a contra-angle at 1000 rpm. A piezo can also be used for this purpose (inserts #SF3 and #SCP, CVDentus).

Clinical Tip: It is important to ensure that all the perforations and dot-connecting maneuvers have passed through the cortical bone and reached cancellous bone, as this will facilitate removal of the block. This can be ascertained by observing prompt bleeding upon exposure of the cancellous bone.

Objective: To obtain a homogenous bone block containing some cancellous bone.

Rationale: Careful shaping and harvesting of the donor bone block facilitates close adaptation to the receptor site.

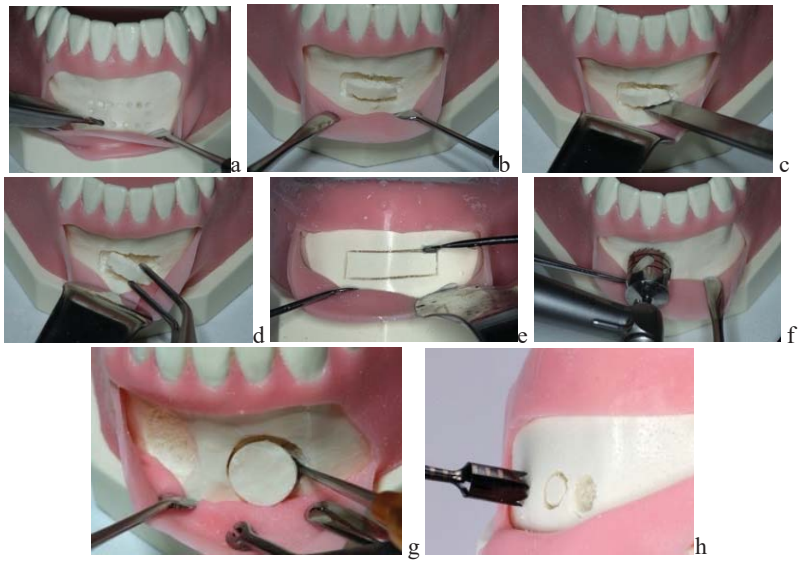


Figure 4.24: Small perforations through buccal cortical bone with a #701 bur to outline the design of the block graft (a). Completion of the osteotomy for a rectangular-shaped block(b). Block being separated with a chisel (c). Removal of the rectangular bone block (d). Osteotomy for a rectangular block done with piezo (e). Round block removal after osteotomy done with a trephine drill (f–g). Osteotomy for a round block done with a piezo insert (trephine shape) (h).

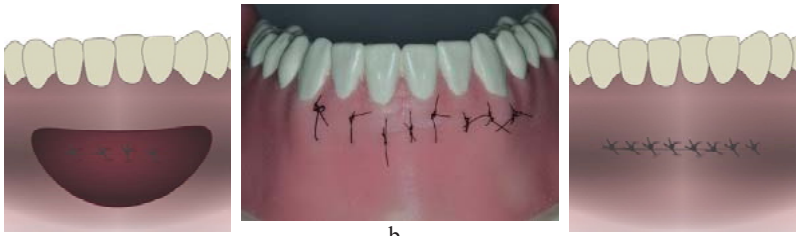
4. Suture

Technique: Start by suturing the connective tissue to the periosteum from the split thickness incision. Resorbable threads should be used for this first layer and then finished with 5.0 nylon sutures, re-approximating the epithelial margins using single interrupted sutures.

Clinical Tip: It is important to use resorbable sutures in the deepest plane because they cannot be removed after healing.

Objective: To allow for primary healing of soft tissue wound edges.

Rationale: Adequate re-approximation of the wound edges allows optimal healing while closure of the flap in two layers reduces the risk of dehiscence.



a b c

Figure 4.25: Suture of the deepest plane, always with a resorbable suture (a). The superficial, epithelial layer is sutured with non-resorbable sutures (b–c).

APPROACH TO DONOR SITE: RAMUS OF THE MANDIBLE

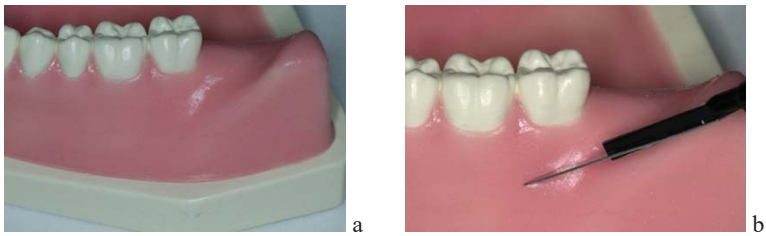
1. Incision

Technique: Once local anesthesia has been achieved, access to the donor area is made via a full incision along the oblique line of the ascending ramus (external oblique ridge) in a posteroanterior direction using a scalpel blade (#15).

Clinical Tip: The incision must be full thickness (touching the bone) to allow for the detachment of a mucoperiosteal flap. Partial incisions make detachment difficult and increase the risk of lacerations, compromising blood flow.

Objective: To fully expose the area of the external oblique ridge.

Rationale: An inadequate incision may result in difficulty detaching the flap and may compromise visualization of the donor site and make it difficult for instrumentation to access the donor site.



a b

Figure 4.26: Straight incision performed with piezo cutting tip along the oblique line of the mandible (external oblique ridge) (a–b).

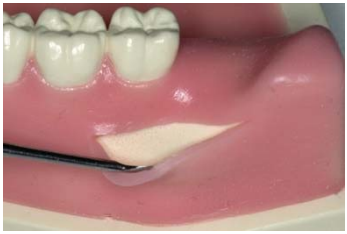
2. Flap detachment

Technique: After the incision, detachment of the full thickness flap begins using a periosteal elevator. A piezo can also be used for this purpose (insert #SLTV-O, CVDentus).

Clinical Tip: Detachment is facilitated if performed from an antero-posterior direction.

Objective: To gain good access to the donor site and safeguard the integrity of the soft tissue flap.

Rationale: Inadequate access may hamper the outcome and risk tearing the soft tissues.


a


b

Figure 4.27: Flap detachment being performed with a periosteal elevator (a). Flap detachment being done with a piezo (b).

3. Osteotomy and bone harvest

Technique: Once access to the donor site is obtained, several small perforations are made very close to each other using the tip of a #701 bur on a straight handpiece at 20000 rpm, which will outline the size of the block to be removed. After drilling, join the perforated dots and remove the block using chisels and/or straight elevators. If resistance is felt and it is difficult to fracture off the bone block, a diamond disc may be used at the base of the graft to complete the osteotomy and finish the harvest. A piezo can also be used for this purpose (inserts #SF38, #SF3-R and #SF3-L, CVDentus). Depending on the size of the bone block, which is based on the demands of the grafting site, another option is the use of bone scrapers if the volume of donor bone required is minimal. The bone scraper can collect cortical bone chips using back and forth strokes, with hand pressure placed on the tip of the scraper.

Clinical Tip: For safety reasons, it is advisable to support the lower edge of the mandible and/or keep the patient in occlusion during the removal of the donor block bone to prevent injuries to the temporomandibular joint or even a fracture in the angle of the mandible. Graft thickness should never exceed 1/3 of the thickness of the mandibular ramus to avoid damaging the inferior alveolar nerve.

Objective: To obtain a homogeneous bone block containing some cancellous bone.

Rationale: Careful harvesting of the appropriate size and shape of bone block facilitates adaptation to the receptor site.

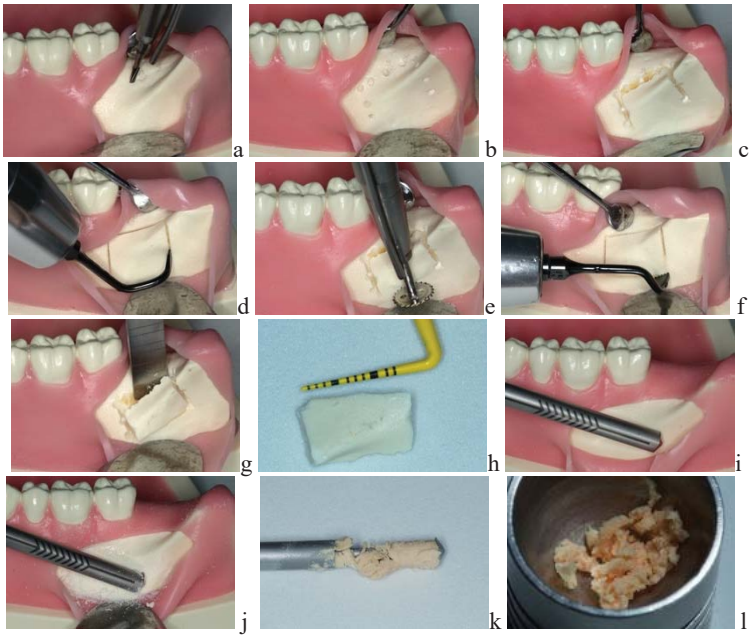


Figure 4.28: Small perforations being created with a #701 bur to outline the shape of the block graft (a–b). Completion of the osteotomy (c). A piezo can be used for the osteotomy (d). A diamond disc is used along the inferior margin to create the lower horizontal score line in cases of resistance to the out-fracturing of the block of bone (e). An angled piezo insert can also be used to create the inferior margin osteotomy (f). Block being separated with a chisel (g). Rectangular bone block obtained (i). Bone scraper in position (h). Bone chips being obtained by using back and forth pressure strokes (j). Bone chips collected inside a bone scraper (k). Bone chips collected by a bone scraper (l).

4. Suture

Technique: Simple or continuous running sutures in a posterior-anterior direction may be used.

Objective: To allow for healing by primary intention.

Rationale: Adequate coaptation of the edges of the surgical wound optimizes healing.

Figure 4.29: Completion of suturing using single interrupted or continuous running sutures.

CHAPTER 5

MAXILLARY SINUS FLOOR AUGMENTATION

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INTRODUCTION

Post-extraction alveolar bone loss is a common finding in clinical practice and may severely compromise implant placement. The posterior maxilla has an additional factor leading to more alveolar ridge resorption: bone loss occurs through dimensional changes of the alveolar process from inferior to superior direction and also from superior to inferior direction due to pneumatization (enlargement) of the maxillary sinuses. This resorption pattern combined with a relatively high prevalence of edentulous posterior maxilla make reconstructive surgery in the area of the maxillary sinuses a routine occurrence in implant dentistry, not to mention the fact that maxillary sinus elevation is considered a highly predictable approach when correctly performed. As the maxillary sinus is a natural cavity, the scientific literature supports the use of bone substitute biomaterials for sinus floor augmentation (e.g., no mandatory need for an autograft use). Therefore, the scope of the current chapter is to present the use of interpositional grafts inside the sinus between the floor of the sinus and the sinus membrane (appositional grafts are discussed in Chapter 4).

There are two surgical techniques to raise the maxillary sinus membrane: the lateral window technique and the transcrestal osteotome technique. The former demands an extensive full thickness flap and the creation of the window in the lateral wall of the sinus in order to gain access to the sinus membrane, which is then detached and raised from the floor of the sinus cavity to create room/space for inserting the graft material. The latter approach, also known as atraumatic technique (this term is debatable as there is no surgical technique that does not cause trauma), does not require

access through the lateral wall of the maxillary sinus. Instead, elevation of the sinus floor is performed via the same alveolar osteotomy created for implant placement using instrumentation specifically designed to permit access to the floor of the sinus cavity through the osteotomy created to accept the dental implant.

It can be generally stated that the transcrestal technique is indicated in situations where the amount of sinus floor elevation required is small (about 2–3 mm) and, in such cases, it is common practice to install an implant concurrently. The lateral window technique is indicated for larger reconstructions and delivering larger volumes of donor bone material where the residual alveolar ridge is less than 2 mm in height. The decision to install an implant simultaneously with grafting should be made based on the amount of alveolar ridge height available to provide sufficient bone support to achieve primary implant stability.

It is not the aim of this textbook to discuss the indications and limitations of each technique, nor is it to discuss the feasibility of simultaneous implant placement. This chapter will therefore discuss the two main surgical techniques for augmenting the maxillary sinus floor: (1) the lateral window technique and (2) the transcrestal technique.

THE LATERAL WINDOW TECHNIQUE

1. Incision

Technique: Following local anesthesia, three incisions are performed: a straight incision along the bone crest and two releasing vertical incisions (distally and mesially), which should be divergent (wider at the base superiorly in the vestibule than crestally-inferiorly). The flap should be full thickness, i.e., the scalpel blade making the incision must touch the bone. The depth of incisions can be verified using a periosteal dissector.

Objective: Full thickness incisions allow subsequent full thickness flap detachment.

Rationale: The full thickness mucoperiosteal flap allows for unimpeded access to bone, which is essential to prepare the surgical site to create the osteotomy to gain access to the sinus floor and for implant placement.

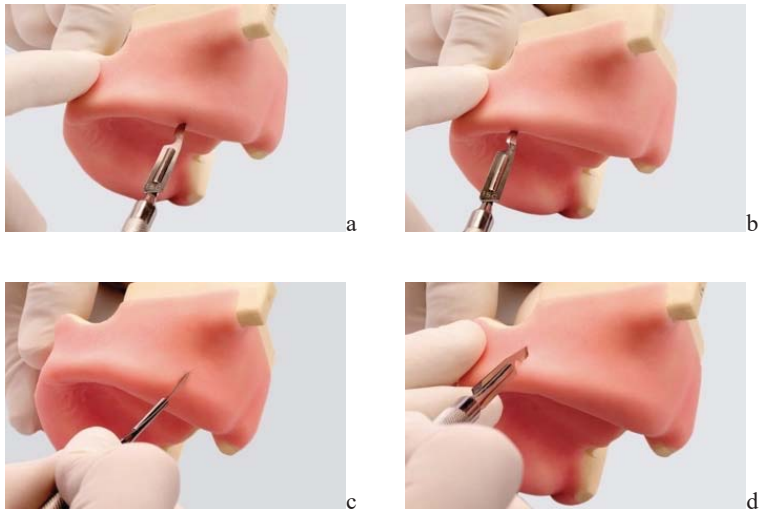


Figure 5.1: A 15 C blade is used to make an incision on the bone crest from posterior (a) to anterior (b). Using a 15 C blade, two vertical releasing incisions are made, one posteriorly (c) and another anteriorly (d).

2. Flap detachment

Technique: Once the incisions are made, a full thickness flap dissection should follow using a periosteal elevator. A piezo can also be used for this purpose (insert #SLTV-O, CVDentus).

Clinical Tip: Flap reflection is greatly facilitated if started anteriorly with the periosteal elevator dissecting posteriorly.

Objective: To obtain adequate access to the bone surface in the posterior maxilla and create the osteotomy.

Rationale: Raising a mucoperiosteal flap provides access to bone of the lateral wall of the maxillary sinus, which is essential for an osteotomy and the subsequent elevation of the sinus membrane lining.

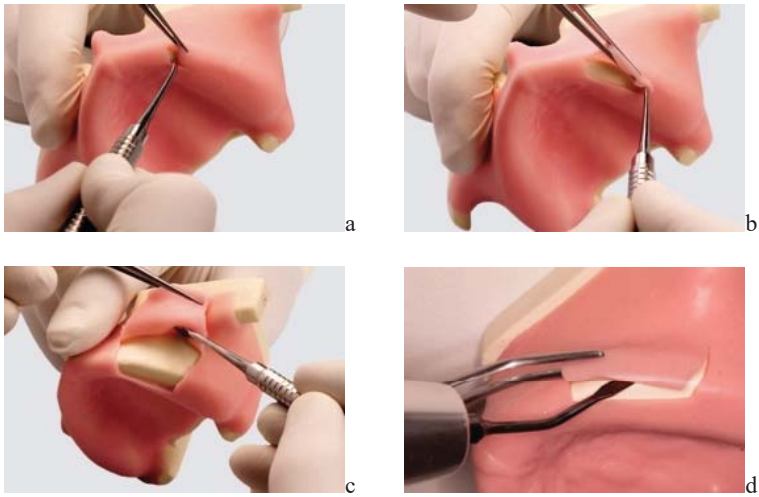


Figure 5.2: Periosteal elevator being used to raise a full thickness flap near the anterior releasing incision (a). Periosteal elevator raising the flap anteriorly, working towards the posterior region (b). Buccal flap raised. (d) Detachment performed with piezo (c).

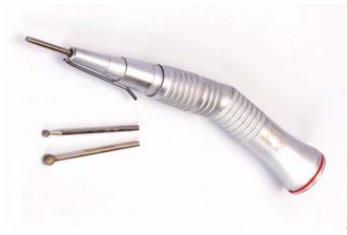
3. Osteotomy

Technique: Once the flap has been raised, a spherical diamond bur rotating at 28000rpm attached to a 1:2 surgical handpiece coupled to an electric motor is used to carry out the osteotomy under constant saline irrigation to obtain access to the sinus lining. A piezo can also be used for this purpose (inserts #SR2, CVDentus). If the bone window is wide, an "island" of bone can be maintained in the middle (partial osteotomy) but, if the window is small, a full osteotomy and removal of the window should be performed.

Clinical Tip: If the bone is thick or dense cortical bone, an osteotomy can be started using a carbide bur, though the preparation should always be finished with a diamond bur, which reduces the risk of tearing the sinus membrane. Another option may be ultrasonic piezoelectric tips, which significantly minimize the risk of tearing the membrane.

Objective: An osteotomy provides access to the maxillary sinus lining.

Rationale: An osteotomy must be performed gently and carefully to reduce the risk of injuring or tearing the membrane lining the maxillary sinus.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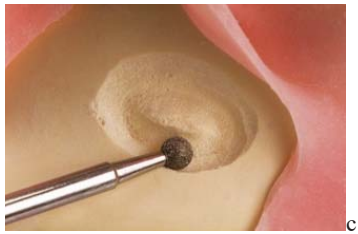
b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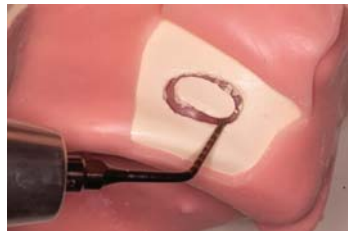

e

Figure 5.3: Surgical angled handpiece 1:2 and spherical diamond burs (KG PM 6:08) (a). Outlining the osteotomy (b). An osteotomy during the final preparation stage using a fine diamond round bur. The sinus membrane is close (c). A light beamed from inside the sinus cavity of the model shows the close proximity with the sinus membrane and the "island" of bone in the middle portion of the window (partial osteotomy technique) (d). An osteotomy performed with a piezo (e).

4. Dissecting the sinus lining

Technique: Upon completion of osteotomy, the sinus lining should begin by using specially designed curettes along the periphery of the osteotomy. The sinus curettes have different head angles (see specific curette kits in the presentation of Part 1). Curettes should always contact bone internally (medial wall) to reduce the risk of injury to the sinus membrane. It is important to highlight that this aspect of the surgical technique is extremely

delicate. A piezo can also be used for this purpose (inserts #SE1 and SLTV-O, CVDentus).

Objective: Allow elevation of the maxillary sinus lining minimizing the risk of tearing it.

Rationale: Freeing the membrane lining along the full extent of the osteotomy prevents localized stretching, which could result in tearing.

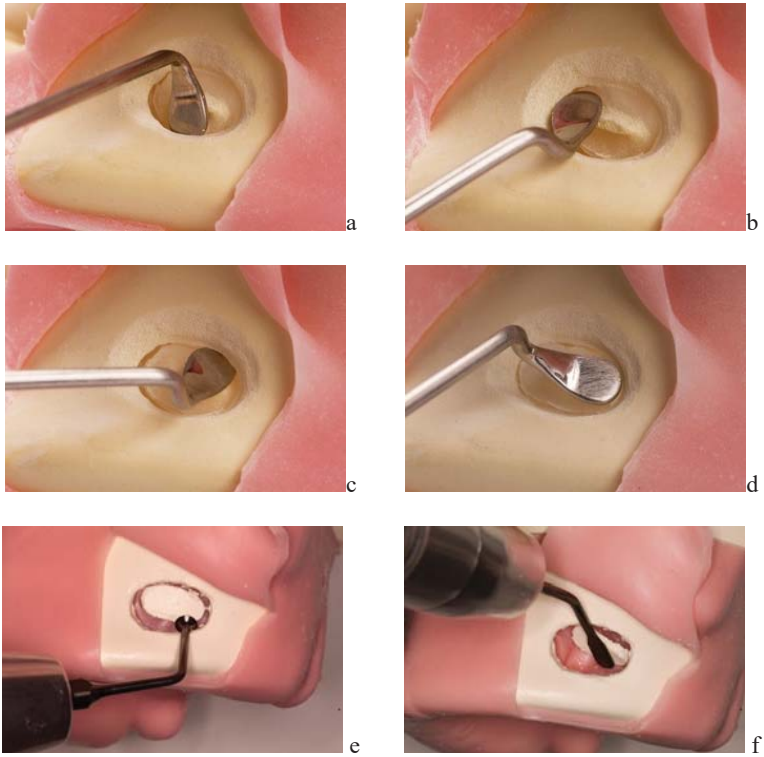


Figure 5.4: Curette starting detachment of the lower aspect of the membrane (a). Curette initiating the detachment of the anterior portion (b). Curette detaching the upper portion (c). Curette detaching the posterior portion of the membrane (d). Dissection performed with a piezo, insert #SE1 (e). Elevation of the sinus membrane with a piezo, insert #SLTV-O (f).

5. Elevating the sinus membrane

Technique: Once window detachment is complete, elevating should follow using a 90° angled curette. The angled curette must contact the medial side of the palatal bone wall when elevating the sinus lining, allowing adequate displacement and preventing localized stress on the membrane, which could tear as a result. A piezo can also be used for this purpose (insert #SLTV-O, CVDentus).

Clinical Tip: The integrity of the lining can be ascertained visually by asking the patient to breath in and out. If the membrane rises (during inspiration) and lowers (during expiration), this is an indication that it is not perforated or torn.

Objective: Create space for the insertion of graft material.

Rationale: Successful elevation of the lining (homogeneously) allows the proper adaptation of the grafting material.

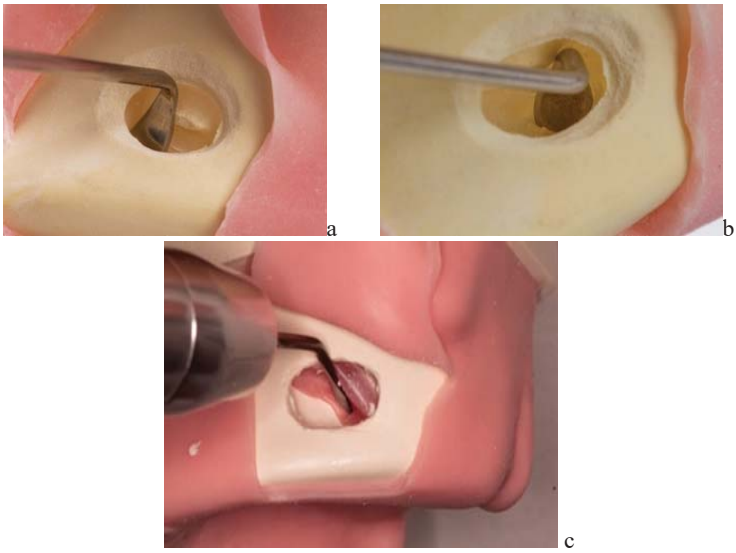


Figure 5.5: A right angle curette starting elevation of the sinus membrane (a). Right angle curette finishing the sinus membrane detachment. Note that the curette remains in contact with the palatal wall (b). Elevation using a piezo, insert #SLTV-O (c).

6. Bone Grafting

Technique: The grafting material is inserted into the sinus cavity after hydration in normal saline. If the graft material is autologous, then hydration is unnecessary. One must take care to adapt the graft adequately by compressing the material against the bone walls.

Clinical Tip: The grafting material should not be compacted densely but compressed lightly onto the recipient bed. Dense compression may increase the risk of tearing the sinus lining but this also reduces the osteoconduction potential of the graft, since it is desirable to leave the porosities within the graft material to permit adequate spacing to accommodate new bone formation.

Objective: Fill the sinus cavity with mineralized material.

Rationale: Mineralized materials appear to be the best framework for repairing relatively extensive bone cavities.

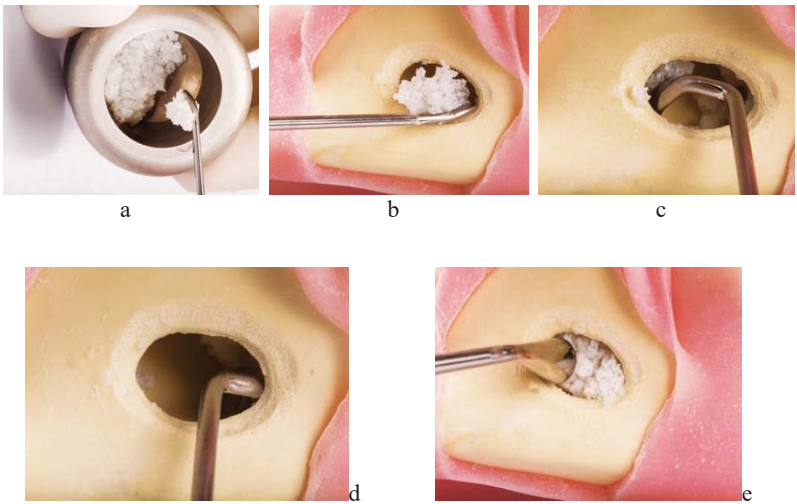


Figure 5.6: Xenograft (coarse particles) hydrated with saline (a). Xenograft (large particles) being delivered into the sinus cavity (b). Xenograft (large particles) being adapted to the anterior wall (c). Xenograft (large particles) being adapted against the posterior wall (d). Adaptation of the final layer of xenograft compressing towards the sinus floor (large particles) (e).

BONE GRAFT USING BIOMATERIALS DELIVERED IN BLISTERS

If the choice of graft material is from blister packages (typically syringe format), it must be remembered that the graft material needs to be rehydrated while still inside the syringe prior to application. This is made possible via a small orifice at the tip of the syringe.

Figure 5.7: Xenograft (large particles) packaged in a syringe (a). Xenograft (large particles) are hydrated with saline (b) using the container syringe and plunger (c). The cap is then removed from the syringe (d) and the application tip is fitted to allow insertion (e). The biomaterial is inserted and compacted (f) until the defect is completely filled (g).

7. Membrane adaptation

Technique: Trimming the membrane should ensure full coverage of the graft material. Wherever possible, the edges of the membrane should be positioned away from the incision(s) line(s), as this would risk exposing the membrane.

Clinical Tip: A template can be made prior to trimming the membrane (see the section on the free gingival graft in Chapter 3).

Objective: To keep the grafting material in position and protect it from the influence of cells derived from adjacent soft tissues.

Rationale: The use of a suitable membrane reduces the risk of fibrosis, as it prevents micromovement of the graft material, as well as interference from highly proliferative cells in the adjacent soft tissue.

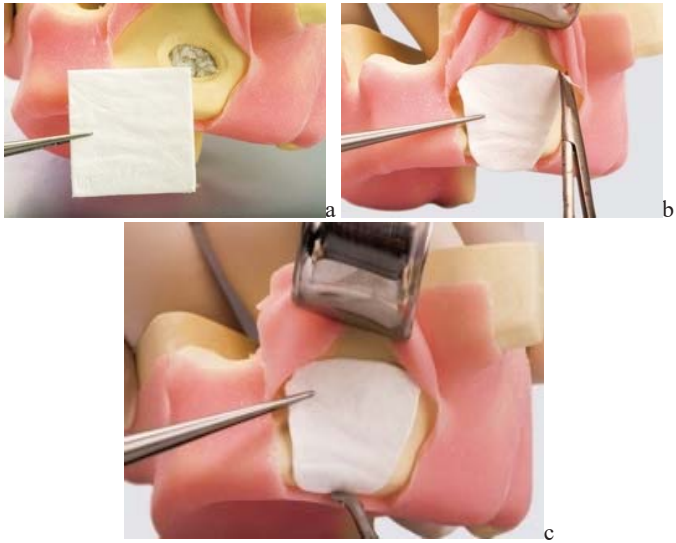


Figure 5.8: Xenogeneic membrane being cut (a–b). Note the presence of the word "Up", indicating the side of the membrane to be positioned facing the flap. Porcine collagen membrane adapted to the recipient bed (c).

8. Suture

Technique: Once the resorbable membrane is in place, the edges of the surgical wound must be sutured. Keeping the knots away from the incision line minimizes the problems relating to biofilm accumulation and scarring. The use of monofilament sutures also hinders bacterial and plaque build-up.

Objective: Allow healing by primary intention.

Rationale: Adequate approximation of the edges of the wound optimizes the healing process.

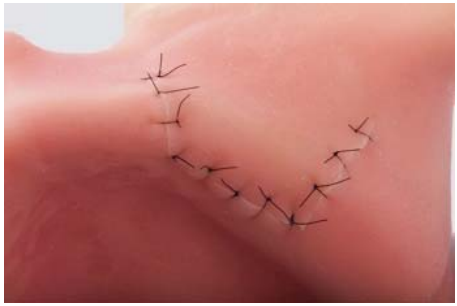


Figure 5.9: Single interrupted sutures, taking care to leave the knots off the incision line.

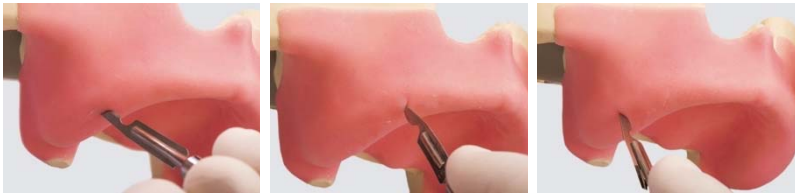
THE TRANSCRESTAL TECHNIQUE

1. Incision

Technique: After local anesthesia, a straight incision is made along the alveolar crest. If adjacent teeth are present, intrasulcular incisions can be made around them, thus avoiding the need for releasing incisions. If the region is completely edentulous, two releasing incisions are often necessary (one distally and another mesially). The flap(s) must be full thickness, i.e., the scalpel blade creating the incision must contact bone. Confirmation of the incisions can be ascertained with a periosteal dissector.

Objective: Deep incisions enable subsequent full thickness flap detachment.

Rationale: Deep incisions allow subsequent full thickness, mucoperiosteal flap reflection granting access to bone, which is essential to access the surgical site for implant placement.



a b c

Figure 5.10: 15C scalpel blade in incising the crest of the alveolar mucosa (a). 15C scalpel blade making a relieving incision in the anterior area (b) and in the posterior area (c).

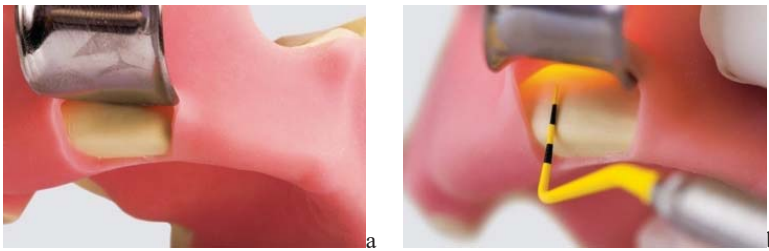
2. Flap reflection

Technique: Once the incisions are made, the full thickness flap should be raised using a periosteal elevator. A piezo can also be used for this purpose (insert #SLTV-O, CVDentus).

Clinical Tip: Flap elevation can be made substantially easier if performed from anterior to posterior.

Objective: To gain adequate access to the underlying bone to allow preparation of the surgical bed.

Rationale: Elevating a mucoperiosteal flap.



a b

Figure 5.11: Raised buccal flap (a). The light beam inside the plastic model head reveals the height of the maxillary sinus (about 7 mm from the top of the bone crest) (b).

3. Drilling

Technique: Once the flap has been elevated, a spear point drill and, subsequently, a 2 mm diameter twist drill are used on a 20:1 speed-reducing contra-angle coupled to an electric motor at 800 to 1200 rpm under constant saline irrigation. The drills are driven into the alveolar bone until the drill tip reaches between 1 and 2 mm from the maxillary sinus floor based on prior radiographic planning.

Objective: The use of drills creates an open crest to allow the insertion of osteotomes to push against the thin maxillary sinus floor.

Rationale: Deepening the drills towards the maxillary sinus floor leaves a small bone wall (1mm to 2mm thick) along the sinus floor, which facilitates the insertion of osteotomes to break the remaining bone in a controlled manner.

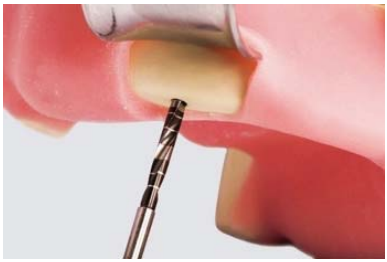


Figure 5.12: 2 mm diameter twist drill inserted until the tip is approximately 1 to 2 mm from the maxillary sinus floor.

4. Osteotomy using Summers' osteotomes

Technique: Following the initial drilling, a Summers' osteotome kit is used to enable fracturing through the remaining bone separating the sinus floor. A surgical mallet should be used to strike the osteotome. Calibers from the instrument kit (similar to the diameter of drills from the surgical kit) are used to determine the depth of the preparation. For example, to place a 3.75 mm diameter implant, the socket preparation should be completed with a 3 mm diameter twist drill to accommodate the 3 mm diameter osteotome.

Objective: To break through the remaining apical bone wall.

Rationale: Breaking the apical bone wall grants access to the maxillary sinus lining for lifting.

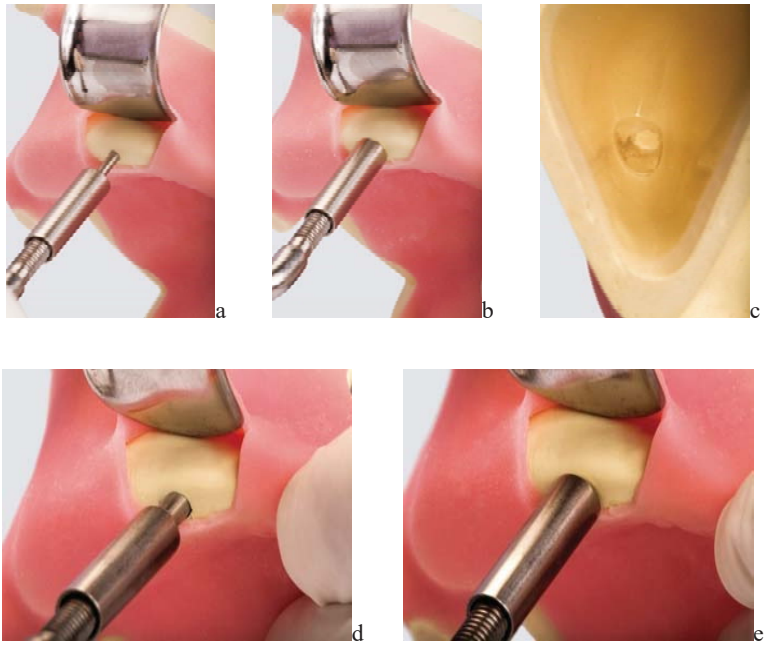


Figure 5.13: The 2 mm diameter osteotome is used to raise the floor of the maxillary sinus by 2 mm. Note that the osteotome stop is set to prevent further penetration (a–b). The bone preparation and elevation of the sinus membrane can be seen from an internal view of the maxillary sinus (c). The 3 mm diameter osteotome is used to raise the floor of the maxillary sinus by 2 mm. Note the stop of the instrument set to prevent further penetration (d–e).

5. Bone Grafting

Technique: Following hydration with saline, the graft material is inserted into the sinus cavity through the opening created by the twist drills with the help of the last osteotome used (larger caliber). The depth into which the graft should be positioned can be monitored using the markings on the osteotome.

Clinical Tip: Unlike grafting using the lateral window technique, the transcrestal technique requires the use of small granules of biomaterial, due to the limited access through the small diameter of the implant osteotomy.

Objective: Fill the space created with mineralized material.

Rationale: Mineralized biomaterials appear to be the best grafting material for the maxillary sinus.


a

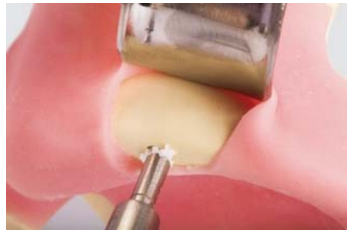

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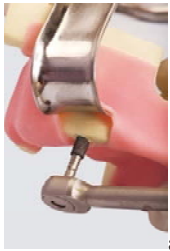
Figure 5.14: The 3 mm diameter osteotome being used to insert the Xenograft biomaterial (small particles) (a–b).

6. Implant placement

Technique: Once the bone graft has been inserted, the implant can be placed in a conventional fashion (for details of the procedure, see Chapter 1) through the same opening used to deliver the bone grafting material.

Objective: Install the implant into the surgical cavity.

Rationale: If the remaining bone will allow adequate primary stability, an immediate implant placement would reduce the treatment time.


a


b

Figure 5.15: Following insertion of the bone graft to the apical portion of the surgical socket, the implant is installed in a conventional manner (a–b).

7. Suture

Technique: Once the implant has been installed and a cover screw connected, suturing the surgical wound edges is performed using simple interrupted sutures. Keeping the knots away from the incision lines

minimizes the problems related to biofilm accumulation and scarring. The use of monofilament sutures has the added benefit of hindering bacterial build-up.

Objective: Allow healing by primary intention.

Rationale: Adequate approximation of the edges of the wound enables effective healing.

Figure 5.16: Single interrupted sutures with care taken to leave the knots off the incision line.

PART 2

PROCEDURES FOR TEETH-SUPPORTED PROSTHESES

Part 2 of this manual is intended to describe the clinical procedures in Prosthodontics step-by-step, according to the EPPIC team's (a Portuguese acronym for Campinas' Periodontics, Implantology, and Prosthodontic Team) protocol. Such procedures are adopted for training students and in our daily clinical practice.

It is essential to point out, however, that every prosthetic procedure requires a wide range of prior planning based on systematic data collection, which is not part of this textbook, as it is a "practical" guide rather than a "conceptual" study. It is, therefore, important to keep in mind that the procedures described herein can only be successful if they are carried out within the specific indications of each case and based on careful planning.

The area of Prosthodontics is extensive and demands a good grasp of many techniques and many details. It is a fact that in a small space—like a textbook—one cannot cover all aspects of prosthetic dentistry. It is also a fact that changes in the area of Oral Rehabilitation have occurred very quickly in recent times, which has generated new techniques and new materials.

CHAPTER 6

SEMI-ADJUSTABLE ARTICULATOR MOUNTING AND OCCLUSAL APPLIANCES

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INTRODUCTION

Articulators have been part of dentistry for many years and are typically used for occlusal analysis, diagnosis, treatment planning, preparation of indirect restorations, and oral rehabilitation. These devices, as the name suggests, serve to articulate opposing casts of the maxilla and mandible in order to simulate the mandibular movements. They are mechanical instruments that represent the temporomandibular joints, the mandible, and the maxilla, simulating the relationship between the maxillary and mandibular teeth. Currently, the most cost-effective and time-saving devices are semi-adjustable articulators (SAA).

SAA are devices that simulate some mandibular movements, such as protrusion, lateral, opening, and closing. They have adjustable condylar distances and also allow adjustments of the angle of the articular eminence and the angle of Bennett.

Despite such an array of possible applications, articulators have some limitations regarding the full simulation of an *in vivo* masticatory system, e.g., rigid instruments and limited movements in addition to their straight condylar guides, which are unlike the human anatomy. Consequently, there may be some difficulty in precisely reproducing the movements of rotation and translation of the condyle in the temporomandibular joint, since SAA have no articular disc. Because of these limitations, it is common to find articulators that have average fixed values for the intercondylar distance, the eminence angle, and the angle of Bennett.

SAA are composed of several parts that are articulated together: a body, which will house the maxillary and mandibular branches, onto which the stone casts are fixed; the condylar guides, which articulates with the condylar posts; and the incisal pin, which aims to guide the lateral and protrusion movements between the two branches in the three spatial planes––horizontal, frontal, and sagittal.

The facebow is an accessory device of the SAA, which is usually used to transfer the spatial position of the patient's jaw relative to the TMJs and the cranium base to the articulator. This, in turn, is achieved by mounting the maxillary cast, whereas interocclusal registration is used for mounting the mandibular cast, which may vary according to its purpose (see Table 6.1).

Materials used in this Chapter

- Semi-adjustable articulator preferably standardized for interchangeable mounting (model A7 Plus—Bio Art)
- Facebow (model Elite, Bio Art)
- Alcohol burner lamp
- Alginate
- Alginate powder scoop and water measure set (specific for the alginate brand used)
- Auto-polymerizing acrylic resin
- Beading wax
- Bite wax
- Bowl and spatula for alginate
- Bowl and spatula for dental stone type III
- Bowl and spatula for die stone type IV
- Carver LeCron Standard
- Cotton
- Dental Stone type III
- Die stone type IV
- Hermetic plastic housing (Humidifying chamber)
- Huffman's Leaf Gauge
- Impression compound sticks
- Set of stainless-steel impression stock trays
- Silicone for bite registration with the respective dispenser and mixing tip
- Silicone-based hot glue gun
- Thin double-sided occlusal marking paper
- Two Miller Forceps
- Vibrator

- Wooden spatulas


a


b

Figure 6.1: (a) Semi-adjustable articulator (BioArt model A7 Plus). (b) Elite facebow (BioArt).

Obtaining Diagnostic Casts

1. Stock Tray Selection

Technique: Select the most appropriate size of stock trays, trying them in the patient's mouth for both arches. Ideally, the tray should cover all teeth maintain a distance of 3 to 5 mm from all oral tissues (see more details in Chapter 10).

Purpose: To prevent patient discomfort and to ensure enough space to impression material in all directions.

Rationale: The selection of the proper size of the stock tray allows comfort to the patient and avoids distortions caused by the irregular thickness of the impression material along the mucosae.


a


b

Figure 6.2: (a) Stock trays set. (b) Stock tray selection covering all teeth surfaces and ensuring no contact with the oral tissues.

2. Stock tray individualization

Technique: The stock tray can be modified with beading wax covering its edges of the maxillary and mandibular trays. After putting the wax over the tray flanges, it must be heated in order to soften the wax, which encourages plastic deformation and facilitates adaptation along the buccal sulcus. Heating can come from a flame lamp or immersion in hot water. For the maxillary arch, gently draw the maxillary lips down to shape the wax. In the mandibular arch, in addition to gently pulling the mandibular lip up, ask the patient to move his tongue up and out of the mouth.

After defining the walls of the individualized tray, it is useful to customize the palatal area with wax or with putty silicone. After this, the insertion path should be rehearsed.

Objective: To help contain the alginate and ensure that the most profound aspect of the buccal sulcus is copied uniformly and also to determine the tray position that will be used at the moment of the impression.

Rationale: Reproduce hard-to-reach areas and control the thickness of the impression material, which avoids distortions. It also facilitates the insertion of the tray during the impression, making the procedure more straightforward and accessible.


a

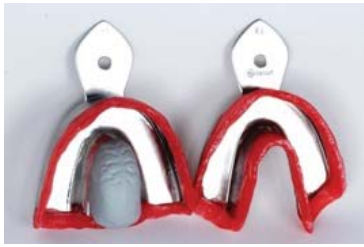

b

Figure 6.3: (a) Accommodating the wax around the edges. (b) Adapted maxillary and mandibular stock trays.

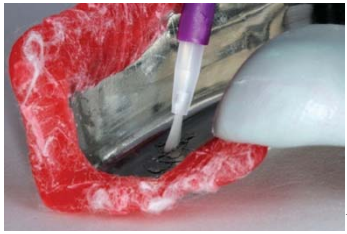
3. Improve alginate retention

Technique: The alginate retention can be improved by cutting several grooves into the wax and also into the putty silicone using a LeCron spatula. Afterwards, cotton wool is rubbed against the wax.

Objective: Optimize alginate retention.

Rationale: Improving mechanical retention of the impression material diminished, reduces the odds of distortion or even displacement.


a


b


c

Figure 6.4: (a) Grooves made in the wax and the putty silicone. (b) Applying adhesive on the inner surfaces of the tray and the silicone. (c) Finished appearance of the individualized tray after cotton.

4. Alginate preparation and manipulation

Technique: Using the dosing set provided by the manufacturer, mix water and powder (usually 2 scoops for the mandibular tray and 3 for the maxillary tray). First, place the water in the mixing bowl and then add the powder at the time of mixing, which should be vigorous against the flexible wall of the rubber bowl, following the time recommended by the manufacturer.

Purpose: To obtain a homogeneous dough.

Rationale: Adding the powder to the water increases the homogeneity of the alginate, which reduces the formation of air bubbles within the material.


a


b

Figure 6.5: (a) Alginate and specific dosing kit according to the selected brand. (b) Alginate manipulation in a rubber bowl.

5. Loading the tray

Technique: Fill the previously individualized tray with the impression material quickly as homogeneous as possible.

Clinical Tip: Load the tray close to the edges so that the alginate does not flow out and down the patient's throat.

Purpose: The material must occupy the entire length of the tray within the working time stipulated by the manufacturer.

Rationale: Prevent the material from setting during the loading of the tray.

Figure 6.6: Loading the tray with alginate.

6. Impression taking

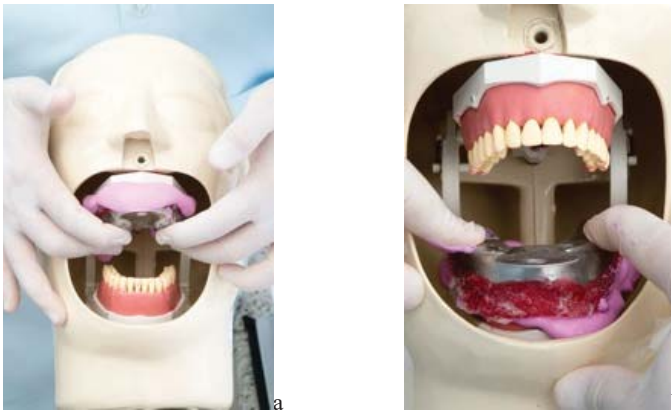
Technique: With the patient positioned at approximately 60-degrees, take the loaded tray into the patient's mouth by pushing away one of the labial commissures. After that, center the tray according to the maxillary arch and

the midline (as was defined and rehearsed previously), position parallel to the occlusal plane, and then push it in only one direction and movement against the arch. The maxillary lip and the perioral tissues should then be drawn. Keep it in position for the entire setting time recommended by the manufacturer. It is not recommended to move the tray during the setting time. Tray removal should be done in a single, quick movement.

The sequence is the same for the mandibular arch. Right after the tray is seated, instruct the patient to lift and move his tongue.

Objective: Copy the arches accurately.

Rationale: Tray removal before the material setting causes severe distortions.



a b

Figure 6.7: (a) Correct position of the tray for the maxillary arch. (b) Position of the tray during the mandibular arch impression.

7. Evaluation and disinfection of the impressions

Technique: The evaluation of the impression must be done visually after cleaning the surface with tap water and gently drying it with blown air. The visual analysis aims to find out the presence of any type of failure, such as air bubbles or the exposure of the wax in noble areas; the failure to copy any critical area of the mouth (including buccal sulcus); and any shriveled, distorted, or torn areas.

The mandibular impressions should be finalized by sealing the tongue area with alginate.

The impression should be disinfected by spraying 1% sodium hypochlorite for 1 minute and then rinsing under running water. According to the alginate characteristics, it is recommended to pour the die stone immediately. In case that is not possible, the impressions must be stored inside a humidifying chamber.

Objective: Evaluate the impression tends to guarantee the quality of the procedure, which allows the obtaining of accuracy casts.

Rationale: The use of decontamination protocol is vital to prevent cross-infection and to protect the entire work team, including the laboratory staff.


a


b

Figure 6.8: (a) Evaluation of the maxillary mold. (b) Evaluation of the mandibular mold.

8. Pouring the impressions

Technique: Die stone type IV should be mixed in a specific rubber bowl, according to the water:powder ratio recommended by the manufacturer (similar to alginate, it is also recommended that the water is poured into the bowl before the plaster powder). The mixing time should also follow the manufacturer's recommendations. Pouring should be performed on a vibrator, with a stone positioned on the side walls letting it flow down to the teeth areas. This maneuver must be done until the entire impression is filled. At this point, the professional may choose between filling the whole impression with die stone type IV or using dental stone type III gypsum for the final filling. In this case, it is necessary to promote some retentions before pouring the dental stone type III, which should be done only after the first layer is completely set. In the case of alginate impressions, it is recommended that the final set of the stone takes place in a humidifying chamber. Once the stone is set (about 40 minutes), the cast is removed from the impression and ideally finished by trimming the excess material around it.

Objective: The correct technique allows to obtain a high-quality cast which has adequate resistance and is free from bubbles.

Rationale: In many cases, the cast is the only information the lab staff has access to regarding the situation of the patient's mouth and so it must, therefore, transmit quality information.

a b c

d e f

Figure 6.9: (a) Follow the correct water:powder ratio determined by the manufacturer. (b) Pouring the impression with die stone under vibration. (c) Retention maneuver in type IV die stone for mechanical imbrication to dental stone type III. (d) Aspect just after pouring dental stone. (e) Impression inside a humidifying chamber awaiting the final set of the stone. (f) The final aspect of the diagnostic casts.

SEMI-ADJUSTABLE ARTICULATOR

Introduction

A semi-adjustable articulator is defined as a mechanical instrument that represents the temporomandibular joints and jaws, to which maxillary and mandibular casts may be attached to simulate some or all mandibular movements. It is a tool that can be used for diagnostic, planning, or treatment.

The mounting of the SAA is done in two stages: first positioning the maxillary cast and then the mandibular cast.

The maxillary cast can be mounted in several ways: using a facebow for registration, with a mounting platform representative of the Camper plane, or a plane parallel to the ground or even in a random position. For this chapter, the SAA will be mounted using a facebow, as it is the most popular method and also the most complex.

The mandibular cast is assembled from an interocclusal record, which varies according to the purpose of SAA mounting (diagnostic, occlusal splint, treatment planning, or many other kinds of treatment). This assembly can be done following two references: Centric Relation (CR, representing the ideal position of the TMJ) or Maximal Intercuspal Position (MIP, representing the present status of the teeth). In the case of MIP assembly, no material of any kind is used, the casts are simply placed in occlusion against each other. In cases where the reference is the TMJ, CR recording is completed according to the goal of the mounting and, consequently, the desired vertical dimension (see Table 6.1).

Table 6.1: Guidelines for interocclusal record and articulator mounting according to the type of conduit.

AIM	Occlusal Vertical Dimension	Mandibular Position	Interocclusal Record	Incisal Pin position
Treatment (short fixed partial dentures)	Present	MI	Unnecessary	Zero
Occlusion analysis	Present	CR	"Premature contact"	Compensating for the record thickness (usually position +2mm)
Treatment planning	Ideal	CR	Ideal OVD	Zero
Occlusal splint	Increased	Spontaneous mouth closure	1–2 mm before occlusal contact	Zero
Complete dentures	Estimated	CR	Orientation planes (Rims)	Zero

CR (centric relation); MI (maximum intercuspal)

SEMI-ADJUSTABLE ARTICULATOR MOUNTING FOR OCCLUSAL ANALYSIS

The indication of occlusal analysis occurs when the patient is indicated and when a diagnostic of the occlusion status is necessary in cases that do NOT need alteration of the occlusal vertical dimension.

1. Positioning the occlusal fork in the maxillary arch

Technique: Establish three points on the fork (one in the most anterior region of the arch and two posteriors: one on each side) with an impression compound or with silicone for the interocclusal record. The center of the fork must coincide with the facial midline, which does not always coincide with the maxillary central incisors' midline. After the establishment of the

correct position, the fork is pushed vertically against the maxillary teeth and stabilized until the set time of the material. The stability of the fork should be checked after the hydrocolloid has cooled down.

Clinical Tip: In cases of over erupted posterior teeth, use them for registration, and compensating the height of the impression compound material for the other reference teeth.

Objective: Record the maxillary arch onto the occlusal fork.

Rationale: The maxillary cast must be stabilized on the fork for mounting.

a

b

Figure 6.10: (a) Aligning the fork in the maxillary archway from two three-point impression compound. (b) Final positioning of the fork in line with the facial midline.

2. Positioning the transfer set on the face

Technique: The fork must be fitted and locked in the transfer set. The positioning of the transfer set is performed first from within each auditory meatus and then the third (anterior) point made by the nasion (most common) or by the infraorbital reference point. It is important to note that, in all these steps, each bolt corresponding to the area must be securely tightened.

Objective: The facebow records the spatial relationship of the maxillary arch to some anatomic reference point or points and then transfers this relationship to an articulator; it orients the dental cast in the same relationship to the opening axis of the articulator.

Rationale: The position of the cast in the SAA must be as most accurate as possible in order to achieve better results from the diagnosis.

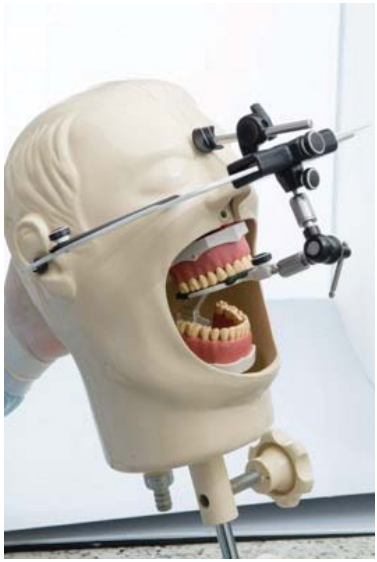


Figure 6.11: Correct positioning of the facebow to record the maxillary arch.

3. Mounting the maxillary cast

Technique: The fork portion of the transfer should be removed from the facebow wings and mounted to the base of the articulator using the transfer assembly. This base should be attached to the mandibular arm of the articulator. The maxillary cast is attached to the fork and the maxillary mounting plate with mounting stone. In order for the stone to adhere to the cast, it is recommended to groove retentions in the base of the maxillary cast. In addition, the base of the cast must be rehydrated.

Objective: To ensure the right position of the maxillary cast according to the base of the skull and the TMJs.

Rationale: In order for the SAA to be able to simulate the mandibular movements accurately, the distance from the cast to the TMJ must be as accurate as possible.

Figure 6.12: Maxillary cast mounted through the transfer set attached to the lower branch of the SAA.

4. Interocclusal record

Technique: The mounting of the mandibular cast starts with the interocclusal record of the position needed. In order to facilitate positioning and reproducibility at the moment of the record, the use of a calibrator (JIG or Leaf-gauge) is recommended. In the case of CR recording, one must confirm whether the patient's mandible can be manipulated into CR and also establish the height of the record. In cases with occlusal analysis purposes, the record should be completed leaving as little space as possible before the premature contact, which is achieved with the calibrator previously programmed. The ideal record material should be very soft at the time of registration and rigid upon removal. Although not ideal, the most commonly used material is wax, but auto-polymerizing resin or silicone specific for interocclusal record is preferable, which promotes more predictable outcomes.

💡***Clinical Tip:*** Capitalize on the fact that the patient is wearing a gauge and write down on the patient's record where there is premature contact. It will be useful in the verification of the SAA mounting.

Objective: Define the position of the mandibular cast according to the mounting goal.

Rationale: The right position of the mandibular cast on the SAA depends on the accuracy and the stability of the record in both casts.

a b c

Figure 6.13: (a) Occlusal record using a JIG and silicone (Futtar). (b) Record made using leaf-gauge and auto-polymerizing resin. (c) Record in wax.

5. Mounting the mandibular cast

Technique: First, the interocclusal record must be correctly adapted to both casts, so it has to be tested and, if necessary, trim it in order to let it be stable. After that, it is necessary to adjust the settings for mounting to occlusal analysis (Table 6.1), and the incisive pin should be located in the +2mm position (in order to compensate for the thickness of the recording material). Then, with the maxillary cast already mounted, the articulator must be turned upside down. The interocclusal record should be seated between both casts, which must be secured to each other so that they do not change position during mounting procedures. A suggestion here would be using wooden spatulas and hot glue to join the casts together. A little hot glue should be deposited on the sides of the maxillary and mandibular casts, and then wooden spatulas are fixed to the glue at both ends. The cast is attached to the mandibular mounting plate with mounting stone (the same as the maxillary cast). The incisal pin must be touching the incisive plate throughout the setting of the stone.

Clinical Tip: For gluing to be effective, the casts must not be wet.

Objective: Define the position of the mandibular cast on the articulator in relation to the maxillary cast, according to the position registered in the mouth.

Rationale: The relationship of the casts to each other is fundamental so that the mandibular movements can be adequately simulated.

a b c

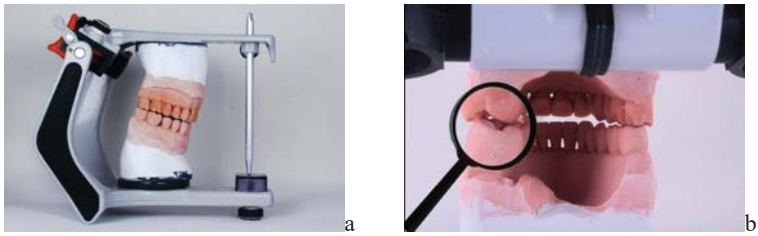
Figure 6.14: (a) Interocclusal record positioned between the maxillary and mandibular casts (note the retention indents made in the base of the cast to aid stone retention). (b) Arrow indicating the +2 position of the incisal pin. (c) Mandibular cast during mounting (note the attachment of the casts to each other using wooden spatulas and hot glue).

6. SAA Mounting Check

Technique: Once mounting is complete, it must be checked whether it is correct. It is, therefore, necessary to remove the occlusal registration and place the incisal pin at the zero position (or very close to it) for the casts to migrate to the MIC position. In this procedure, it is necessary to detect premature contact on the SAA. Premature contact should be the same as in the mouth

Objective: To detect possible mounting errors.

Rationale: When the SAA is mounted incorrectly, it may not adequately reproduce the relationship between the arches leading to a misdiagnosis.



a b

Figure 6.15: (a) Relation of the casts in the SAA after removal of the occlusal record and with the incisal pin at the zero position. (b) Premature contact detected on the SAA (should be the same as in the mouth).

OCCLUSAL SPLINT

Introduction

Occlusal devices are usually made in acrylic and may have a multitude of shapes, according to the indication and characteristics of the patient. The most used occlusal devices for protection of the stomatognathic system and rehabilitation treatments are **stabilization** occlusal appliances, which are also known as occlusal splints (OS).

The OS is characterized by covering only one arch (commonly the maxillary arch) and being 1 to 2 mm thick at the shortest distance between opposing teeth. They are usually made from thermo-polymerizable acrylic resin, have a flat occlusal surface, and provide a smooth lateral disocclusion on canines.

When performed correctly, the OS provides an ideal situation for the patient's masticatory system, promoting a stable position of the condyles against the articular eminence walls (stabilized TMJs in the ideal position), preventing further shortening of the masticatory muscles during parafunctional events, and distributing occlusal loads to all teeth. Consequently, they can be a great preventative tool for the masticatory system.

The use of an OS is therefore highly recommended in restorative dentistry, both before high complexity rehabilitation treatments and, later, to protect the treatments performed.

The fabrication method of the OS can be direct (with a thick resin sheet associated with auto-polymerizing resin), indirect (made with thermo-polymerizing resin), or digital (by printing or by milling). In the present chapter, the sequence presented is based on the indirect method.

The technique to fabricate an occlusal splint for the indirect method uses a SAA and diagnostic casts, usually with alginate impressions. However, in these cases, the mounting of the SAA is more straightforward compared to other types of mounting (Table 6.1). It is not necessary to use a facebow to fabricate the stabilization of OS, and the mounting of the maxillary can be done with a plate that simulates the Camper’s plane, making it simpler, faster, and more comfortable for the patient.

Therefore, in the first visit, the dentist needs to take the impressions and an interocclusal record. The installation of the OS is completed on the second visit.

A. First visit

1. Obtaining maxillary and mandibular casts

2. Interocclusal record

Technique: The interocclusal record is made using a calibrator to precisely determine the occlusal space that will be filled by the OS (thickness of the OS), and it is made using the same materials used for other occlusal registrations for diagnostic mounting (silicone, auto-polymerizing resin, or wax). Usually, the space required is 1–2mm between the teeth of the premature contact, and it can be calibrated with a leaf-gauge or a JIG.

Objective: Determine the best relationship between the arches to fabricate a comfortable and efficient OS.

Rationale: An incorrect relationship between the casts in the SAA leads to much trouble and time wasted when the dentist has to install and adjust the OS; it also requires more visits for the patient to achieve a complete adaptation to the OS.

3. Mounting the SAA for fabricating OS

Technique: The mounting process is the same as the occlusal analysis, although the mounting of the maxillary cast is different as it uses a Camper's plane platform instead of the facebow. This platform is attached to the lower branch of the SAA, and the maxillary cast is centered in it (the traces of the platform help to define the best position). Then, a mounting stone is placed to connect the cast to the plate of the upper branch. The rest of the process follows the same sequence presented before.

Objective: Enable SAA mounting quickly and efficiently.

Rationale: To gain time.

a b

Figure 6.16: (a) Maxillary cast positioned according to the Camper plane platform. (b) SAA mounted and showing the space that will be filled by the occlusal splint.

B. Second visit (Installation of the OS)

The acrylic OS is fitted to the patient's mouth in three steps:

1. Internal adjustment (adaptation to maxillary teeth)
2. Adjustment for opening and closing
3. Adjustment for excursive movements

Figure 6.17: Stabilization acrylic occlusal splint

4. Internal adjustment

Technique: The internal adjustment is made with thin marking film to the inner aspect of the OS until the patient feels comfortable with it. Only the markings that match the tightening complaint reported by the patient should be removed. Adjustment should be performed using a fine cylindrical tungsten carbide cutter or spherical drill.

Objective: To ensure comfort to the patient when wearing the OS and without pressing the maxillary teeth.

Rationale: Some patients fail to wear their OS correctly due to discomfort of tightening of their teeth and, when poorly adjusted, an OS may traumatize the teeth.


a


b


c


d

Figure 6.18: (a) Area for internal adjustment. (b) Marking paper positioned for internal checks and adjustment. (c) Adjusting the inner aspect of the splint. (d) Occlusal splint internally adjusted.

5. Opening and closing adjustment

Technique: The external adjustment (occlusal adjustment of the plate) only begins after the patient feels comfortable with the OS. This adjustment is made with thin articulating paper using two Miller forceps simultaneously. The patient is asked to open and close the mouth with the articulating paper interposed between the OS and the mandibular teeth (the black side facing the device). The appliance is then adjusted using a tungsten carbide cutter positioned horizontally to the appliance (to keep the edges always smooth). This adjustment must be made until contact is established on all mandibular teeth against the appliance.

Objective: Distribute occlusal loads evenly.

Rationale: With the contacts properly distributed, no tooth will undergo excessive occlusal loading, which will, in turn, protect the entire masticatory system.

a b c

Figure 6.19: (a) Position of the articulating paper for occlusal check and adjustment. (b) Appearance of the splint after marking and adjusting on opening and closing. (c) The correct drill position perpendicular to the flat surface of the splint.

6. Adjustment in excursive movements

Technique: The adjustment for the excursive movements only begins after the adjustment at opening and closing is finished. This adjustment is made using fine red marking paper and also using two Miller forceps simultaneously. The patient is asked to perform lateral and protrusive movements. It is desirable to have no red marks or traces on the area of the posterior teeth, horizontal traces on the canine region (evidencing canine disocclusion), or vertical traces in all anterior teeth (showing an anterior disocclusion pattern). The analysis of the movement must show a smooth movement.

The adjustment is made with the tungsten carbide cutter drill positioned horizontally to the appliance. It should only be finished when there is no red contact on the area of the posterior teeth of the appliance or the incisor region. It is therefore key that only two lines are left—one on each canine.

Objective: Provide ideal lateral and protrusive guidance for the mandible.

Rationale: Harmonious excursive movements demand less muscular activity than unbalanced excursions, which also prevent levered movements of the appliance. This increases its effectiveness and promotes comfort to the patient.

a b

Figure 6.20: (a) Position of the articulating paper for occlusal check adjustment during excursive movement. (b) Appearance of the appliance after adjustment, with black contacts for all teeth, lateral guides on the canines, and protrusion on all anterior teeth.

Final characteristics of the occlusal splint

- Must be stable and retentive.
- All teeth must have contact with the flat surface of the device.
- Eccentric contacts only on anterior teeth in a smooth pattern.
- In the upright position, posterior contacts should be heavier than anterior contacts.
- Must be flat and polished.

CHAPTER 7

TEETH PREPARATION FOR RESTORATIVE PURPOSES

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INTRODUCTION

Tooth preparation is the process of the selective wear of the tooth structure in a predetermined amount and location within a sequence of pre-established operative steps, using selected and specific instruments in order to create space for restoration.

Tooth preparations must fulfill some criteria (mechanical, biological, adhesive, and esthetical) to be done effectively and to achieve the desired results:

A) *Mechanical:* This relates to the strength needed for the preparation to bear occlusal loads. In general, it is now known that such strength is provided mainly by the remaining healthy tooth structure. Therefore, the less tooth tissue removed, the stronger the restoration—respecting the minimum thickness required by the restoration material (for example, metal-ceramic crowns must be at least 1.5 mm thick). This criterion also includes the maintenance of the restoration and filling parameter, such as retention and stability.

B) *Biological:* Biological aspects are related to the preservation of periodontal and pulpal health. This parameter is, therefore, determined by the position of the cervical margin (periodontium) and by the conservative reduction of dentinal tissue in order to protect the pulpal tissue.

D) Adhesive: Maintenance of dental tissue, especially enamel, improves the adhesive. Therefore, the indication of partial coverage restorations has increased a lot nowadays.

C) *Esthetical:* This refers to the reflection and transmission of light in a way that mimics the optical properties of the natural teeth. It is a priority that the selection of material occurs before the preparation is carried out (whenever possible); therefore, this technique provides sufficient space for the lab technician to create the necessary optical effects. Usually, 1.5mm is the required space for crowns in the body part of the crown, and 2.0mm on the incisal area to mimic optical properties adequately.

In order to optimize the preparation, it is desirable to have a sequence of easy execution and, additionally, to do it is as quickly as possible, while achieving the predetermined goals and fulfilling all desirable requirements. Thus, one of our concerns was to design a technique that allows the professional to evaluate the performance during the preparation and to use the smallest possible number of steps and drills.

It is essential to highlight that the advent of new materials (ceramic or not) and the development of new adhesive restorative techniques allow many preparation designs. It is, therefore, crucial to understand the mechanical and esthetic characteristics of the selected materials to apply the correct indication and design.

The partial coverage restoration preparations must be as conservative as possible so that they do not interfere with the material strength, retention, and stability. When these principles are not correctly followed, the tooth structure and/or the restoration itself can be compromised in the medium or long term. Partial preparation techniques must focus on the adhesive concepts and, of course, be based on adhesive materials (glass-matrix ceramics, resin-matrix ceramics, or composites). As the variables on partial preparation designs are practically infinite, the recommendation is, first, to reconstruct the tooth with composite and, after that, wear the structures according to the selected design:

- *Inlay:* Preparations that accommodate indirect fixed intracoronal restorations, which do not evolve the cusps.
- *Onlay*: Preparations that accommodate an indirect partial coverage that restores one or more cusps and adjoins the occlusal surface.

- *Overlay*: Preparations that accommodate an indirect partial coverage that restores the full occlusal surface, thereby bonding the restorative material to the occlusal surface (also known as the "tabletop").

A crucial point is the quality of the surface and the definition of the cervical lines and walls. Because of this, our selection has major importance in the preparation procedure. So, the selection of the correct granulation and design maximizes the desired outcomes. Based on this statement, we adopted the use of an ultrasound with special diamond tips (these special tips are made from a direct diamond growth over the tip, which are different from conventional tips that have grains of glued diamond). This technology was patented by CVDentus.

This chapter will present the preparation techniques for full coverage crowns (in anterior and posterior teeth), and also the preparation for partial coverage (onlay technique). The preparation for laminate veneers is presented in Chapter 15.

Materials used in this Chapter

- Putty silicone
- Knife
- Motor + straight handpiece + contra-angle (or electric motor)
- Diamond burs (*the number of the burs described in this chapter is based on the Edenta brand)
- Clinical examination kit containing probe, clinical mirror, and tweezers
- Space calibrators (Fleximeter, Bausch) + occlusion spray (Arti-spray, Bausch)

SEQUENCE OF CROWN PREPARATION FOR ANTERIOR TEETH

The technique presented herein is focused on allowing sufficient space for bilayer restorations, such as ceramometal crowns as well as ceramics with alumina, zirconia (Y-TZP), or lithium disilicate copings with feldspathic ceramic coverage. This sequence can also be used for monolithic ceramic crowns made with zirconia, lithium disilicate, lithium silicate, feldspathic, or even composites.

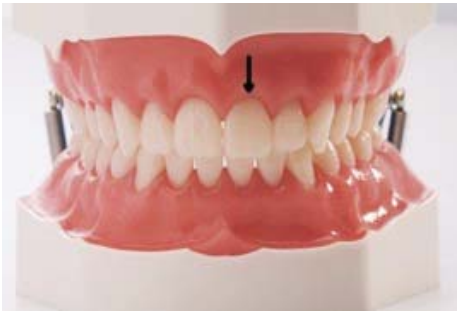


Figure 7.1: Target tooth is the left upper central incisor

1. Impressions for silicone index

Technique: Using putty silicone, and without a tray, take two impressions from the tooth to be prepared or from the diagnostic wax-up. In one of the indexes, make a cross-section and, in the other two, longitudinal sections, limiting the tooth to thirds (cervical, middle, and incisal).

Clinical tip: Leave the buccal aspect of the index quite thick and carry the material to the vestibule bottom area.

Purpose: Check the amount and pattern of reduction to accommodate the crown.

Rationale: Establish adequate reduction to provide esthetics and strength to the restoration as well as maximum preservation of healthy tooth tissue.

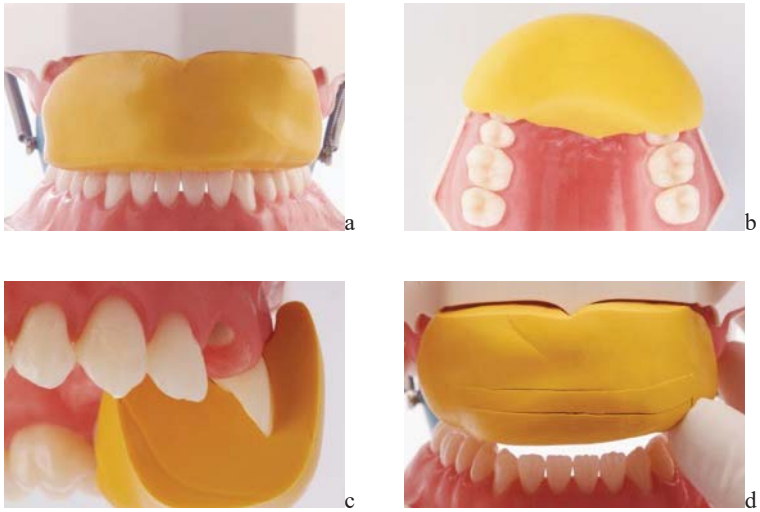


Figure 7.2: (a-b) making the silicone index without an impression tray. (c) Sagittal section. (d) Longitudinal sections.

2. Proximal reduction

Technique: Using a "pencil tip" diamond bur (G859.314.014) with a taper of approximately 5°, reduce the interproximal surfaces of the tooth at the expense of the target tooth opening a space of about 1.5 mm in the adjacent teeth.

Objective: To allow sufficient space for a larger bur (G850.314.014) that will be used, without touching the adjacent teeth.

Rationale: Preserve the adjacent teeth.

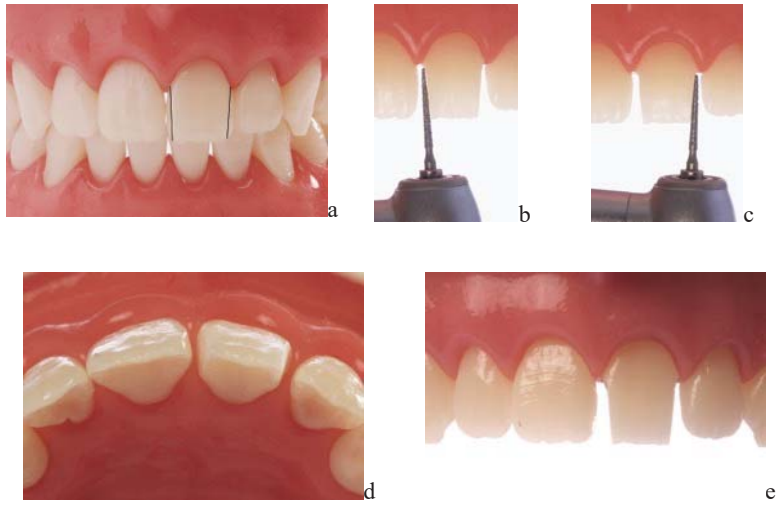


Figure 7.3: (a) Positioning the diamond burs to avoid the adjacent teeth. (b-c) Position of the diamond bur on each interproximal surface. (d-e) Incisal and frontal view of the reduced tooth.

3. Incisal reduction

Technique: Using a tapered with round edge diamond bur (G850.314.014) positioned approximately 40º to the long tooth axis, reduce the incisal edge by 1.5mm (this is the diameter of the middle portion of the active surface of the bur).

Objective: To determine the height of the prepared tooth and to provide space for the translucency and opalescence area of the ceramic.

Rationale: Determining the height in advance facilitates the establishment of the three buccal inclinations needed to provide the appropriate esthetic properties for the crown.

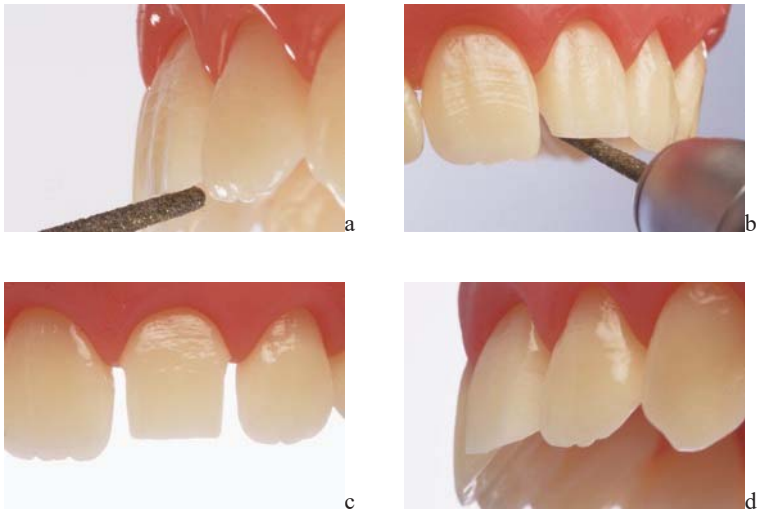


Figure 7.4: Positioning of the diamond bur in sagittal (a) and frontal (b) views. Frontal (c) and proximal (d) aspects of the reduced tooth.

4. Orientation grooves: buccal surface

Technique: Make orientation grooves using the full thickness of the same diamond bur (G850.314.014) on two inclinations: (1) cervical region, three grooves following the inclination of the long axis of the tooth; (2) incisal zone, two grooves following the original inclination of this area.

Clinical tip: Leave the first lot of preparations at the supragingival level.

Objective: To safely determine the adequate amount of reduction to accommodate the crown.

Rationale: The use of orientation grooves allows the reduction sequence to be performed more firmly and, therefore, with a lower risk of inaccuracy, thereby facilitating the finish line.

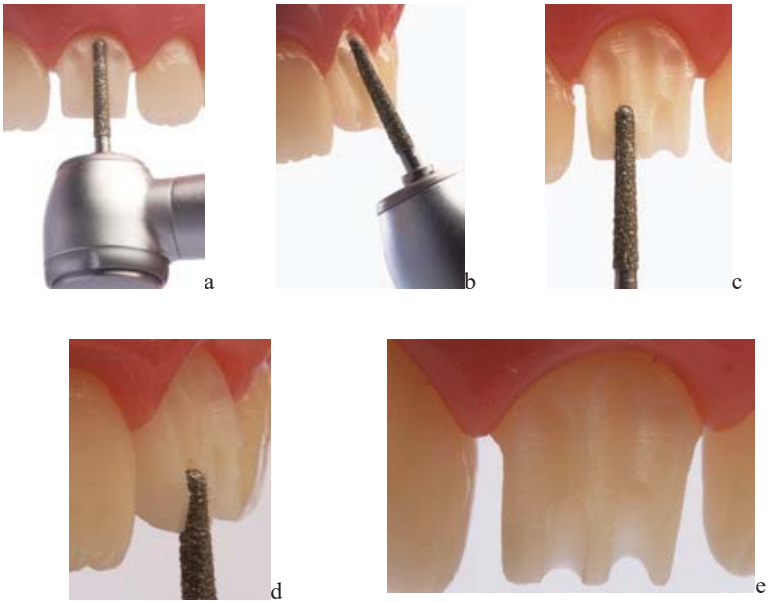


Figure 7.5: (a-b) Positioning the diamond bur on the first inclination in frontal and lateral views. (c-d) Positioning of the diamond bur for the second inclination. (e) Aspect of the prepared tooth in frontal view.

5. Joining the buccal orientation grooves

Technique: Join the orientation grooves with the same diamond bur (G850.314.014) following the same inclination and thickness of the orientation grooves. The interproximal surfaces should also be included at this stage.

Clinical tip: The use of the sagittally cut silicone index is indicated to check the reductions and, if necessary, make any corrections.

Objective: To predict the amount and the inclination of the esthetic region of the crown.

Rationale: The preparation of the buccal surface first, which is a critical region for the esthetic outcome, makes it easier to estimate the reduction needed in the palatal surface.

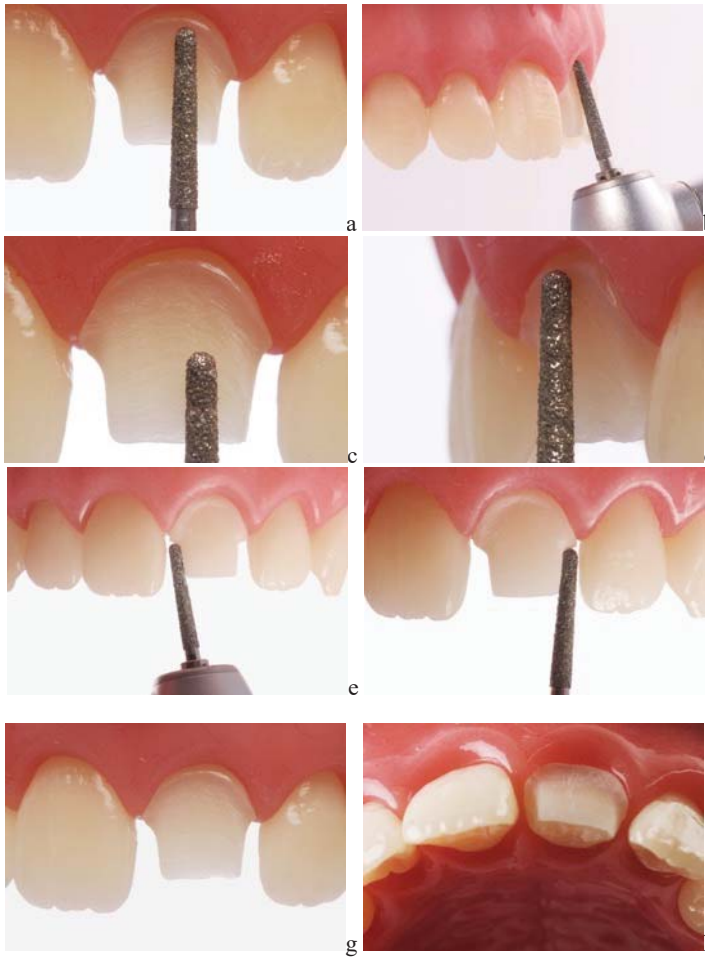


Figure 7.6: (a-b) Positioning the diamond bur on the first inclination—frontal and lateral views. (c-d) Positioning the diamond bur for the second inclination. (e-f) Positioning the diamond bur on the interproximal surfaces. (g-h) The aspect of the prepared tooth—frontal and incisal views.

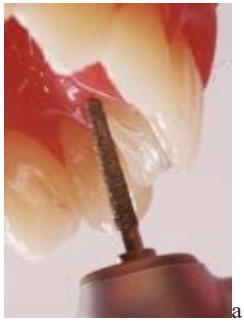
6. Palatal cervical reduction

Technique: Using the same diamond bur (G850.314.014), make reductions along the marginal gingival contour aiming at a rounded bevel finish line.

The bur must be parallel to the long axis of the tooth, along with the first inclination of the buccal area, in order to promote the main retention area.

Objective: To determine the cervical finish line of the palatal aspect of the tooth.

Rationale: The palatal cervical finish line defined before reducing the palatal concavity prevents a loss of retention during this phase. In the case of a pronounced cingulum, the cervical finish line on the palatal aspect may be left supragingival to facilitate impressions and plaque control.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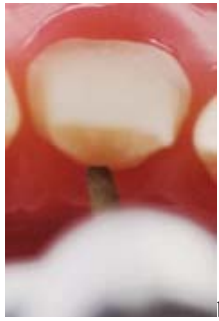
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c

Figure 7.7: (a-b) Positioning of the diamond bur along the long axis of the tooth in the cervical region. (c) Retention area.

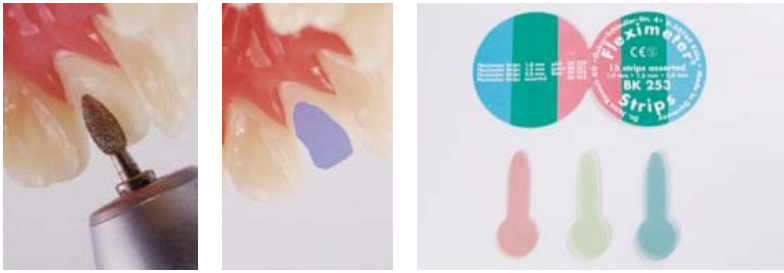
7. Palatal concavity reduction

Technique: Using a football-shaped diamond bur (G369.314.025), follow the same inclination of the palatal concavity for the prepared tooth and adjacent teeth. The depth of this reduction varies according to the interocclusal space, bearing in mind that a minimum area of 1.5 mm in height with uniform reduction must be left.

Clinical tip: Assessment of the reduced surfaces should be done with the patient closing into MIP and also during the excursion of the mandible. There are some space gauges available in the market (Bausch), which can assist in this assessment.

Purpose: To produce a uniform space for the ceramic, without affecting the retention areas of the tooth.

Rationale: Ceramics with uniform thickness are much more mechanically resistant when compared to crowns with high variable thickness.



a b c

Figure 7.8: (a) Positioning the diamond bur on the inclination of the palatal concavity of the tooth. (b) Reduced area not involving the retention area of the concavity. (c) Space calibrators to assess tooth reduction.

8. The buccal and interproximal cervical finish line

Technique: Using a tapered with round edge diamond bur (G850.314.014) positioned parallel to the long axis of the tooth, vertically deepen the cervical finish line in both the buccal and proximal areas. As the ideal position of the cervical finish line is a subject that has recently been revisited, for this manual, we will assume that it is at the 0.5mm intrasulcular mark. Placing a thin retractor chord (without chemical agents) may help define the position of the cervical finish line since the gingival biotype may considerably influence this decision and it also helps to protect the gingiva from any contact with the diamond bur.

Objective: To establish the design of the cervical finish line. In this case, we are using a wide bevel (rounded end).

Rationale: The position of the cervical finish line determines the degree of ease of molding and the tooth/restoration transition area. A rounded cervical finish line facilitates luting cement flow.

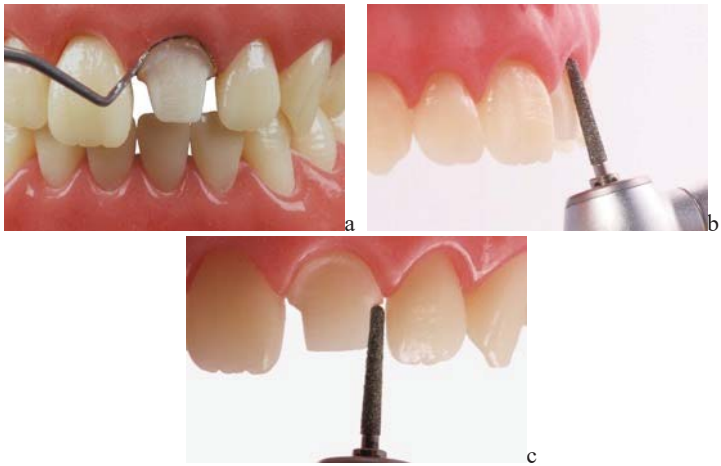


Figure 7.9: (a) Area to be reduced for adequate positioning of the cervical finish. (b) Diamond bur positioned along the long axis of the tooth on the buccal surface. (c) Diamond bur positioned along the long axis of the tooth on the interproximal surface.

9. Refining and polishing

Technique: Using the same design of diamond bur, but with minor granulation (C850.314.014) # 4138FF and/or polishing rubber stones, smooth down the entire preparation following the natural inclinations of the tooth. At this stage, the third inclination of the buccal area could be performed to facilitate the esthetic characterization of the ceramic.

Clinical tip: Polishing paper discs may be used to round the incisal angles.

Purpose: To leave the entire preparation with rounded edges and as smooth as possible.

Rationale: With the advent of new adhesive types of cement, there is no longer any need to leave preparations rough to increase friction retention. Smoother preparations facilitate impression taking and also cement flow, thus optimizing the adaptation of the final restoration.

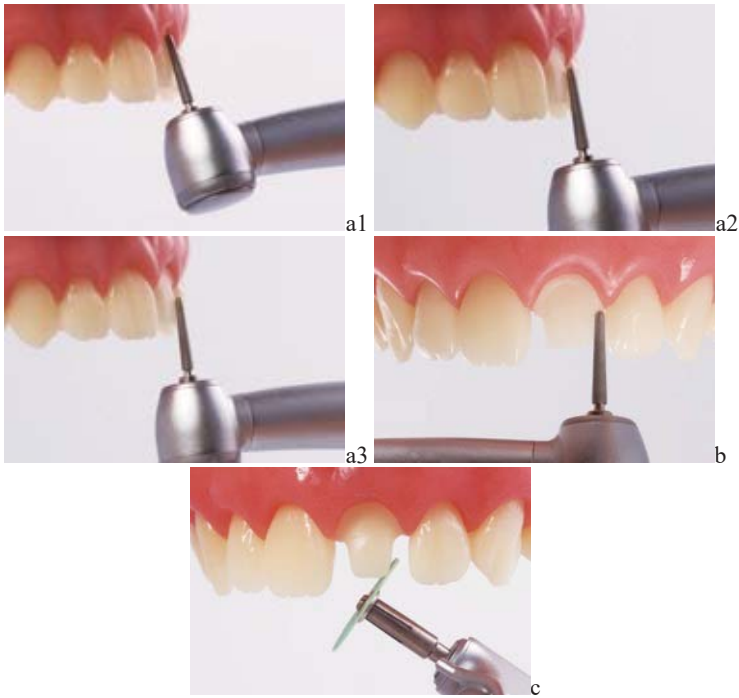


Figure 7.10: (a) Triple inclination of the buccal surface. (b) Diamond bur positioned at the interproximal angles. (c) Finishing the incisal angles with polishing discs.

10. Evaluation with the silicone index

Technique: Using the silicone index prepared before the preparation, check the depth and uniformity of reduction from both lateral and occlusal views for the cervical, middle, and incisal thirds.

Objective: To evaluate the final preparation form.

Rationale: If the preparation is not adequate, this evaluation allows for correction to take place.


a

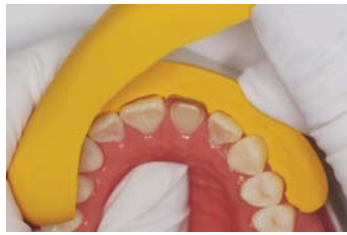

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Figure 7.11: (a) Side view of the reduced tooth. (b) Occlusal view of the reduced area at the three-thirds of the prepared tooth.

Final Preparation Characteristics

• Defined, regular, and very smooth cervical finish (green area)

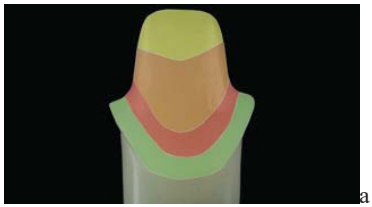
• Taper of 2º to 5º on all peripheral surfaces of the tooth, mainly 1/3 in the cervical surface (red zone)

• Greater taper in the middle third (5º to 10º) (orange area)

• Incisal taper (yellow area)

• Sufficient wear for esthetic characterization at the incisal edge (blue area)

• Uniform space according to the opposing tooth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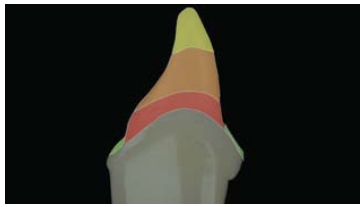
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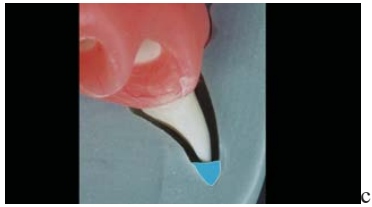
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Figure 7.12: (a–c) Different functional areas of the preparation.

SEQUENCE OF CROWN PREPARATION FOR POSTERIOR TEETH

Figure 7.13: Target tooth—Right lower first molar.

1. Initial impressions for the silicone index

Technique: Using heavy silicone without an impression tray, take an impression from the tooth to be prepared from the working wax-up. Cut the silicone index in half (cross-section in relation to the long axis of the teeth).

Purpose: To check the amount and reduction pattern to accommodate the crown.

Rationale: Achieve adequate reduction to provide esthetics and strength to the restoration, as well as the maximum preservation of sound tooth tissue.

a

b

Figure 7.14: (a) Putty silicone impression of the posterior teeth without a tray. (b) Silicone index.

2. Interproximal reduction

Technique: Using a "pencil tip" diamond bur (G859.314.014) with a taper of approximately 5°, reduce the interproximal surfaces of the tooth at the

expense of the target tooth to open a space of about 1.5 mm to the adjacent teeth.

Objective: To allow sufficient room for a larger bur to be used without touching the adjacent teeth.

Rationale: Preserve the adjacent teeth.

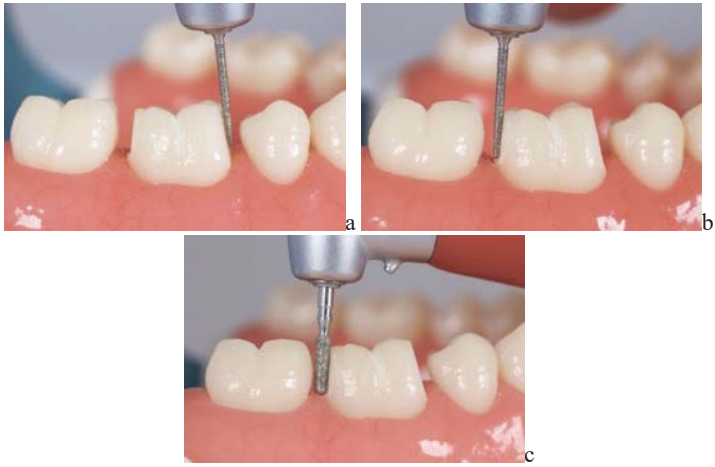


Figure 7.15: (a-b) Positioning of the diamond bur in the interproximal surface to avoid the adjacent teeth. (c) Space measurement using the diamond bur # 4138C.

3. Occlusal reduction

Technique: Reduce the occlusal surface by 1.0mm with a tapered with round edge diamond bur (G849.314.012) following the inclination of the cusps (slightly less than the active tip). After evaluating the orientation grooves, join them together using the same diamond bur and inclination of the grooves.

Objective: To determine the height of the prepared tooth, preserving as much tooth structure as possible, without affecting the mechanical and esthetic properties of the restoration.

Rationale: Establishing the depth of the preparation in advance facilitates establishing the two inclinations needed to provide the crown with the desired properties.

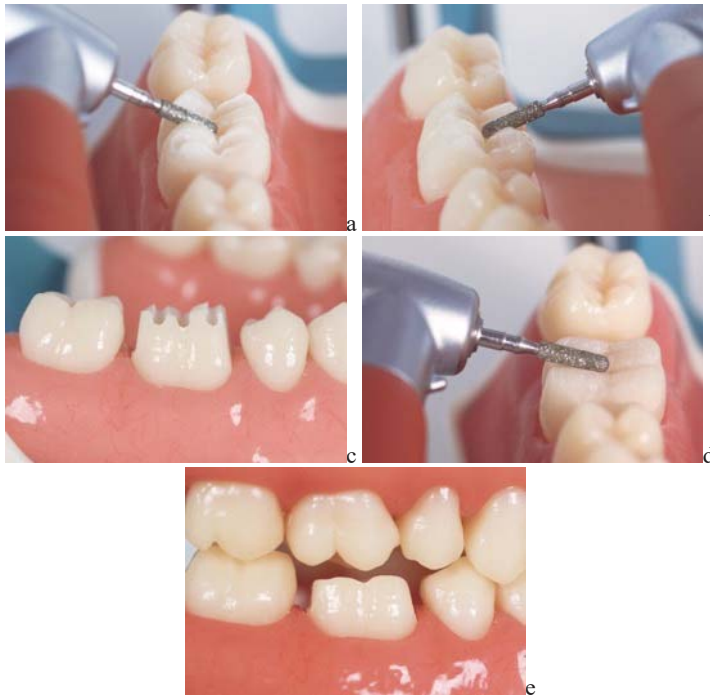


Figure 7.16: (a–b) Reduction of the orientation grooves on the buccal and lingual cusps. (c) Appearance of the buccal aspect of the tooth after the orientation grooves. (d) Joining the grooves. (e) The final aspect of the occlusal reduction concerning the opposing arch

4. Buccal orientation grooves

Technique: Make orientation grooves using the full thickness of the diamond bur (G849.314.012) on two inclinations: (1) cervical region, three grooves according to the inclination of the long axis of the tooth; (2) occlusal surface, two grooves following the original inclination of this area.

Clinical tip: Leave the first lot of preparations at the supragingival level.

Objective: To safely determine the adequate amount of reduction to accommodate the crown.

Rationale: The use of orientation grooves allows the reduction sequence to be performed firmly and, therefore, with a lower risk of inaccuracy, thereby facilitating the finish.

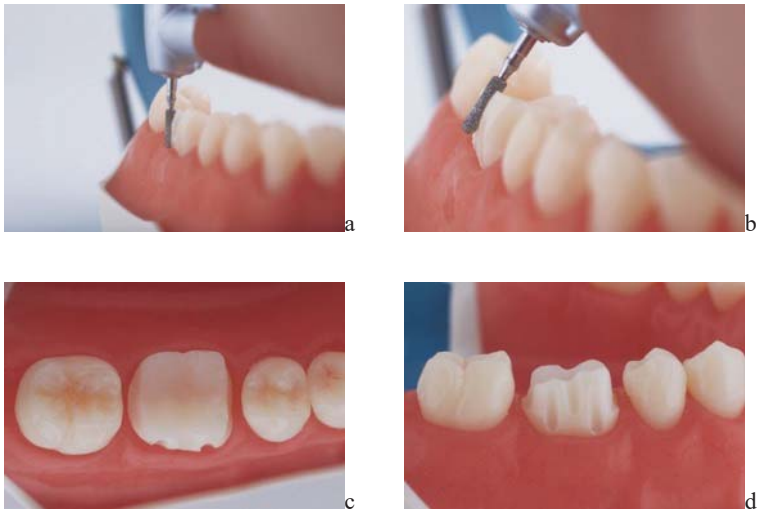


Figure 7.17: (a) Positioning the diamond bur on the first (cervical) inclination. (b) Positioning the diamond bur on the second inclination (occlusal). (c) Occlusal view of the orientation grooves. (d) Buccal view of the orientation grooves.

5. Lingual grooves

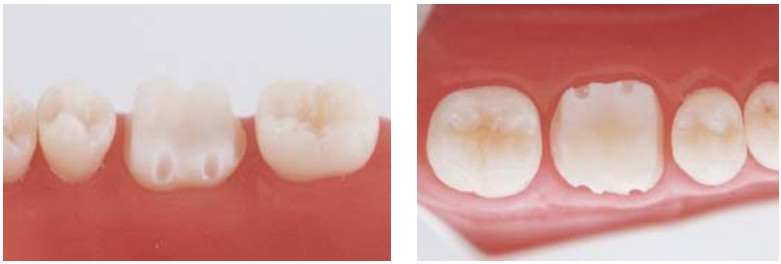
Technique: Make orientation grooves using the full diameter of the diamond bur G849.314.012) against the lingual surface.

Upper teeth: Two inclinations (cervical and occlusal).

Lower teeth: A single taper.

Objective: Safely determine the amount of reduction needed to accommodate the crown.

Rationale: Making orientation grooves allows the reduction sequence to be performed firmly and, therefore, with a lower risk of inaccuracy, thereby facilitating the finish.



a b

Figure 7.18: (a) Lingual view of the orientation grooves of the lingual surface. (b) Occlusal view of the buccal and lingual orientation grooves.

6. Joining the orientation grooves

Technique: Join the orientation grooves by grinding down the remaining untouched tooth using the same diamond bur (G849.314.012) and following the same depth (diameter of the diamond tip) and inclinations (cervical and occlusal).

Objective: Safely determine the amount of reduction to accommodate the crown.

Rationale: Making orientation grooves allows the reduction sequence to be performed firmly and, therefore, with a lower risk of inaccuracy, thereby facilitating the finish.

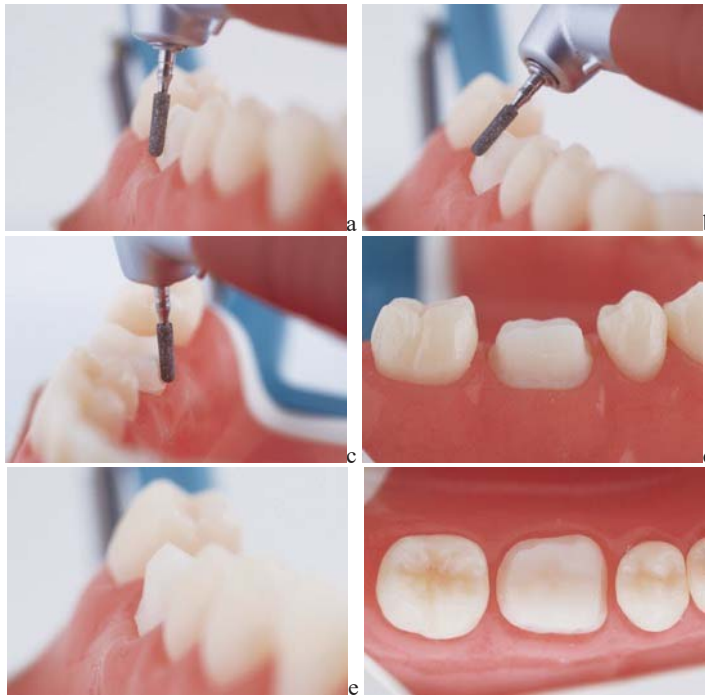


Figure 7.19: (a) Position of the diamond bur joining the orientation grooves in the first inclination. (b) Position of the diamond bur for joining the orientation grooves in the second inclination. (c) Position of the diamond bur for joining the orientation grooves on the lingual surface. (d-e) Buccal and interproximal views after joining the orientation grooves. (f) Occlusal aspect after joining the orientation grooves.

7. The cervical finish line

Technique: Using a diamond bur with the same design but minor granulation (F850.314.014) parallel to the long axis of the tooth vertically deepens the cervical finish into the buccal and proximal surfaces. In this region, whenever possible, keep the cervical finish at the supragingival level.

Objective: To determine the design of the cervical finish. In this case, we are using a wide bevel (rounded).

Rationale: The position of the cervical finish line influences the level of difficulty to take impressions and the tooth/restoration transition area. A round cervical finish line facilitates cement flow.

Figure 7.20: Preparation of the cervical finish line with a diamond bur positioned parallel to the long axis of the tooth.

8. Refining

Technique: Using the same diamond bur (F850.314.014), smooth down the entire preparation following the pre-established inclinations.

Clinical tip: The use of a 1:5 contra-angle significantly improves the outcome of this process.

Purpose: To regularize the preparation.

Rationale: Regularized surfaces facilitate the adaptation of the restoration.

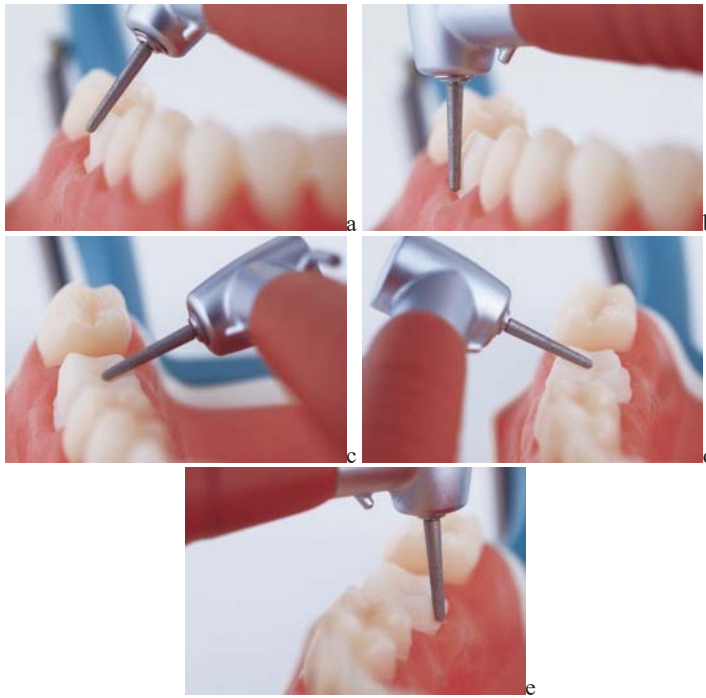


Figure 7.21: (a–e) Smoothing the walls of the preparation according to the predetermined inclinations.

9. Polishing

Technique: Polishing can be done with abrasive rubbers in decreasing order of grain on all prepared surfaces. Rounded angles can be achieved using sandpaper discs in decreasing order of grain.

Purpose: To leave the preparation as smooth as possible.

Rationale: Rounded angles are essential to prevent stress concentration. They are also critical in cases of milled restorations (CAD/CAM systems).

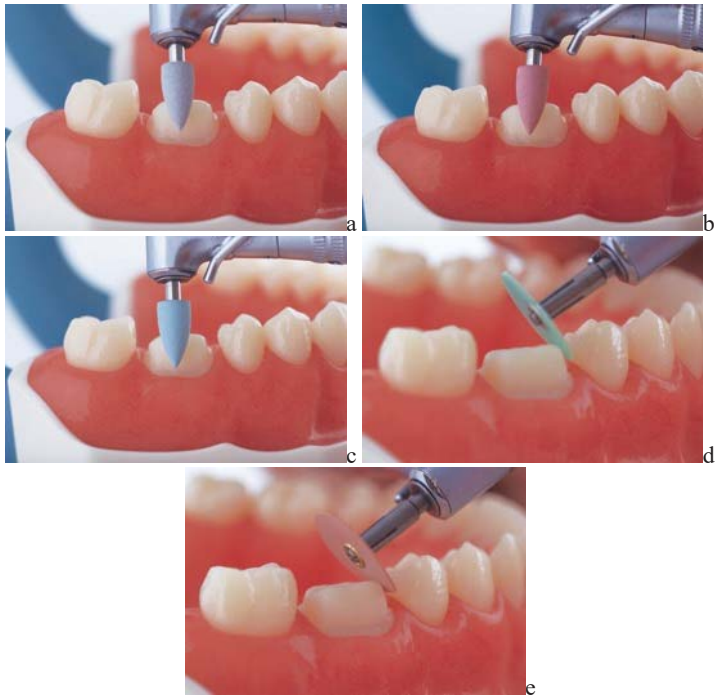


Figure 7.22: (a) Initial polishing with high granulation rubber (gray). (b) Polishing with medium granulation rubber (pink). (c) Final polishing with low granulation rubber (blue). (d) Rounding the sharp angles with high grain discs (green). (e) Angle rounding with small granulation discs (pink).

10. Evaluation with the silicone index

Technique: Using the silicone index prepared before the preparation, check the depth and uniformity of the reduction.

Objective: To evaluate the final preparation form.

Rationale: If the preparation is not adequate, this evaluation allows for correction to take place.

Figure 7.23: Proximal view of the reduction and the silicone index.

Final Preparation Characteristics

- Defined, regular and very smooth cervical finish line
- Taper of 2º to 5º on all peripheral surfaces of the tooth, mainly 1/3 in the cervical surface
- Greater taper in the middle third (5º to 10º)
- Rounded angles
- Uniform space according to the opposing tooth

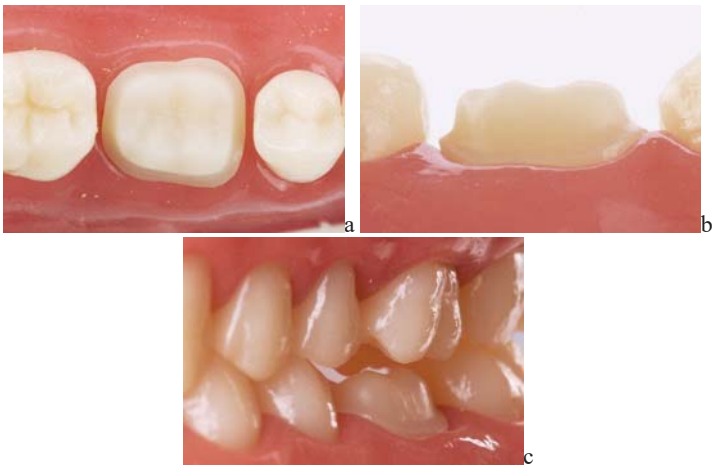


Figure 7.24: (a) Occlusal view of the prepared tooth. (b) The buccal aspect of the preparation. (c) Relationship between the prepared tooth and the opposing arch.

SEQUENCE OF ONLAY PREPARATION

1. Initial impressions for the silicone index

Technique: Using putty silicone without an impression tray, take an impression from the tooth to be prepared or from the working wax-up. Cut the silicone index in half (cross-section in relation to the long axis of the teeth).

Clinical tip: The width of the index is crucial to avoid distortion, which could interfere in the evaluation process.

Purpose: To check the amount and reduction pattern to accommodate the crown.

Rationale: Achieve adequate reduction to provide esthetics and strength to the restoration and also maximum preservation of sound tooth tissue.

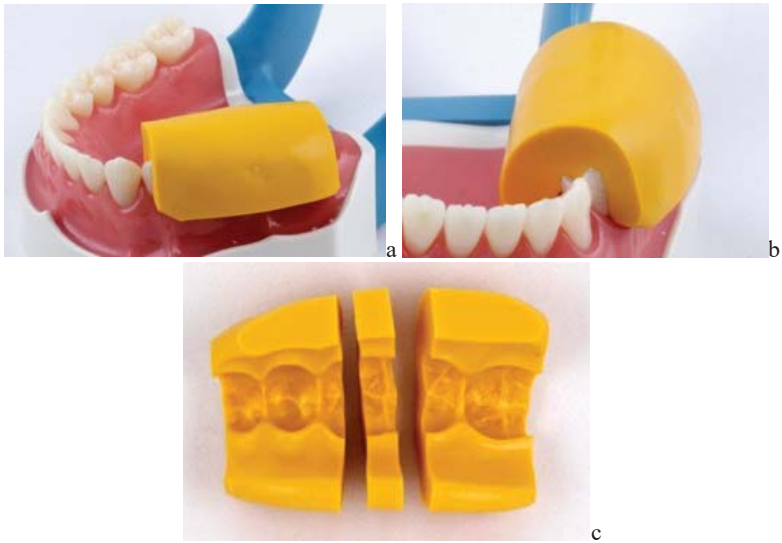


Figure 7.25: (a-b) Silicone index in position. (b) Frontal view of the silicone index with the appropriate thickness. (c) Transversal cut of the index to evaluate the preps.

2. Interproximal reduction

Technique: Using a "pencil tip" diamond bur (G859.314.014) with a taper of approximately 5°, reduce the interproximal surfaces of the tooth at the expense of the target tooth to open up a space of about 1.5 mm in relation to the adjacent teeth.

Objective: To allow sufficient room for a larger bur to be used without touching the adjacent teeth.

Rationale: Preserve the adjacent teeth.

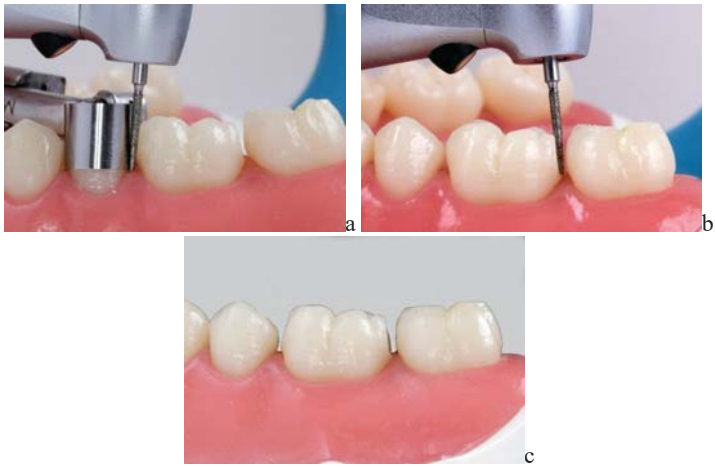


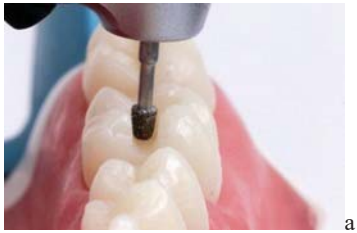
Figure 7.26: (a) Reducing the proximal surface with protection against the adjacent tooth. (b) Reducing the distal surface. (c) Final aspect of the interproximal reduction.

3. Creating the isthmus

Technique: Using a tapered with round angle Diamond bur (#G845KR.314.018) aligned parallel to the long axis of the tooth, and wear the occlusal surface in an isthmus so that it is the width of 1/3 of the occlusal table and its depth corresponds to the active part of the bur. It is essential to round the internal inner angles

Objective: Generate the occlusal isthmus according to the correct taper in order to allow the settlement of the restoration.

Rationale: The occlusal isthmus is crucial in the retention of the restoration issue and impact on the material strength.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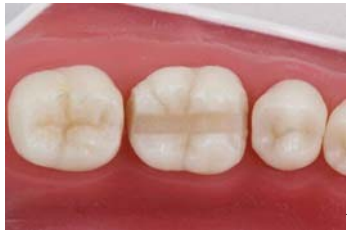
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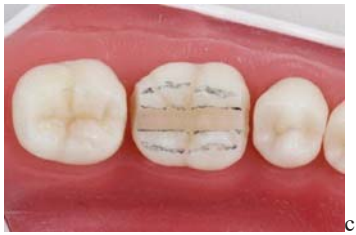
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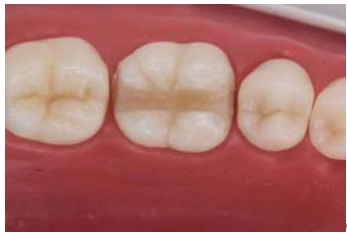
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Figure 7.27: (a) Selective reduction of the occlusal surface. (b) Occlusal view of the isthmus reduction. (c) Drawing the reduction (1/3) of the length of the occlusal surface. (d) Rounding the internal angles.

4. Creating the proximal boxes

Technique: Using the same diamond bur (G845KR.314.018) aligned parallel to the long axis of the tooth, create the proximal boxes based on the affected dentin depth.

Objective: Create the proximal boxes alerting to define the finish line in tooth structure and flat gingival floor.

Rationale: Removal of all affected tissue and old restorative material.

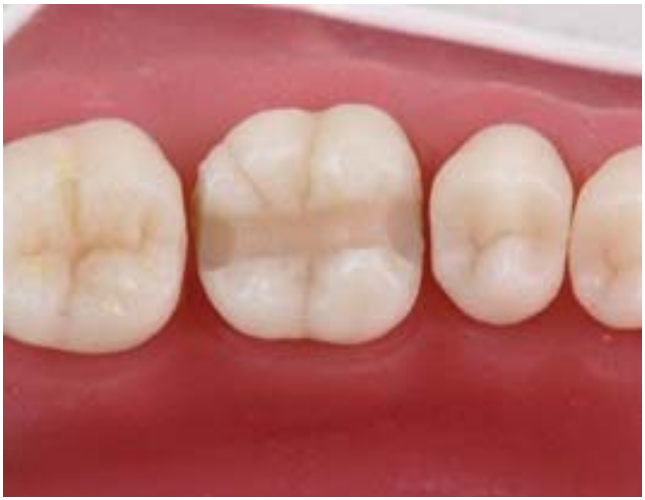


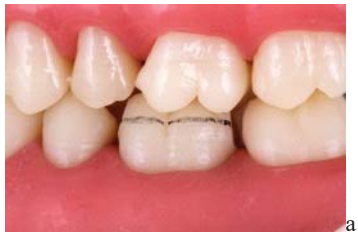
Figure 7.28: Final aspect of the proximal boxes.

6. Cuspal reduction

Technique: Firstly, it is recommended to outline the boundaries of the functional surface of the working cusps, which includes the tip of the cusps and the external and internal steeps. Then, create the orientation grooves with a cylinder round diamond bur (G882.314.014), establishing the depth according to the diameter of the bur, which must aligned parallel to the surface of the internal and external steeps of the cusps. After that, evaluate the grooves, and, if they are adequate, join them until the walls are regular.

Objective: Reduce the cusp in a uniform and predictable way

Rationale: Adequate reduction preserves the remaining tissue and promotes enough resistance to the restorative material.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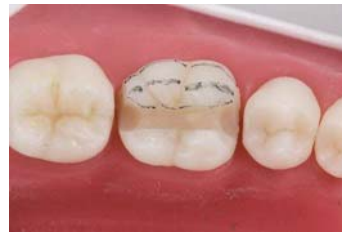
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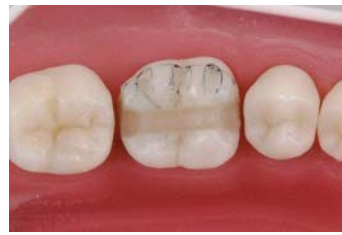
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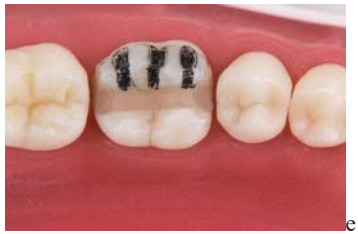
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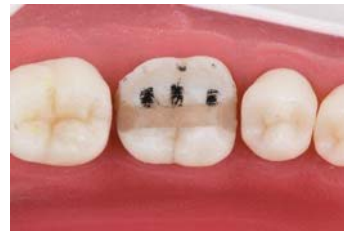
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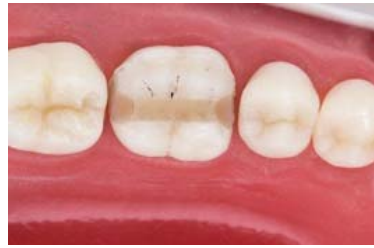
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Figure 7.29: (a-b) Outlined the functional surface of the working cusps. (c) Inclination of the bur according to the external aspect of the surface. (d) Orientation grooves on the buccal surface. (e) Orientation grooves on the occlusal surface. (f) Union of the grooves in the buccal surface. (g) Occlusal view of the cusp reduction.

7. Refinement

Technique: This step is performed with diamond burs with minor granulation (F845KR.314.018 and F882.314.014) or, preferably, with ultrasound tips (CR-4U). This procedure aims to smooth all the walls, so the inclination and the depth must follow all the wear as before.

Objective: All of the preparation floor walls should be smooth, and all the Cavosurface angles must be defined.

Rationale: Well-defined and smooth walls facilitate the polishing phase.

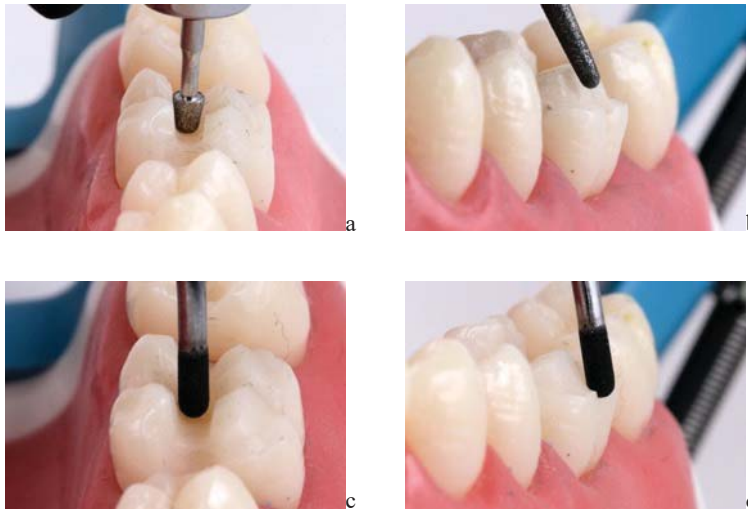


Figure 7.30: (a–b) Refining the pulpal floor and the cusp reduction with fine granulation diamond burs. (c–d) Refining the walls with an ultrasound tip.

8. Evaluation with the silicone index

Technique: Seat different parts of the silicone index on the prepared tooth to assess, visually and with a periodontal probe, if the reduction fulfills the requirements to the material thickness.

Objective: To check the space removed and, if necessary, correct the inadequate areas.

Rationale: The thickness of the restorative material is a key factor in the success in the long-term.

Figure 7.31: Analysis of the reduction with the silicone index correctly seated on the prepared tooth.

10. Polishing the prepared surfaces

Technique: Using abrasive rubbers in a decrescent sequence, polish all the prepared surfaces. This can also be done with an Arkansas-type stone.

Objective: Make all the prepared walls as smooth as possible.

Rationale: Smooth surfaces facilitate the impression and luting procedures, thereby improving the flowability of these materials.


a

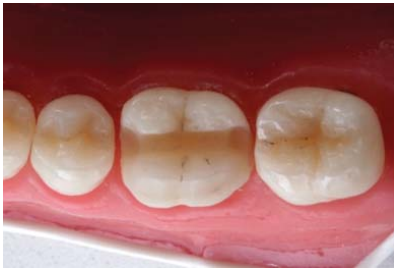

b


c

Figure 7.32: (a) Polishing the surfaces with Arkansas-type stone. (b) Abrasive rubbers for polishing in a sequence according to its decrease abrasiveness. (c) Polishing with abrasive rubber.

Final characteristics of the onlay preparation

- Tapered, smooth, and well-defined walls
- Rounded internal angles
- Cavosurface angles well-defined and without bevels
- Pulpal floor lightly concave
- Axial walls tapered divergent to the occlusal surface (6 to 10 degrees)
- Convergent surrounding walls (10 to 15 degrees)
- Occlusal isthmus with at least 2mm depth and 2mm width
- At least 0.5mm away from the adjacent teeth
- Supragingival margins located in enamel
- Recovering the working cusps with at least 2mm thickness
- Recovering the balancing cusps with at least 1.5mm thickness
- Chamfer with 1.5mm width



a

b

Figure 7.33: (a–b) The final aspect of the preparation in an occlusal and lateral views.

CHAPTER 8

RESTORATION OF ENDODONTICALLY-TREATED TEETH

Bruno Rodrigues Reis
Rielson José Alves Cardoso
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Rina Andrea Pelegrine
Thaís Cássia Machado
Marcelo Lucchesi Teixeira

INTRODUCTION

Restoration of endodontically-treated teeth may be performed in several ways, and the choice of technique is related to the quantity, quality, and distribution of the remaining tooth tissue, especially regarding the preservation of marginal ridges. Restorations can, therefore, be direct or indirect, and with or without intracanal posts.

As endodontically-treated teeth show a higher failure rate than vital teeth, it is crucial to plan the restoration modalities concerning mechanical, biological, functional, esthetical, and adhesive parameters. However, such failures are classified according to their cause into biological or mechanical categories.

Biological factors are associated with the recontamination of the root canal system, which may happen due to bacterial leakage through the root apex, via the coronal portion, or by contamination during the execution of the restorative procedures. It is therefore fundamental that, regardless of the technique chosen, cleaning and disinfection procedures should always be performed for the root, and the final restoration should be able to isolate the tooth from further contamination. *Mechanical* factors are related to fractures or the restoration's loss of retention.

With regard to the remaining structures, the direct restoration technique with composite resin is only indicated for teeth that have had their marginal ridges preserved. If the tooth has lost its ridges or requires clinical crown

augmentation, indirect restorations (full or partial) should be used instead. However, the decision-making process must be focused on the preservation of the remaining structures, as well as evaluating the available adhesive area and the presence of the ferrule effect area.

Intracanal retainers may consist of a cast metal post-and-core (CM) or post-and-core build-ups associated to glass-fiber posts (GFP). Typically, CM failure occurs secondary to root fracture, whereas GFP failure happens due to debonding. Therefore, the characteristics of the root canal preparation are different for each approach.

As the restoration of endodontically-treated teeth is a subject that involves many variables, it is recommended that other sources of information be revised for an optimized understanding of this subject. In this chapter, the direct technique of casting a metal core (in a posterior tooth) and a glass-fiber post (in an anterior tooth) will be discussed. However, it is essential to note that both techniques can be used for anterior and posterior teeth.

CLEANING AND DISINFECTION TECHNIQUE OF THE ROOT CANAL

Materials/instruments

- Tipi irrigation tips
- 5ml syringe
- Root canal aspiration cannula

a. Irrigation/aspiration—5ml of sodium hypochlorite at 1%

Objective: Removal of the debris created during the procedures of root canal preparation.

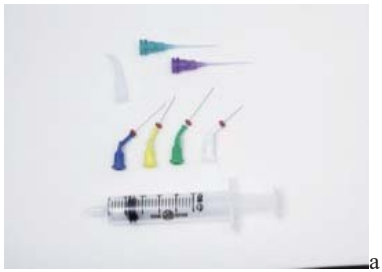
b. Irrigation/aspiration—3ml of EDTA-T for 2 minutes

Objective: Removal of the smear layer.

c. Irrigation/aspiration—5ml of sodium hypochlorite at 1%

Objective:

- Neutralization of EDTA-T
- Root canal disinfection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b

Figure 8.1: (a) Material needed for the canal disinfection. (b) Hypochlorite irrigation.

MECHANICAL ASPECTS: FERRULE AND SUPPORT SERVICE

Mechanical aspects relating to the strength of the endodontically treated tooth are primarily associated with viable dentinal tissue, according to its amount and distribution. Therefore, preservation of dentin structure becomes an essential factor for success; however, in practice, it is the distribution of dentine that makes the difference regarding mechanical strength.

Two main factors influence the long-term success of such restorations:

The ferrule effect: This comes from fitting a crown that completely embraces a ring of healthy tooth tissue at least 2 mm in height.

Mirror area: The mirror area is fundamental for CM, as it improves the distribution of tensions and prevents post intrusion, thus stopping it from acting as a wedge, which in turn would lead to root fracture. In the case of GFP, the surrounding area is crucial for adhesive purposes.

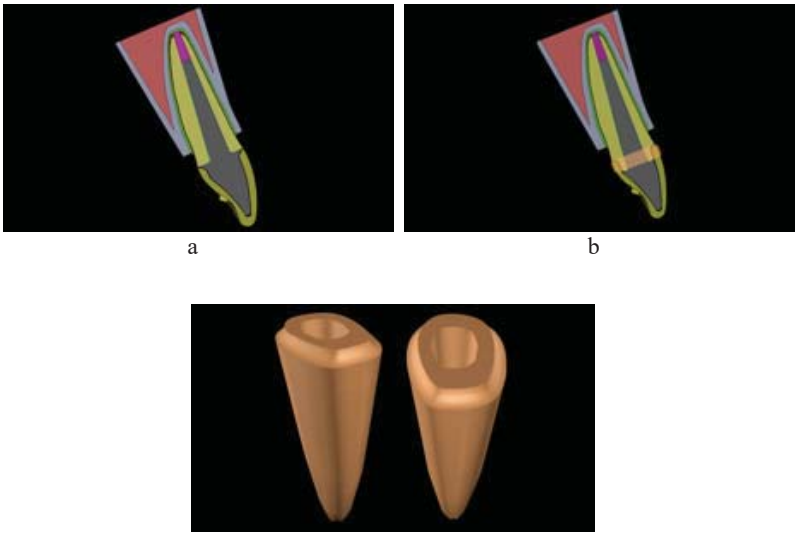


Figure 8.2: (a) Tooth with no ferrule (crown does not embrace healthy dentin). (b) Ferule ring, in which the crown protects the remaining tooth. (c) Preparation with ferrule and mirroring.

1. Preparation of the remaining tooth

Technique: Using a conical round diamond bur (# 4138) determines the position of the cervical finish line (with the bur directed to the long axis of the tooth). The remaining tooth structure should then be checked for any unsound dentine that does not offer strength. Such tissue should then be trimmed away with the diamond bur positioned horizontally (perpendicular to the long axis of the tooth).

Clinical tip: The position of the cervical finish line should be defined as 1mm short of the ideal location in order to allow rubber dam placement.

Purpose: To preserve the maximum amount of viable dentin to accommodate future restoration.

Rationale: The strength of the tooth-post-restoration system is dependent on the quantity, quality, and distribution of dentin.

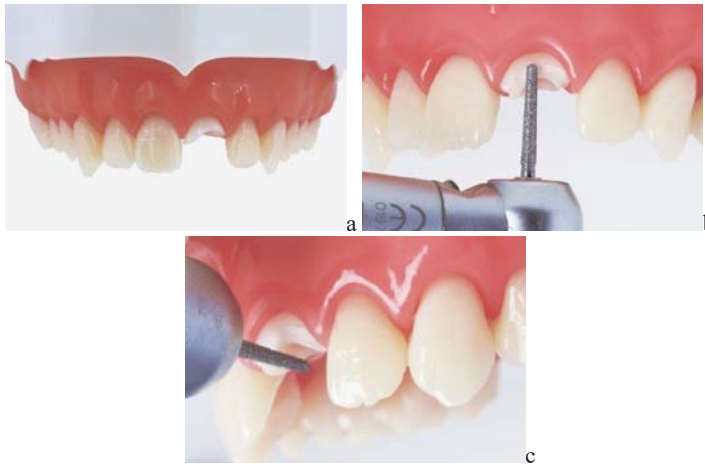


Figure 8.3: (a) Target tooth left upper central incisor. (b) Preparation of the cervical finish line. (c) Preparation of the coronal aspect.

2. Initial X-ray for post-working length measurement

Technique: Take a periapical X-ray from the target tooth. Film holders are essential for this step.

Objective:

- Visualization of the length of the tooth
- Determining the mesial and distal cervical reference points
- Obtaining reference measurements

Justification:

- Optimization of planning
- Safety
- Prevention of iatrogenic events
- Respect to biomechanical criteria

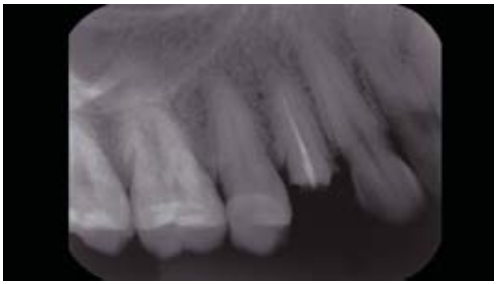


Figure 8.4: Periapical X-ray with references for post-working length.

3. Calculating the dimensions of the intracanal post

Technique: In order to calculate the dimensions of the retainer, it is essential to establish which material the post will be made of since the mechanical properties of a CM are very different from those of a GFP. For GFP systems, the post-selection index should be used over the radiographic image (step 6 on page 217).

Objective: To optimize the mechanical resistance of the restorative system (remaining tooth- restoration) from the stress originated by occlusal loads.

Rationale: The failure index for endodontically treated teeth is much higher than that for vital teeth. Restorative system protection is, therefore, paramount to minimize risks.

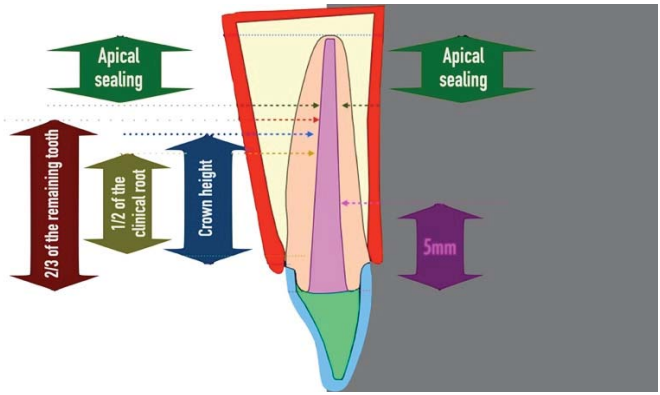


Figure 8.5: Rules for calculating the dimensions of the post.

Table 8.1: Rules for calculating the length dimensions of intracanal posts.

	CAST METAL POST-AND-CORE	GLASS-FIBER POST
Length	• Minimum 5 mm of obturation apically • The crown height/intracanal post length ratio must be at least 1:1 • Must exceed half of the root length (Distance between the alveolar bone and the apex of the root • 2/3 of the total length of the remaining root	• Minimum 5 mm of obturation apically • At least 5mm of the post within the root canal (this difference is due to the different elastic modulus for the CM and GFP, which promotes better stress distribution)
Width	• Apical diameter of at least 1 mm • Core diameter in relation to the surrounding walls: 1/3 wall + 1/3 post + 1/3 wall	• Elect a post diameter thinner than the intracanal width and reline it with composite (preservation of tooth tissue and post-adaptation to the tooth are key factors for the success of GFP)

4. Rubber dam

Technique: several methods exist to set up the rubber dam into place (e.g., starting with the clamp, starting with the rubber sheet, or placing the whole set together). The ideal technique should be chosen according to the clinical characteristics of the case.

Objectives:

- Prevent saliva contamination into the canal during preparation.
- Prevent recontamination.
- Safety: to prevent ingestion of chemicals, waste material, or small instruments.

Justification:

- Helps to maintain root canal asepsis.
- Safety during the procedure.
- Prevents swallowing and/or aspiration of materials and instruments.

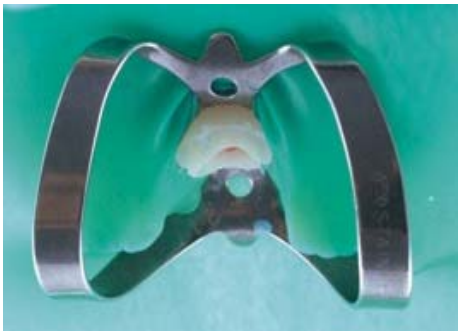


Figure 8.6: Isolated tooth for post preparation (note the preparation of the cervical finish line defined at least 1 mm supragingival to facilitate the rubber dam placement).

METALLIC CAST POST-AND-CORE

1st Session

(See previous steps on page 205)

5. Canal emptying

Technique: Access to the root canal can be made by removing the temporary dressing using a cylindrical or spherical diamond bur at high speed or with a spherical ultrasound tip. Emptying itself is done using endodontic drills at a low speed up to the pre-established length. In cases of multirooted teeth, the larger root and the other canals should just be emptied enough to prevent rotation of the core.

Objectives: To establish the dimensions of the intracanal portion of the CM.

Rationale: The largest root has a greater amount of periodontal ligament fibers, which optimizes stress distribution.


a


b


c

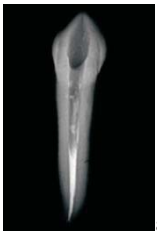
Figure 8.7: (a-b) Emptying the canal using a set of drills. (c) The aspect of the tooth afterward.

6. Radiographic confirmation of root canal emptying

Technique: Take an X-ray of the target tooth using a film holder.

Objective: Confirmation of the complete removal of obturating material from the emptied region. It is also essential to verify that the desired dimensional parameters have been achieved.

Rationale: Due to the elliptical shape of the canals, gutta-percha can be found smeared in the surrounding walls. As radiographs can be distorted, it is also important to compare all of the X-rays that have been taken.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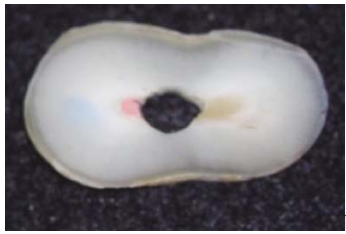
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Figure 8.8: (a) Radiographic appearance of an inadequate emptying. (b) Horizontal section of the tooth illustrating difficulty to remove gutta-percha.

7. Root canal cleaning and disinfection

(See page 203)

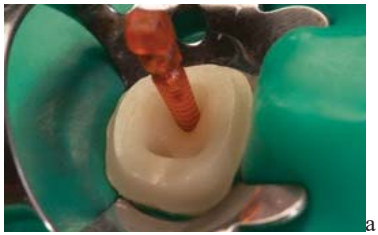
8. Adjusting the prefabricated pattern post

Technique: Post adjustment at this stage only aims at wearing down the prefabricated pattern post. To be adjusted, the post must necessarily reach the entire length of the canal and also enter and exit the canal passively.

Objective: To calibrate the prefab post so that it can be relined to the canal, making it compatible with the preparation performed.

Rationale:

- Minimization of acrylic resin in the apical region
- Controlled polymerization shrinkage
- Minimized modeling distortion
- High adaptation and sealing at the moment of cementation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b

Figure 8.9: (A and B) Verification of the prefab pattern post adaptation to the canal.

9. Lubrication of the canal and the remaining tooth

Technique: Root canal lubrification can be carried out using solid or liquid petroleum jelly or water-based lubricating gel. To do this, an endodontic file # 10 (or drill # 1) wrapped in cotton is used for the canal while a cotton ball or a specific brush for this task should be used for the coronal aspect of the preparation.

Objective: Isolate the canal and the remaining tooth structure so that the acrylic resin does not stick to the walls.


a


b

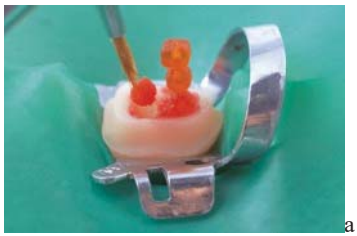
Figure 8.10: (a-b) Internal lubrication of the canal using drill #1.

10. Modeling the canal with autopolymerizing acrylic resin (AAR)

Technique: Modeling of the canal is performed by filling it with AAR following the Nealon brush technique (see page 229) and then inserting the post into the canal (before the resin loses its shine and becomes matte).

Clinical tip: In order for the patterned post to not get stuck to the canal, it is recommended that the post be removed before insertion, and then re-inserted very quickly.

Objective: To copy the shape of the canal as accurately as possible.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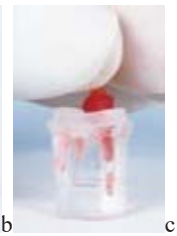
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Figure 8.11: (a-b) Filling the canal (before and after the insertion of the prefab post pattern) using the Nealon technique. (c) Brief removal of the patterned post to prevent adherence to the root canal walls.

11. Build-up the core portion

Technique: The coronal portion is also made with AAR following the Nealon technique. To do this, the resin is incrementally added, and preparation is later carried out with a maxicut drill out of the mouth or with

diamond burs intraorally. The shape of the coronal core should follow the criteria of crown preparation (Chapter 7, page 200).

Objective: To ensure that the coronal portion of the core is shaped like an ideal crown preparation.

Rationale: The core/remaining tooth assembly should act as a prosthetic preparation, with the same mechanical characteristics of ideal preparation, protecting the remaining tooth structure, supporting tissues, and also the crown.

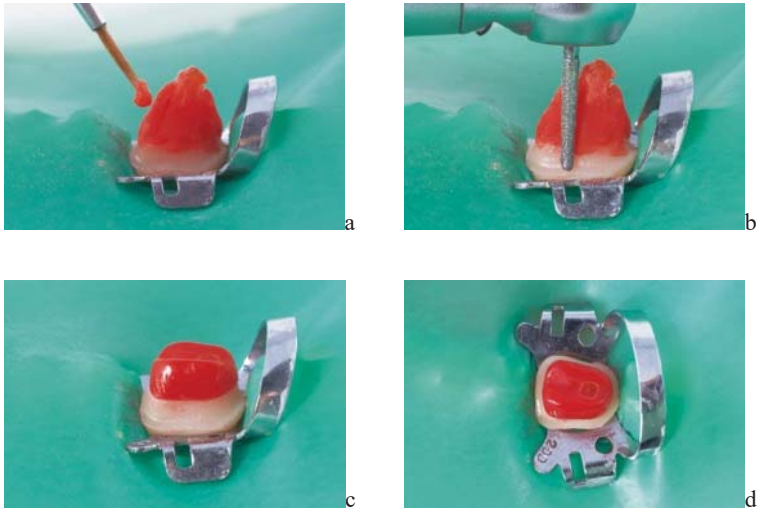


Figure 8.12: (a) Filling the coronal portion with AAR using the Nealon technique. (b) Preparation of the coronal portion using diamond burs for crown prep (may also be done outside the mouth using a maxicut drill). (c and d) Appearance of the core after preparation and finishing.

12. New root canal disinfection and sealing

(See page 203)

2nd Session

13. Core sterilization

Objective: To eliminate micro-organisms from the post-core device to prevent recontamination of the clean canal.

Rationale:

- Cement a sterile device into the canal
- Ensure asepsis throughout
- Comply with biosafety rules and regulations

Figure 8.13: Packed core after autoclaving.

14. Root canal disinfection

(See page 203)

15. Core try-in

Technique: Preferably with a rubber dam, after the disinfection of the canal, the core must be unpacked and tried in, which must occur passively and without any effort during insertion into the canal. If there is any type of resistance to insertion, the core must be adjusted: Evaluate the presence of positive bubbles in the root portion using a magnifying glass; if so, they should be removed with a duragreen stone or diamond bur. Also, the presence of convex areas in the root portion should be evaluated and smoothed off. Such adjustments should be performed until entirely passive settling of the core within the remaining tooth structure is achieved.

Clinical tip: Occlusion spray can be used to expose areas of contact that may be preventing adequate seating.

Objective: To adapt the post-and-core to the tooth in a passive way.

Rationale: Forced settling of the post-and-core may induce root fractures that will certainly compromise the tooth.


a


b

Figure 8.14 (a) Adjustment of retentive areas evidenced occlusion spray. (b) Appearance of the post-and-core adapted to the tooth.

16. X-ray to confirm post-and-core adaptation

Technique: X-ray the target tooth using a film holder/positioner.

Objective:

- Visualize the length of the core concerning the emptied space in the root canal.
- Check adaptation to the surrounding walls.

Rationale:

- Prevent voids inside the root that could easily be re-contaminated by fluids entering through the dentin.
- Confirm fulfillment of biomechanical requirements.

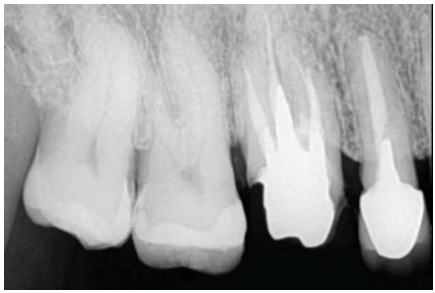


Figure 8.15: Periapical X-ray to verify post-and-core adaptation.

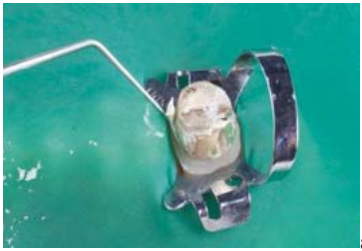
17. Cementation of the CM

Technique: If any adjustments to the core are needed, disinfection of the canal and the post must be carried out. The root portion of the cast metal core should be roughened to increase frictional retention. The cement of choice for the post-and-cores can be decided between zinc phosphate, glass ionomer cement, or self-adhesive resin cement. The manufacturer's recommendations must be strictly adhered to in all respects, including the removal of excess luting material. The abutment tooth is now ready for a temporary crown (Chapter 9) and impressions (Chapter 10).

Clinical tip: Adjustments to the core should be avoided after cementation so that the cement has time to fully polymerize without mechanical disturbances. Thus, any necessary adjustments not made previously should be performed at another session.

Objective: To cement the post-and-core to the tooth, forming a "single body".

Rationale: Excess of cement will not allow an adequate crown fit.


a

b

Figure 8.16: (a) Excess removal of cement after initial polymerization. (b) The final aspect of the CM cemented.

GLASS-FIBER POST

5. Emptying the canal

(See previous steps on page 205)

Technique: This should preferably be done using a rubber dam. Establish access to the canal by removing the temporary dressing using a cylindrical or spherical diamond bur at high speed or with a spherical ultrasound tip.

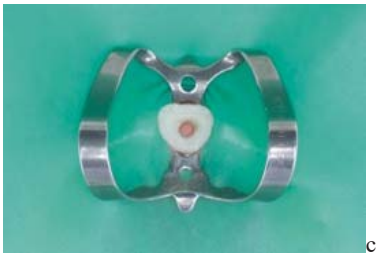
The emptying itself may be performed using endodontic drills (# 2, 3, and 4) at a low speed up to the post working length.

Objective: To establish the dimensions of the intracanal portion of the glass-fiber post to be fitted.

Rationale: The right length is crucial to the mechanical characteristics of the prosthesis.


a


b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d

Figure 8.17: (a-b) Emptying of the canal using an endodontic drill. (c-d) The appearance of the tooth after emptying the canals.

6. Radiographic selection of the fiber post

Technique: Take a periapical X-ray of the target tooth using a film holder and then select the post length by placing the post length selection ruler over the X-ray for pin selection. This step allows the selection of the post by a suitable diameter in the apical and cervical portion of the post in relation to the remaining tooth. This X-ray is also useful to check whether the canal has been emptied adequately. It is recommended to select a post thinner than the width of the canal and reline it with composite.

Clinical tip: One of the main factors for the success of GFP is related to its adaptation to the walls of the remaining tooth. Thus, it is ideal to select the post in relation to both the apical portion, as well as the cervical portion of the working length, which is where the highest stress concentrations occur and, therefore, where adaptation should be best. In some cases, double taper posts (Whitepost DCE - FGM) should be used.

Objectives: To determine the most suitable post in relation to the remaining root structure, thus optimizing the mechanical properties of the tooth-restoration set.

Rationale: Correct post-selection prevents unnecessary removal of viable dentin tissue since it is known that abutment strength relates to the quantity and distribution of viable dentin.

Figure 8.18: X-ray with the overlapping post-selection ruler.

7. Preparation of the canal

Technique: This step is necessary if the chosen approach will not reline the post. Otherwise, evaluate if it is advantageous. If so, using the specific sequence of burs from the post system selected, remove the obturation at low speed following the pre-established working length.

Clinical tip: The use of rubber stops to control the insertion of the drill is essential in this procedure. Be careful to not remove sound dentine.

Objective: To model the root canal shape to the dimensions of the post, optimizing adaptation.

Rationale: Careful preparation prevents the removal of viable dentin.

Figure 8.19: Preparation of the canal with specific drills and rubber stops to determine the length of the preparation.

8. Post try-in

Technique: The post should be tested to ensure it is seating passively and is reaching the full extent of the prepared length. The length can be tested using a hemostatic forceps to hold the post against the reference point used for the radiographic examination to determine the post working extent. An endodontic ruler can then be used to confirm that the post has gone to length.

Objective: Check post seating according to the length established at planning.

Rationale: Passive seating of the post facilitates cementation.


a


b

Figure 8.20: (a) Post grip with hemostatic forceps to verify the working length. (b) Confirmation of the working length on the post.

9. Preparation of the post for relining

Technique:

• Clean the post by rubbing 70% ethanol for 1 minute along its entire length/.

• Application of Universal Single Bond, 3M ESPE (which already acts as silane and as an adhesive), then wait 20 seconds and dry.

Clinical tip: The use of hydrogen peroxide (35%) for 1 minute and then cleaning with water-air spray improves the adhesion.

Objective: To decontaminate and prepare the post for cementation.

Rationale: The post must be decontaminated to maintain root canal asepsis.

The silane + adhesive combination optimizes the adhesion of the post.

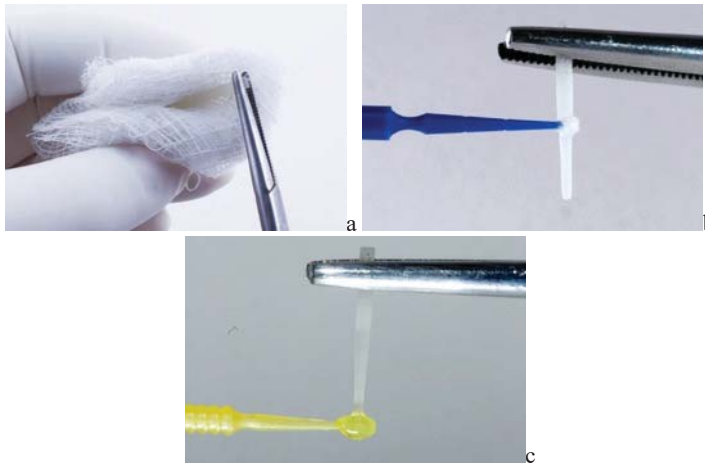


Figure 8.21: (a) Decontamination of the post using 70% ethanol. (b) Etching with hydrogen peroxide. (c) Universal Single Bond application onto the post.

10. Reline the post with composite

Observation: This step is not necessary when the post is fitted to the canal walls.

Technique: After lubricating the canal with water-based lubricating gel, use some composite to embrace the post and insert them into the canal, removing and reseating many times. This maneuver aims to model it according to the canal shape. With the post inside the canal, pre-photopolymerize it for 5 seconds. After, photopolymerize the composite according to the manufacturer's recommendation (usually for 40 seconds).

Objective: Establish an optimal adaptation to the canal walls.

Rationale: The relining approach leads to a thinner luting width, avoids bubbles, and minimizes failures.

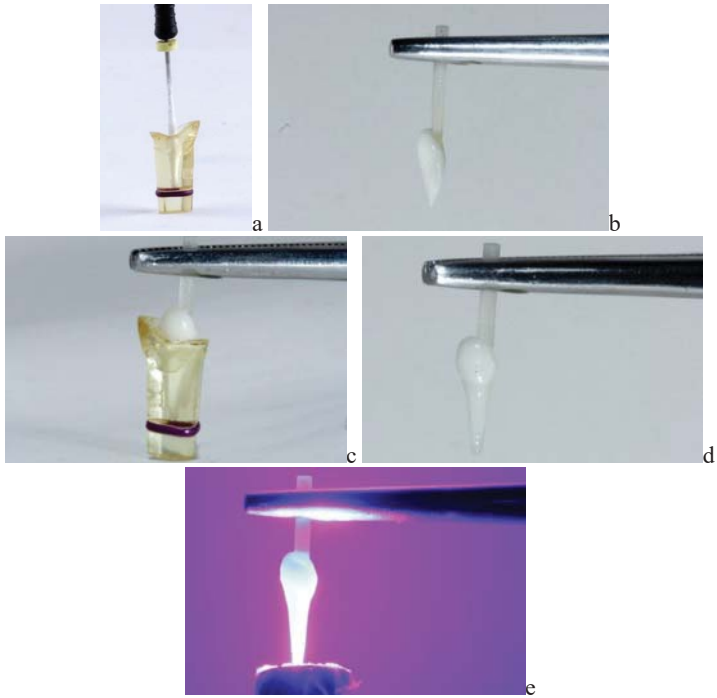


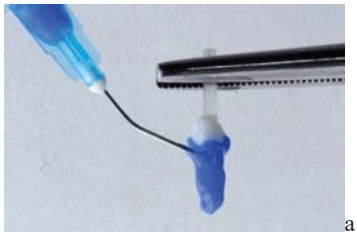
Figure 8.22: (a) Lubricating the canal with water-based gel. (b) Placing the composite around the post. (c) Positioning the post inside the canal (inserting and reseating many times to mold the composite. (d) Post with the composite mold, (e) Photopolymerization of the molded composite.

11. Preparing the relined post for cementation

Technique: The relined post must be etched with phosphoric acid (37%) for 30 seconds, rinsed with air-water spray, and dried with air. Afterwards, the silane + adhesive is applied to the composite. In this case, the use of Single Bond Universal is sufficient.

Objective: To promote adhesion between the composite of the post with the walls of the canal.

Rationale: A proper post cementation is fundamental for the long-term success of tooth restorations since the primary type of failure of prefabricated posts relates to cementation problems.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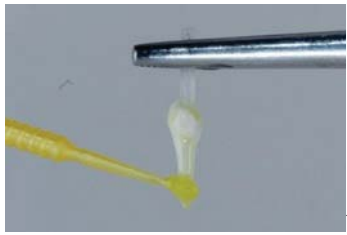
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Figure 8.23: (a) Etching the composite with phosphoric acid. (b) Applying Single Bond Universal.

12. Preparation of the tooth for cementation

Technique:

- Clean the water-based gel with air-water spray
- Dry with air
- Decontamination of the conduit using sodium hypochlorite at 5.25% for 1 minute
- Rinse with plenty of water
- Dry using absorbent paper points

Objective: To decontaminate and prepare the canal for cementation.

Rationale: The cement selected (Rely X U200, 3M ESPE) is not compatible with chlorhexidine hence the need to use sodium hypochlorite. The use of self-adhesive cement allows cementation without phosphoric acid etching, which, if used for longer than 15 seconds, may negatively affect root dentin permeability.

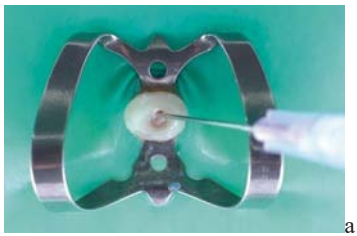
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Figure 8.24: (a) Decontamination of the canal using 5.25% sodium hypochlorite. (b) Rinsing and drying using absorbent paper points.

13. Cementation of the post to the tooth

Technique:

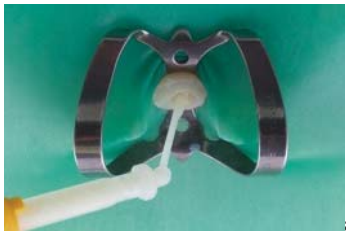
• Application of the cement to the root canal walls, which should preferably be applied using a mixing tip (Rely X U200 automix) inside the canal.

• Position the post inside the canal.

• Light cure for 40 seconds.

Objective: To promote adhesion between the post with the remaining tooth structure.

Rationale: Proper post cementation is fundamental for the long-term success of tooth restorations since the primary type of failure of prefabricated posts relates to cementation problems.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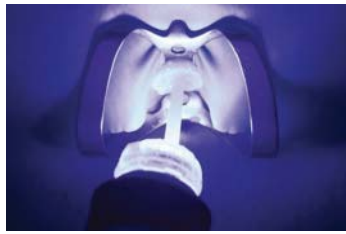
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Figure 8.25: (a) Loading the cement into the canal using a mixing tip. (b) Light curing the cement.

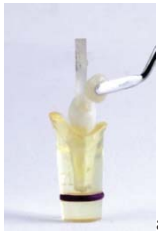
14. Build-up the core

Technique: The coronal core should be built in increments of composite resin simulating the anatomy of the tooth. The build-up core should then be prepared using diamond burs following the principles of an ideal preparation (page XXX). Cutting the occlusal portion of the fiber pin should only be done at the crown preparation stage. The abutment tooth is now ready for the temporary crown (page XXX) and impressions (Chapter 10).

Clinical tip: Well-polished preparations favor impressions and adaptation of the crown. Multi-laminated polishing drills and abrasive rubbers are recommended for this task.

Objective: To shape the coronal aspect of the core according to the principles of an ideal crown preparation.

Rationale: The tooth-core set should act as an ordinary crown preparation, with the same mechanical and optical characteristics of ideal preparation to protect the remaining tooth, supporting tissues, and the crown.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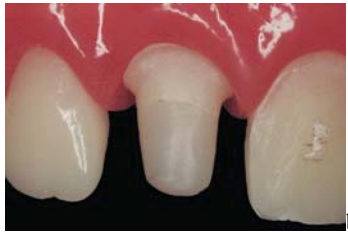
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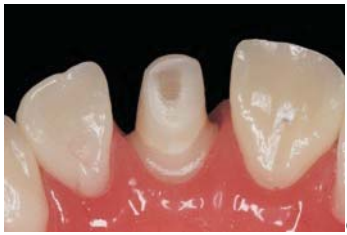
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Figure 8.26: (a) Filling of the coronal aspect of the core with composite resin. (b) The final appearance of the prepared tooth (buccal view). (c) palatal view.

CHAPTER 9

DIRECT PROVISIONAL RESTORATIONS

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INTRODUCTION

The temporization phase is essential for any indirect restorative treatment. It covers the period between the abutment preps and the ceramic restoration through provisional restorations. The definition of provisional is described as "restorations that protect the prepared tooth and simulate the shape and function of definitive restorations".

Nowadays, with the advent of new technologies and restorative modalities, the temporary phase needs not necessarily be performed (as in the case of ceramic laminates where the prep is limited to enamel or in cases of crowns made with CAD/CAM technology from scanning intraoral and immediate milling of the restoration: the chairside process). However, such situations are still very specific, which makes the vast majority of cases require temporary restorations.

The importance of the temporaries is insistently described in all literature sources that address the subject of indirect restorations and is, in many cases, critical to ultimate clinical success. The temporary restoration aims to establish the primary prosthetic functions (function, esthetics, and protection), to serve as a parameter for evaluating the prognosis of the case, to maintain the viability of the periodontal and pulpal tissues (health promotion), and to act as an adjuvant for restorative procedures.

In this chapter, direct temporization techniques for crowns using self-polymerizing acrylic resin (AAR) will be discussed. Indirect techniques will not be addressed since the scope of this book is to only work on clinical procedures, and not on lab-based protocols.

Materials used in this chapter

- Solid Vaseline
- Paintbrush for Vaseline
- Autopolymerizing acrylic resin (AAR) according to the shade of the patient's teeth
- 03 Dappen's pots
- Spatula # 72
- Two-color overhead projector pens (except yellow)
- Knife or scalpel blades (15 or 11)
- LeCron spatula
- Gauze
- Spatula for silicate (# 1 or # 2)
- Marten hair paintbrush # 0 and # 00
- Scissors
- Pencil (0.5) with red, black, and blue lead or fine-point pencil of the same colors
- Set of burs for preps
- Finishing kit for acrylic resin
- Spherical bur # 6 for straight handpiece
- Double-sided two-color fine articulating paper (Bausch)
- Two Miller forceps
- Clinical kit containing probe, mirror, and tweezers

TECHNIQUES FOR THE MANIPULATION OF AUTOPOLYMERIZING ACRYLIC RESIN (AAR)

Manipulated resin technique (Figure 9.1)

Technique: The manipulated resin technique consists of mixing the powder and liquid in a Dappen's dish. Ideally, the liquid should go in first and then the powder—always following a 1:3 ratio (one part of liquid to 3 parts of powder). From this stage, the resin must be mixed with the aid of a spatula and allowed to rest until its plastic phase prior to removing it from the pot for handling.

Resin phases:

After mixing, the resin undergoes five physical stages:

- Sandy stage
- Stringy or fibrous stage
- Dough or plastic stage

- Rubber-like stage
- Stiff stag

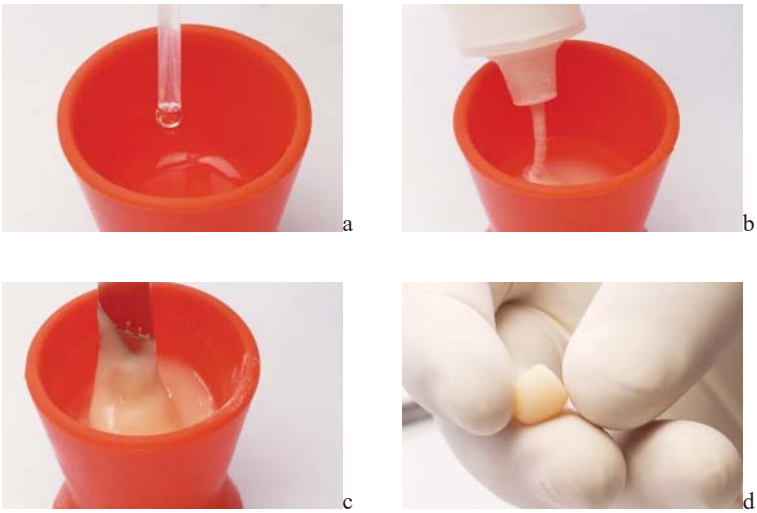


Figure 9.1: (a) Placing the liquid in the Dappen's dish. (b) Insertion of the powder into the Dappen's dish following the 3:1 ratio. (c) Mixing the resin. (d) Manipulation of the resin in its plastic phase.

Wet resin technique (Figure 9.2)

Technique: The "wet resin" technique consists of the same sequence of manipulated resin technique but adding water (preferably under pressure) into the Dappen's dish after mixing the powder with the liquid.

Objective: To eliminate excess monomer from the polymerization reaction of the resin.

Rationale: In addition to facilitating the manipulation of the resin, excessive monomer leaves the restoration porous and, therefore, more mechanically fragile and susceptible to color change.


a


b


c


d

Figure 9.2: (a) Insertion of the monomer liquid into the Dappen's dish. (b) Insertion of the powder into the Dappen's dish. (c) Placing water in the Dappen pot only after the powder has been mixed with the liquid. (d) Manipulation of the resin in its plastic phase.

Nealon technique (brush technique) (Figure 9.3)

Technique: Two Dappen's dishes are needed for the Nealon technique—one containing powder and the other with liquid. Nealon's technique consists of wetting a paintbrush in the liquid and subsequently capturing some powder from the other pot, forming a small ball of resin at the tip of the brush, which can easily be positioned by the clinician.

Clinical tip: In order for the liquid not to thicken in the Dappen's dish, it is recommended that the brush be cleaned regularly on a gauze swab.

Objective: Easily manipulate the resin in small quantities.

Rationale: The Nealon technique is indicated for small portions of resin, since the powder:liquid ratio is not ideal, as generates a more porous and less resistant polymer.

Figure 9.3: (a) Two Dappen's dishes: one containing liquid and the other the powder of the acrylic resin. (b) Capturing the powder with a wet brush.

POLISHING TECHNIQUE FOR ACRYLIC RESIN

Technique: Using a motor (1) polish it down using a rotatory scouring buffing pad; (2) abrasive rubbers in descending order of abrasiveness; and a (3) felt disc with polishing paste.

Objective: Polishing increases the smoothness of the resin, avoiding biofilm accumulation. It also increases the mechanical strength of the temporary.

Rationale: To facilitate hygiene and, consequently, the maintenance of gingival health.

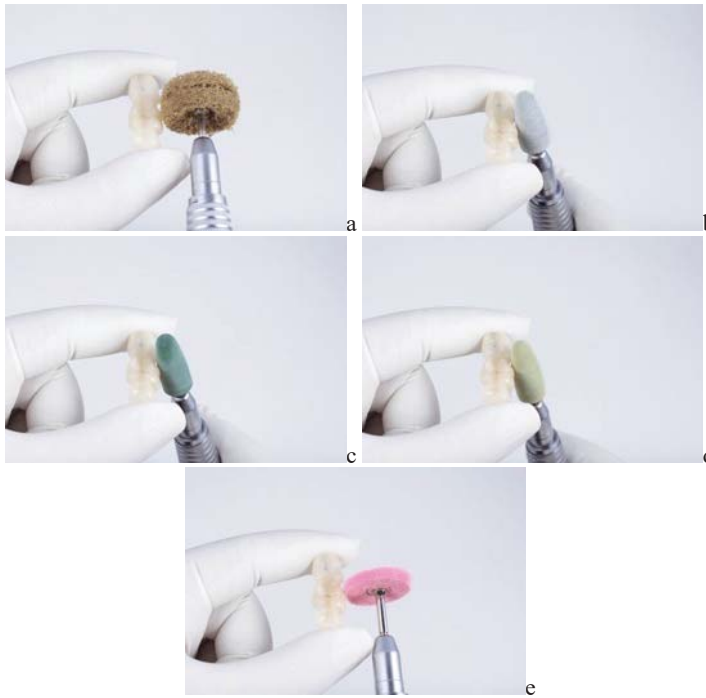


Figure 9.4: (a) Scouring pad disc. (b) High abrasion rubber (gray). (c) Medium abrasion rubber (green). (d) Low abrasive rubber (yellow). (e) Felt disk with polishing paste.

VENEER TECHNIQUE FOR ANTERIOR TEETH

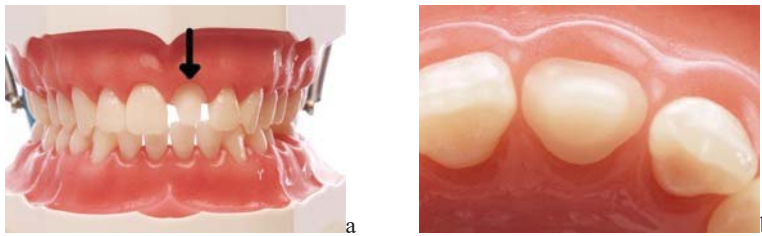


Figure 9.5: (a-b) Upper central incisor.

1. Stock tooth selective shaping

Technique: Select a stock tooth with shade and size compatible with the prepared tooth. Wear the palatal aspect with a narrow diameter tungsten carbide cutter.

Clinical tip: Select a slightly larger stock tooth and trim the cervical area of the tooth but never the incisal.

Objective: To make the veneer thin enough to fit onto the prepared tooth.

Rationale: In cases of insufficient wear, especially on the cervical area, the thick veneer will lead to an over contoured or misaligned restoration on the buccal aspect, thereby losing the advantages of this method.

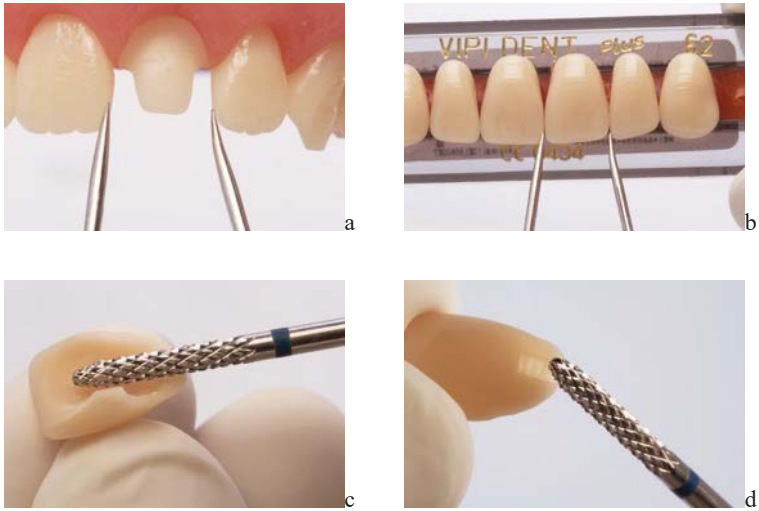


Figure 9.6: (a-b) Selection of the stock tooth according to the width and height. (c) Reduction of the palatal surface of the stock tooth. (d) Height reduction via cervical wear.

2. Stock veneer preparation

Technique: Position the veneer over the buccal surface of the preparation, ensuring size compatibility with the remaining anterior teeth.

Clinical tip: Special attention should be paid to the cervical area, where over contouring is usually found.

Objective: Verify the esthetic predictability of the provisional.

Rationale: If the veneer is poorly positioned, it will lose the desirable optical properties that justified the use of this technique in the first place.


a


b

Figure 9.7: (a) Positioning of the veneer onto the abutment prep. (b) Check the compatibility of the width of the stock tooth with the available space.

3. Lubrication of the preparation

Technique: Using a paintbrush exclusive to this step, apply solid Vaseline or a water-based lubricating gel all over the preparation.

Objective: Prevent the adhesion of the AAR to the prepared tooth.

Rationale: During the polymerization phase, AAR shrinks around the preparation. If there is no lubrication, the temporary may irreversibly stick to the preparation.

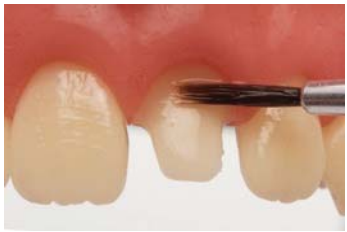


Figure 9.8: Application of lubricant to the preparation and adjacent structures.

4. Positioning of the veneer over the prep

Technique: Using the wet resin technique, manipulate an AAR amount in a ball-shaped during the plastic phase (dough) and squash it down over the entire preparation. At this stage, the stock veneer should be positioned carefully over the resin, respecting the buccal and incisal alignment in relation to the other anterior teeth. For the palatal region, the thumb can be used to sculpt the palatal concavity of the adjacent teeth.

Clinical tip: Brushing liquid on the inner surface of the will improve the adhesion of the AAR.

Objective: Properly position the veneer to achieve an excellent esthetic result.

Rationale: Poor alignment of the veneer prevents the satisfactory esthetic of the temporary.

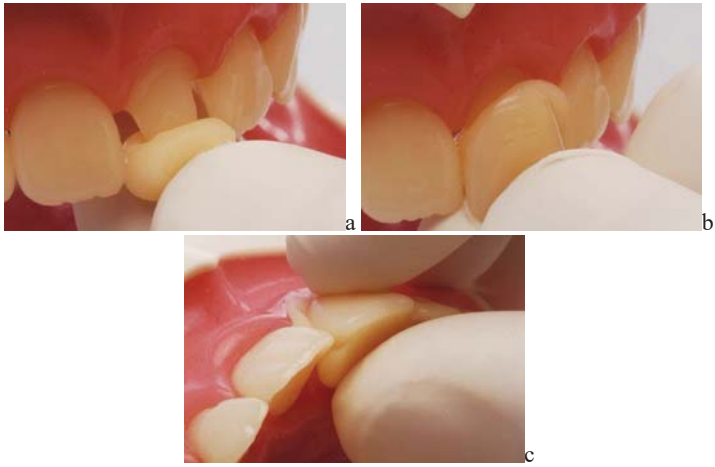


Figure 9.9: (a) Ball-shaped of AAR applied to embrace the prep. (b) Positioning the veneer over the resin lump, still in the plastic phase. (c) Final positioning of the veneer.

5. Removal of excess resin

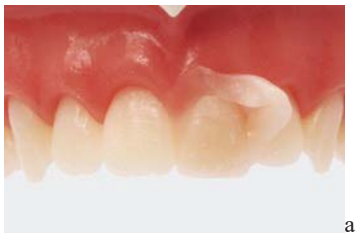
Technique: Using Hollenback spatula, remove excess resin from all around the tooth, especially the proximal areas. Use a thin resin spatula to push the resin into the gingival sulcus to pre-define the emergence profile. During

the exothermic phase of the AAR, cool the resin down with an air-water spray.

Clinical tip: During the final phase of the polymerization (during the exothermic stage), move and reseat the restoration quickly to prevent it from sticking to the prepared tooth.

Objective: The elimination of the resin from retentive areas, allows the removal of the restoration and protects the pulp and periodontal tissues from overheating.

Rationale: Protect the remaining tooth structure, and facilitate the trimming of excess material, thereby optimizing the working time.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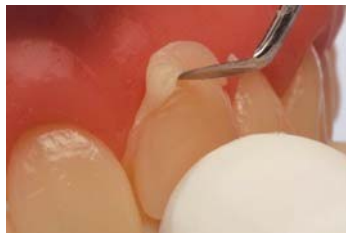

b

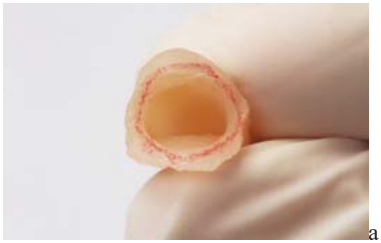
Figure 9.10: (a) Excess of AAR just after the veneer positioning. (b) Excess removal using a Hollenback spatula.

6. Adjusting the cervical finish

Technique: Using a red pencil, mark the boundaries of the cervical finish and use a tungsten carbide cutter type drill along the long axis of the emergence profile of the tooth to trim away the excess resin.

Objective: To promote adaptation at the cervical finish, avoiding over or under contouring.

Rationale: The establishment of a good relationship between the temporary restoration and the gingival tissue maintains gingival health and facilitates impression taking.


a


b

Figure 9.11: (a) Outlining the limits of the cervical finish with red pencil. (b) Excess resin trimming using a fine tungsten carbide cutter parallel to the long axis of the emergence profile.

7. Relining the cervical finish line area

Technique: This step may be unnecessary if the temporary is already correctly adapted to the cervical finish line and the gingival tissue. Assessment of the adaptation must be performed using a dental probe (see Chapter 11 for the correct handling of the probe). If there is a need for relining, AAR must be applied to the cervical finish using the Nealon technique. The restoration should only be positioned once the resin reline has gone matte. The temporary should then be maintained under light finger pressure until polymerization is complete.

Clinical tip: In some cases, it is useful to place a retractor cord to expose the preparation margins. It is essential to lubricate the cord before relining.

Objective: To promote the optimal adaptation of the temporary to the cervical finish line.

Rationale: The establishment of an adequate relationship between the temporary and the gingival tissue helps to maintain gingival health and facilitates impression taking.

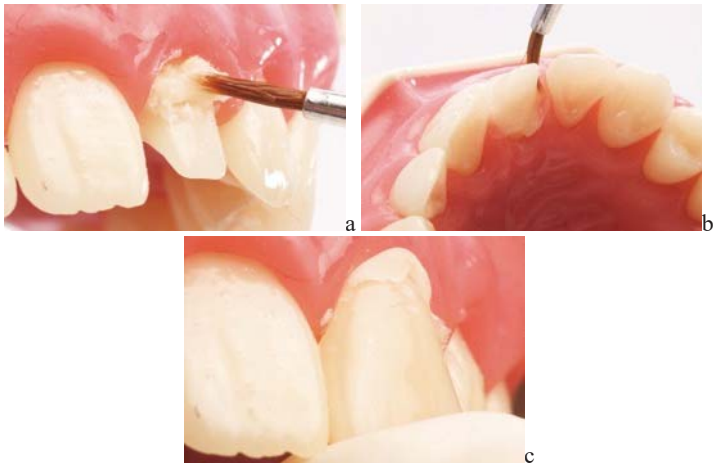


Figure 9.12: (a-b) Application of AAR by the Nealon technique on the buccal and palatal surface. (c) Repositioning the temporary during the plastic stage of the resin with gentle finger pressure until the resin is fully polymerized.

8. Adjustment of the cervical finish

(The same sequence described on Step 6)

9. Evaluation of the temporary concerning the oral tissues

Technique: Verification of the relationship between the temporary and the oral tissues is done in three stages: (1) cervical adaptation using a dental probe; (2) adaptation of interproximal contacts using dental floss; and (3) ideal occlusal contacts (see Chapter 13).

Objective: Protect the oral mucosal tissues.

Rationale: Lack of contact risks the loss of the temporary and gingival inflammation, which compromises the subsequent restorative steps.

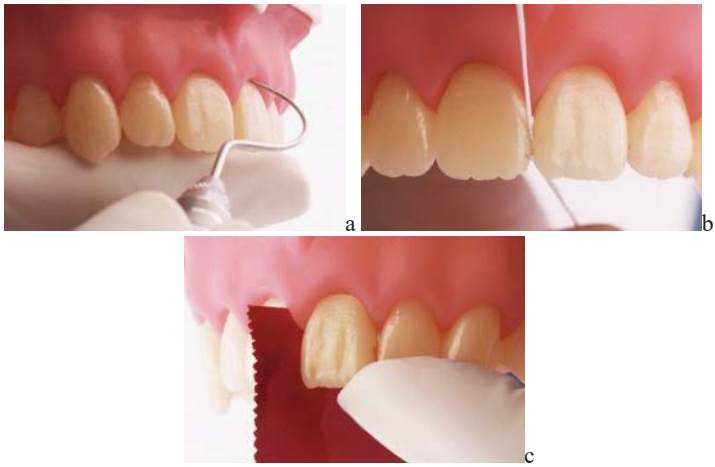


Figure 9.13: (a) Checking the adaptation with a probe positioned at 45 degrees, according to the long axis of the tooth. (b) Interproximal contact verification with dental floss. (c) Checking the interproximal contact with fine marking paper.

10. Polishing

(Sequence described on page 230)

11. Temporary luting

Technique: (1) Lubrication of the outer cervical area of the temporary restoration using solid Vaseline or water-based gel; (2) temporary cement mixing according to the manufacturer's recommendations; (3) cement application to only 1/3 of the inner axial walls using an insertion spatula; (4) hold the restoration in place under finger pressure until the cement is set; and (5) remove excess cement using a probe and dental floss.

Objective: Maintenance of the provisional in position between sessions.

Rationale: The use of temporary types of cement allows easy removal of the provisional restoration and provides a marginal seal.

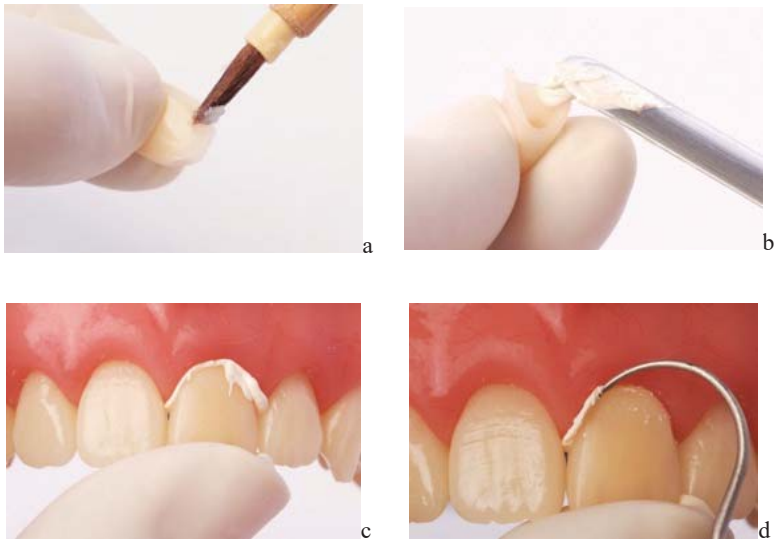
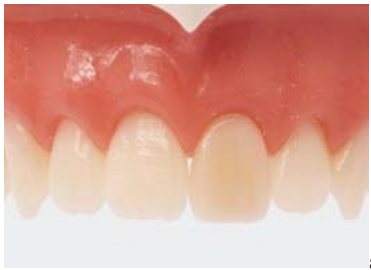


Figure 9.14: (a) External lubrication of the provisional. (b) Insertion of the temporary cement on the inner axial walls. (c) Positioning under finger pressure. (d) Excesses removal.

Final Characteristics of the temporary

- Adequate adaptation to the cervical margin
- Straight emergency profile
- Effective interproximal contacts that allow hygiene
- Ideal occlusal contacts
- Buccal and incisal alignment according to the neighboring anterior teeth
- Smooth and polished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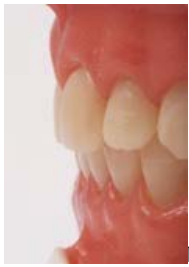
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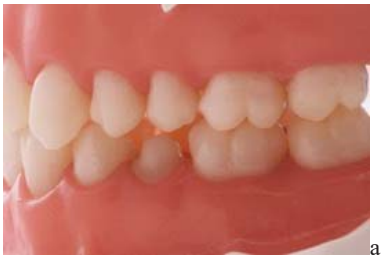
Figure 9.15: (a-b) Final evaluation of the provisional focusing on cervical adaptation, interproximal contacts, and buccal and incisal alignment.

THE MATRIX TECHNIQUE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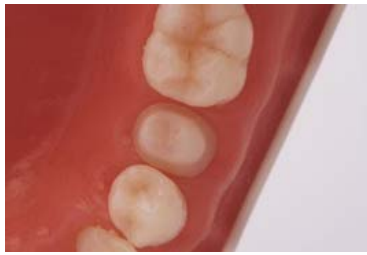

b

Figure 9.16: (a-b) Lower premolar.

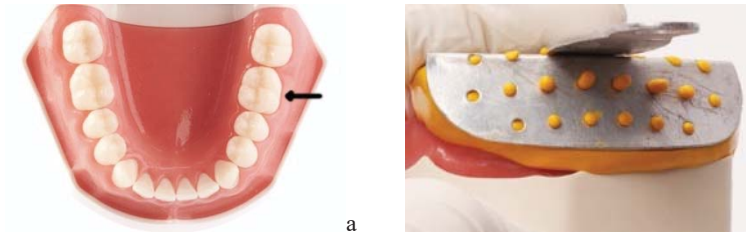
1. Pre-prep impression

Technique: This approach is indicated when the tooth has not yet been prepared. So, using a partial stock tray and putty silicone, take an impression of the tooth to be made.

Clinical tip: Relieve the cervical region of the tooth to be prepared on the inner aspect of the impression. This maneuver prevents strangulation of the resin when inserting the mold back into the mouth.

Objective: To create a template (negative) to facilitate provisional fabrication and produce a matrix.

Rationale: The use of putty silicone allows the mold to be stored during the period of the restorative treatment. If the patient loses the provisional restoration, making a new one becomes, therefore, a much easier task.



a b

Figure 9.17: (a) Target tooth (36) prior to preparation. (b) Putty silicone impression in a partial stock tray before the prep of the tooth.

2. Lubrication of the prepared tooth

Technique: Using a paintbrush exclusive for this step, apply solid Vaseline or water-based lubricating gel throughout the preparation and the surrounding tissues.

Objective: To prevent the adhesion of AAR to the prepared tooth.

Rationale: During the polymerization phase of the AAR, the resin will shrink over the preparation. If no lubrication is applied, the temporary can irreversibly stick to the preparation.

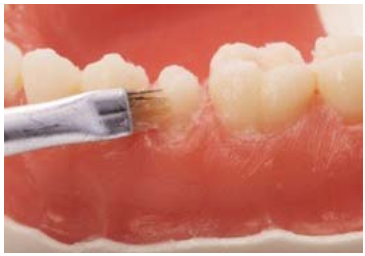


Figure 9.18: Application of Vaseline to the prepared tooth and adjacent areas.

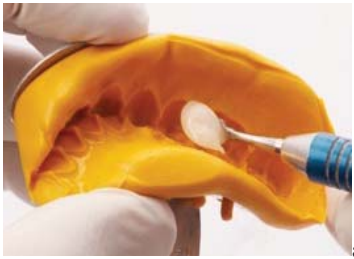
3. Filling the matrix with AAR

Technique: Using the wet resin technique and in the plastic phase, fill the template space of the prepared tooth. Bring the mold into the mouth only after the resin has gone matte (lost its shine). Remove the tray from the mouth after initial polymerization and before heat build-up (exothermic phase), remove the provisional, remove the excess with scissors, and reseat

the restoration during final polymerization, then ask the patient to occlude gently and cool the tooth with air-water spray.

Objective: To make the provisional according to the original tooth, while maintaining the same dimensions and alignment.

Rationale: This maneuver allows adequate cooling of the resin and to print the occlusion of the opposing tooth/teeth. The use of wet resin promotes mechanical strength and color stability compared to the other direct manipulation methods.


a

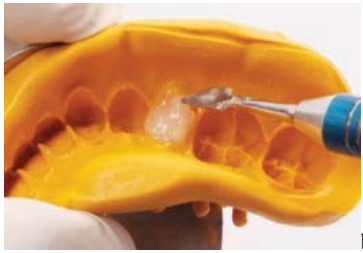

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Figure 9.19: (a-b) Fill the negative space of the prepared tooth with resin in the plastic phase.

4. Adjusting the cervical finish line

Technique: Using a red pencil, mark the limits of the cervical finish. Use a tungsten carbide cutter positioned along the long axis of the tooth's emergence profile and trim away the excess resin.

Objective: To promote adaptation to the cervical finish, without over or under contour.

Rationale: Establishing a good relationship between the temporary and the gingival tissue to maintain gingival health and facilitate impressions.


a

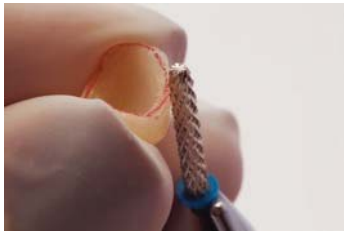

b

Figure 9.20: (a) Outlining the cervical finish with a red pencil. (b) Excess trimming with a tungsten carbide cutter positioned at the long axis of the tooth.

5. Relining the cervical finish line

Technique: This step may be unnecessary if the temporary is already correctly adapted to the cervical finish line and the gingival tissue. Assessment of the adaptation must be performed using a dental probe (see Chapter 11 for the correct handling of the probe). If there is a need for relining, AAR must be applied to the cervical finish using the Nealon technique. The restoration should only be positioned once the resin reline has gone matte. The temporary should then be maintained under light finger pressure until polymerization is complete.

Objective: To promote the optimal adaptation of the temporary to the cervical finish.

Rationale: The establishment of an adequate relationship between the temporary and the gingival tissue helps to maintain gingival health and facilitate impression taking.

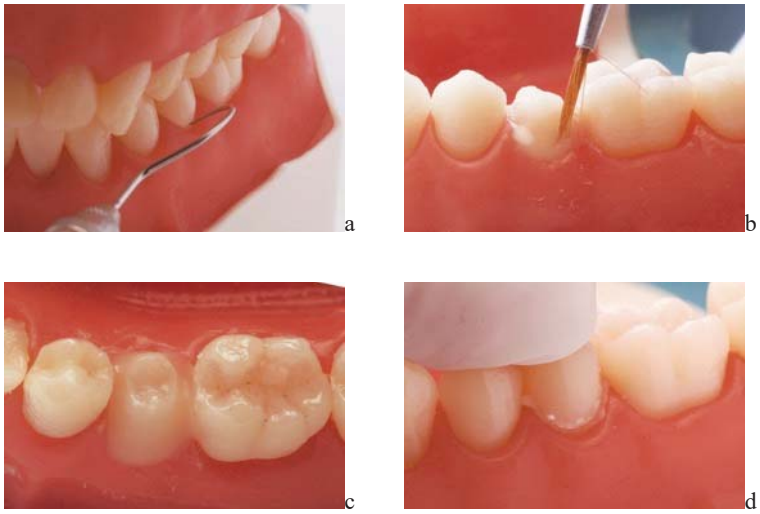


Figure 9.21: (a) Probing to check adaptation around the cervical finish. (b) Application of AAR to the gingival sulcus. (c) Waiting for the resin to go matte. (d) Position the temporary under finger pressure until full resin polymerization.

6. Readjusting the cervical finish

(Same sequence described in Step 4)

7. Evaluation of the provisional concerning the oral tissues

Technique: The verification of the relationship between the provisional and the oral tissues is made in three stages:

• Cervical adaptation using a probe

• Interproximal adaptation contacts using dental floss

• Ideal occlusal contacts with marking paper (see Chapter 13)

Objective: To protection the oral tissues.

Rationale: A lack of interproximal contacts risks loss of the temporary and compromise the subsequent steps of restoration making.

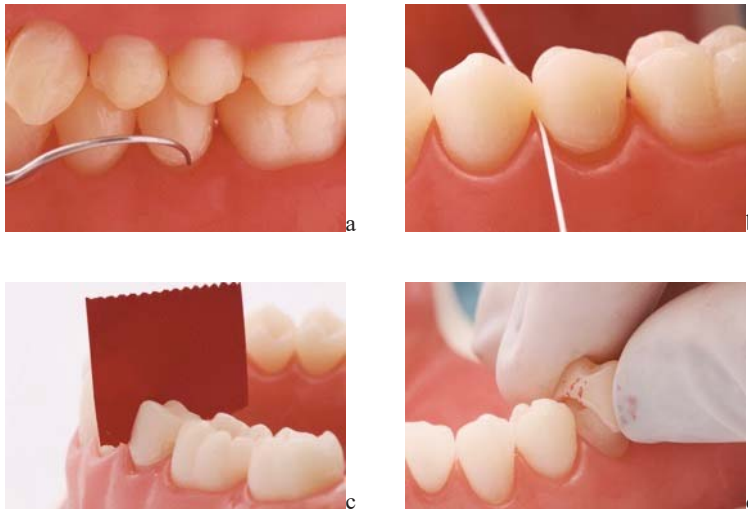


Figure 9.22: (a) Probing to check adaptation. (b-d) Verify adaptation of interproximal contacts with marking paper and dental floss.

8. Polishing

(Sequence described on page 230)

9. Temporary luting

Technique: (1) Lubrication of the outer cervical area of the temporary restoration using solid Vaseline or water-based gel; (2) temporary cement mixing according to the manufacturer's recommendations; (3) cement application to only 1/3 of the inner axial walls using an insertion spatula; (4) hold the restoration in place under finger pressure until the cement is set; and (5) remove excess cement using a probe and dental floss.

Objective: Maintenance of the provisional in position between sessions.

Rationale: The use of temporary types of cement allows easy removal of the provisional restoration and provides a marginal seal.

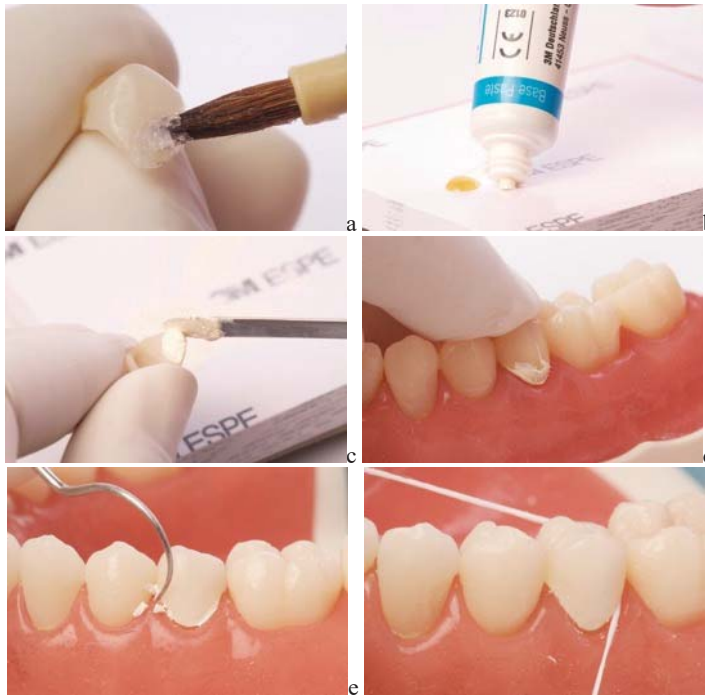
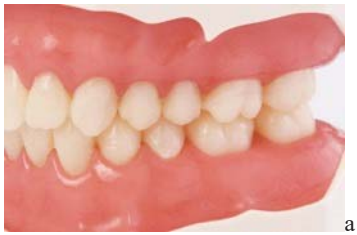


Figure 9.23: (a) External lubrication of the temporary with petroleum jelly. (b) Cement manipulation. (c) Cement application to the provisional. (d) Provisional in position under finger pressure. (e-f) Removal of excess cement with a probe and dental floss.

Final Characteristics of the temporary

- Adequate adaptation to the cervical margin
- Straight emergence profile
- Effective interproximal contacts that allow hygiene
- Ideal occlusal contacts
- Buccal and incisal alignment according to the neighboring anterior teeth
- Smooth and polished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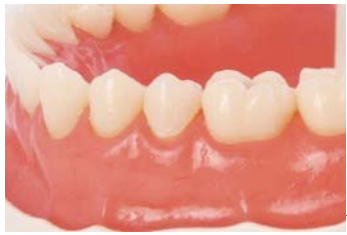

b

Figure 9.24: (a-b) Verify the adaptation of the temporary, interproximal contacts as well as the buccal and occlusal alignment according to the adjacent teeth.

REGRESSIVE SCULPTURE (CARVING) TECHNIQUE

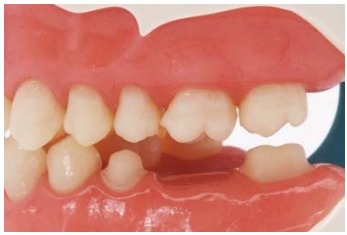


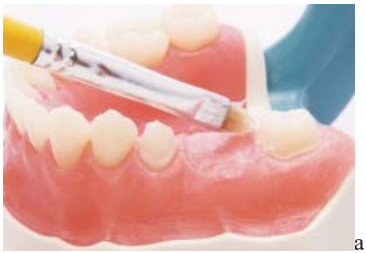
Figure 9.25: Target teeth: 35 and 37 to fabricate an interim fixed partial denture FPD.

1. Lubrication of prepared teeth and opposing teeth

Technique: Using a paintbrush exclusive for this purpose, apply solid Vaseline or water-based lubricating gel throughout the preparation and surrounding teeth.

Objective: To prevent the adhesion of AAR to the prepared tooth.

Rationale: During the polymerization phase of the AAR, the resin will shrink over the preparation. If no lubrication is applied, the temporary can irreversibly stick to the preparation.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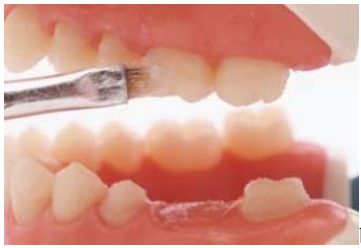

b

Figure 9.26: (a) Lubrication of the prepared teeth. (b) Lubrication of the opposing teeth.

2. Manipulation of the AAR

Technique: Using the wet resin technique, make a cylinder with the AAR during the plastic phase and position it around the prepared teeth. Then ask the patient to occlude to print the occlusal surfaces into the resin. During the exothermic period, cool the resin with water-air spray.

Clinical tip: At the final stage of polymerization, quickly remove and reinsert the resin to prevent it from sticking to the prepared teeth.

Objective: To use the occlusal anatomy of the opposing teeth to establish the functional sculpture of the interim FPD.

Rationale: Heat release is proportional to the volume of resin, so in cases such as this, there is a massive release of heat, which could be potentially harmful to the oral tissues. Cooling is, therefore, essential.

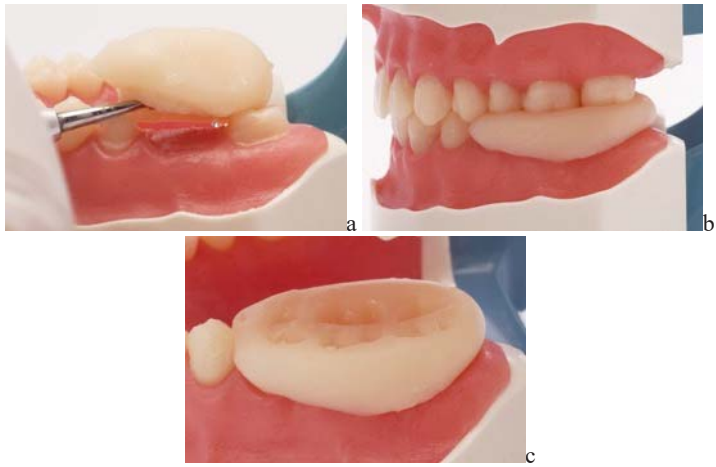


Figure 9.27: (a) Positioning of the resin roll surrounding the prepared teeth. (b-c) Occlusion and impression of the occlusal surfaces on the resin.

3. Establishment of anatomical perimeters

Technique: Using a thin diameter conical tungsten carbide cutter, reduce the interproximal areas—always grinding at the expense of the pontic.

Objective: To establish the coronal limits of the abutment teeth (and, therefore, also of the pontic) of the FPD.

Rationale: To allow the sculpture of the three teeth and establish the best distribution of the areas of each unit.

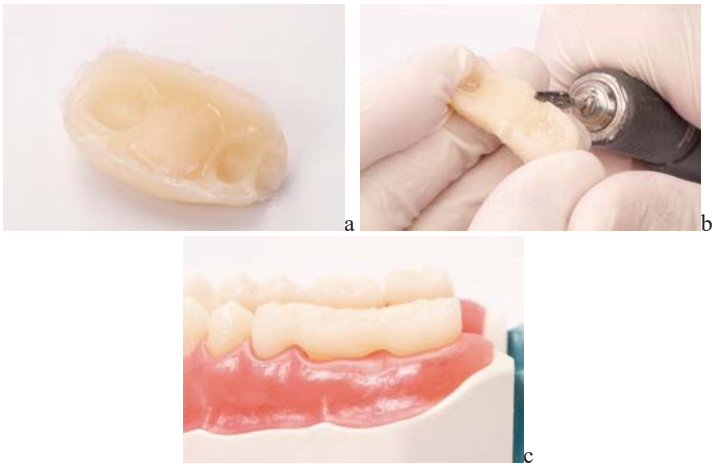


Figure 9.28: (a) Temporary resin with the cervical areas of the abutment teeth. (b) Carving with a thin conical tungsten carbide cutter. (c) Establishment of the perimeters of the fixed bridge.

4. Reference lines

Technique: (1) Using a blue pencil, mark the mesiodistal development groove from the deepest concavities and the central groove of the adjacent teeth. (2) With a red pencil, draw lines to determine the position of the tips of the cusps, using the adjacent teeth and the areas of higher convexity of the occlusal outline as references. (3) Using a black pencil, determine the occlusal plate with reference on the adjacent teeth.

Objective: To determine the parameters for sculpting the occlusal anatomy of the interim FPD.

Rationale: The markings facilitate the sculpting process of the occlusal anatomy and the perimeter that determines the buccal and lingual alignments.

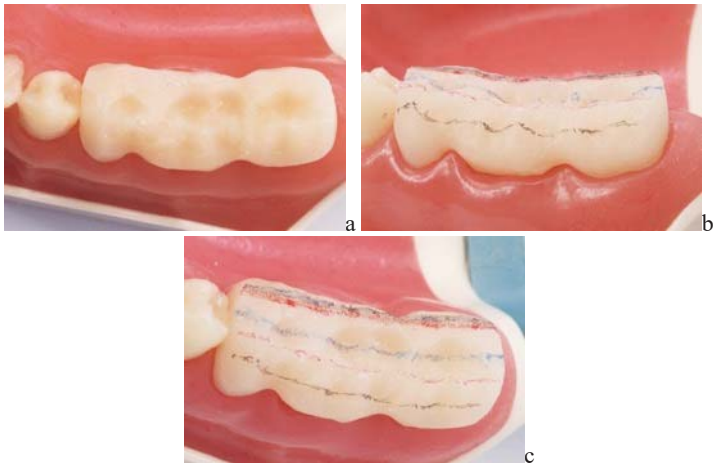


Figure 9.29: (a) Lump of resin in position. (b) Demarcation of the reference lines having the adjacent premolar as a reference. (c) Demarcation of the reference lines according to the peaks and valleys of the impression from the opposing teeth (blue line, central sulcus; red lines, tips of cusps and longitudinal edges; black lines, occlusal plates).

5. Buccal and lingual wall reduction

Technique: (1) Using a tungsten carbide cutter, determine the lingual and buccal surfaces based on the black markings and the cervical margin of the abutment teeth. It is important to note that the inclination of the drill should follow the inclination of the adjacent teeth.

Objective: To establish the buccal and lingual alignments of the temporary bridge.

Rationale: Temporaries that fail to reproduce the buccal and lingual alignments adequately may generate several problems, such as tongue and/or cheek biting, occlusal overload, and food impaction.

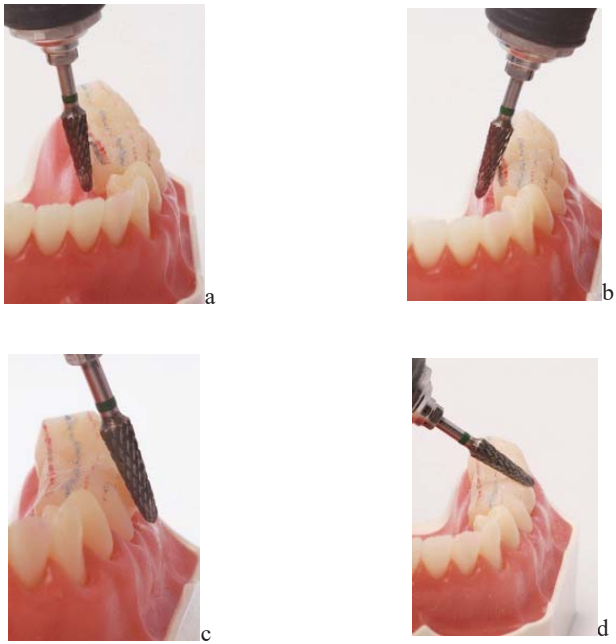


Figure 9.30: (a-b) Drill angulations to establish the lingual walls. (c-d) Buccal inclinations.

6. Preparation of the proximal niches (determination of the connecting areas)

Technique: Using a diamond disk, open the interdental spaces in the teeth connecting points, leaving these areas in a triangular shape.

Objective: Establish interdental geometry.

Rationale: Interdental indents are essential for biofilm control.


a


b

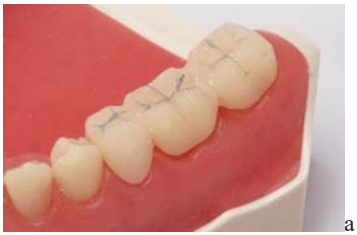
Figure 9.31: (a-b) Wear of the proximal areas with a diamond disk.

7. Area of the opposing cusps (creating the major occlusal grooves)

Technique: Using a blue pencil, mark the lines referring to the main occlusal grooves (both mesiodistal and buccolingual) according to the most profound imprints from the opposing teeth (valleys). From these markings, deepen the grooves with a small drill.

Objective: To establish the cusps and occlusal fossae/pits.

Rationale: The areas of the cusps and pits are fundamental for occlusal harmony.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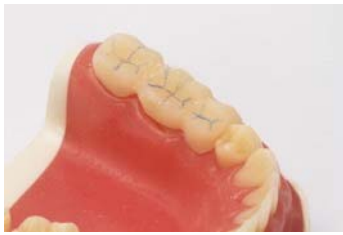
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Figure 9.32: (a-b) Drawing the lines representing the main grooves. (c) Carving the occlusal features with a small drill.

8. Determination of the cervical margin

Technique: Using a red pencil, mark the limits of the cervical finish. Using a tungsten carbide cutter positioned along the long axis of the emergence profile of the teeth, trim away the excess resin.

Objective: To adjust the area of the cervical margin to facilitate the procedure of relining.

Rationale: It is not unlikely to obtain a temporary of this size which does not need relining.


a


b

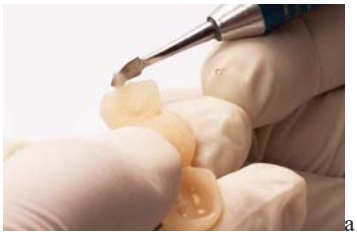
Figure 9.33: (a) Outlining the limits of the cervical finish. (b) Drill position following the emergence profile.

9. Relining the cervical finish

Technique: This step may be performed using the Nealon technique (following the same sequence illustrated previously in the veneer approach, as well as the matrix technique). However, it may also be done in yet a different way. After the resin has been mixed, it is positioned on the inner edges of the temporary (not forgetting to brush monomer liquid beforehand to optimize bonding). Once the material has lost its shine, the temporary must be placed over the teeth and maintained under finger pressure throughout the polymerization time of the resin.

Objective: To promote the optimal adaptation of the cervical area.

Rationale: Ensure gingival health.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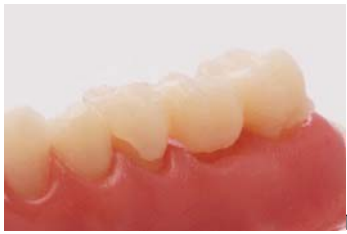
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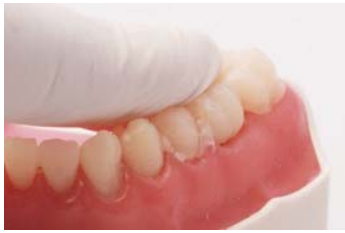
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Figure 9.34: (a) Placement of the resin in its plastic stage onto the inner edges of the interim FPD. (b-c) After the loss of shine, position the temporary under finger pressure until full polymerization of the resin.

10. Adjustment of the cervical margin adaptation

Technique: Using a red pencil, draw the limits of the cervical finish, then trim away the excess resin using a diamond disk (proximal areas), and a tungsten carbide cutter positioned along the long axis of the emergence profile of the tooth.

Objective: To promote adequate cervical adaptation.

Rationale: Safeguard gingival health.


a


b

Figure 9.35: (a-b) Adjusting the cervical end area with the drill positioned along with the emergence profile.

11. Evaluation of the temporary in relation to the oral tissues

Technique: The verification of the relation between a temporary fixed bridge (FB) and the oral mucosal tissues is done in four stages: (1) cervical adaptation using a probe; (2) interproximal contacts using dental floss; (3) adequate space for hygiene in the interproximal niches and correct relationship between the pontic and the mucosal tissue, as evaluated using dental floss and interproximal brushes; and (4) ideal occlusal contacts (see Chapter 13).

Objective: To provide structure to safeguard the intraoral tissues.

Rationale: Lack of adequate contacts leads to the inflammation of the oral soft tissues, which increases the risk of losing the temporary restoration, thereby compromising the subsequent restorative steps.

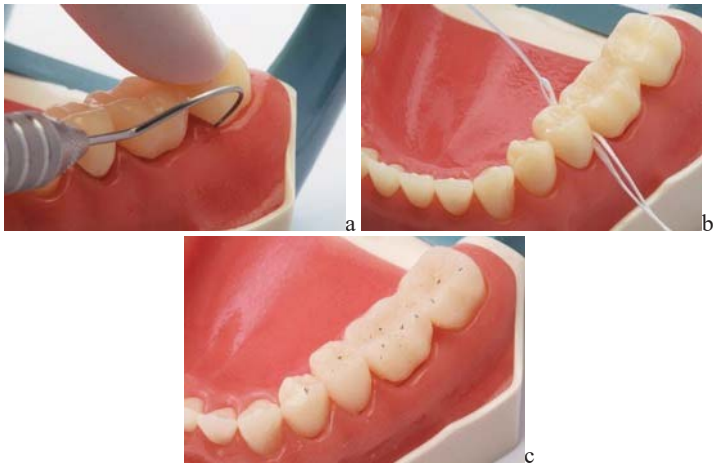


Figure 9.36: (a) Probing the cervical margin. (b) Checking the space for hygiene in the interproximal areas using dental floss. (c) Checking the occlusal contacts.

12. Polishing

(Sequence described on page 230)

13. Temporary luting

Technique: In the case of an interim FPD, in addition to the steps taken for single-unit temporary crowns, tie some knots to the dental floss to facilitate

cement removal from the interproximal areas. In this way, the sequence should be as follows: (1) tie knots to the dental floss at the interproximal regions; (2) lubricateof the outer the area of the cervical margin of the temporary using solid Vaseline or water-based gel; (3) mix the temporary cement following the manufacturer's instructions; (4) apply the cement using an insertion spatula to no more than 1/3 of the internal axial walls of the retainers; (5) apply finger pressure onto the interim FPD until the temporary cement is set; and (6) remove the excess cement using a probe and dental floss.

Objective: To keep the temporary restoration in place in-between visits.

Rationale: The use of temporary types of cement allows the removal of the temporary and provides a marginal seal.

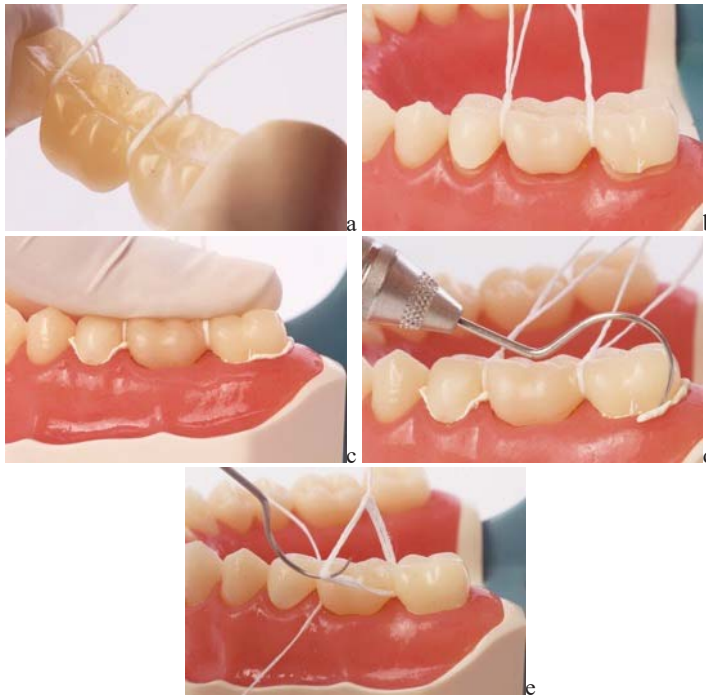
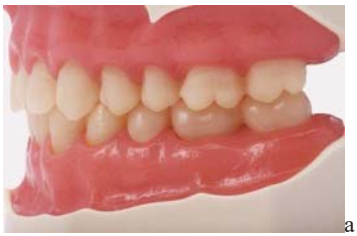


Figure 9.37: (a-b) Placement of the knots at the interproximal surfaces. (c) Position the temporary under finger pressure. (d-e) Excess temporary cement removal with a probe and dental floss ligatures.

Final Characteristics of the temporary

- Adequate adaptation to the cervical margin
- Straight emergence profile
- Effective interproximal contacts that allow hygiene
- Interproximal shaping that allows hygiene
- Correct relation of the pontic to the mucosal tissues
- Ideal occlusal contacts
- Buccal, occlusal, and lingual alignment according to the remaining posterior teeth
- Smooth and polished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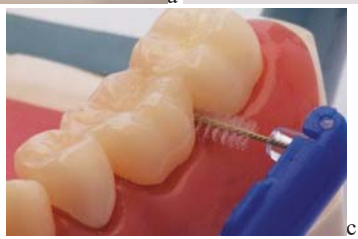
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Figure 9.38: (a-c) Verification of the cervical finish, niches, as well as the buccal, occlusal, and lingual alignments.

CHAPTER 10

IMPRESSIONS

Marcelo Lucchesi Teixeira
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André Antonio Pelegrine
Welson Pimentel Filho

Definition:

Impressions are a series of clinical maneuvers with the purpose of obtaining the negative reproduction of tooth preparations and surrounding areas by using adequate materials and techniques. Their basic objective is to transfer the patient's mouth to the laboratory bench from a faithful copy of the existing intraoral conditions.

With the advent of CAD/CAM technology, transferring the mouth to the virtual environment can be executed in two ways: by direct scanning (intraoral scanning) or by indirect scanning (scanning of the impression or model by a lab scanner). Thus, in this chapter, the two techniques for obtaining the data will be presented

Different kinds of Impression:

Impressions can be divided into two different kinds: for the *reproduction* of oral tissues or for the *transfer* of some prosthetic piece or prosthetic implant component. As they have different goals, their respective techniques are also different; although, in some specific cases, it is possible to obtain a reproductive and a transfer impression in the same procedure.

The aim of **reproduction** impressions is to produce a copy of oral tissues with the greatest possible fidelity. This type of impression is used to obtain study models or antagonists (Chapter 6) or to obtain working models for making indirect restorations, which, in cases where the cervical preparation is situated in a subgingival position, requires a tissue displacement

technique. The purpose of this chapter is to describe the technique for a working impression for indirect restorations.

With the rise of Implantology, the "impression of the implants" as part of the prosthetic operating sequence is a well-accepted norm. Nonetheless, the impression process for implants is quite different from the impression of prepared teeth. The purpose of the **transfer** impression is to spatially position the target object using specific components previously adapted to that object (usually the transfer component in relation to the implant platform or the pre-installed prosthetic component).

The purpose of the **transfer** impression is to spatially position the target object using the specific components previously adapted to that object (usually the transfer component in relation to the implant platform or the pre-installed prosthetic component).

The technique of the transfer impression for infrastructures for implant-supported fixed prostheses is discussed in Chapter 11 while the technique for transferring implant-supported prostheses is described in Chapters 16, 17, and 18.

Impression Materials:

For reproduction impressions, different types of elastic materials can be used: hydrocolloids (which includes alginates) and elastomers (which includes mercaptan, polyether and addition and condensation silicones). For working impressions (subject of this chapter), the materials most indicated for their physical characteristics and precision are polyether and addition silicones. Due to their comprehensiveness, availability, and simplicity of use, focus will be given to addition silicones. This class of materials present different consistencies with different flow and viscosity capabilities. In general, according to these characteristics, the materials are classified as follows:

- Monocomponent: Presents viscosity and adequate flow to be used in individual trays.
- Dense (putty): It has high viscosity (resistance) and low flow, giving support to the impression; it is not indicated to reproduce details.
- Fluid: materials with low viscosity and high flow allow details to be copied very well (supra and subgingivally), but do not have resistance and flow direction, and thus require the external support promoted by dense material. Fluid materials also have different

consistencies, which suggests that they have different indications for use (Table 10.1).

Table 10.1: Characteristics and indications of fluid materials with different consistencies (material used as reference: Panasil, Kettenbach)

		X-light	*Light*	*Regular*
Picture				
Flow		+++	++	+
Viscosity (resistance)		+	++	+++
Technique	***Simultaneous***	+	+++	+++
	Double Impression	+++	+++	+
Better suited for		Subgengival tooth preparations	Tooth preparations	Implant transfer Study models

From these characteristics, it is clear that single-component materials can be used alone, but they need individualized trays, while dense and fluid materials are complementary to each other, and their combined use allows the employment of stock trays, which facilitate (and lowers the cost) the process.

Impression making techniques:

The optimization of results with stock tray is achieved with the association of dense and fluid materials. There are several techniques to do this, which can be summarized in two categories: the *simultaneous technique* (also called the single step technique or double mixing technique) and the *double impression technique* (also called the two-step technique or relining technique).

- *Simultaneous impression:* Both consistencies of the material (dense and fluid) are brought to the mouth in the same impression in a single step.

- *Double impression:* Performed in two steps; first the impression is made with only the dense material (which "individualizes" the tray) and then a complementary impression is made with fluid material, which is responsible for copying the details.

A comparative analysis of the two techniques can be seen in Table 10.2.

Table 10.2: Comparison of simultaneous and double impression techniques

Technique	Simultaneous	Double impression
Placement of dense material (Figure 10.1)	Loading of half of the tray	Loading the whole tray
Undercut making	No	Retentive areas Palatal surface Interproximal regions Escape grooves
Fluid material on the tray	Teeth area only	Teeth area and a small portion of the palatal surface
Fluid material on the mouth	Occlusal and cervical region of the teeth	Cervical region of the teeth
Final assessment of the impression	Visualization of dense and fluid Irregular fluid flow	Basically, only fluid visualization Uniform fluid flow
Disadvantages	4 hand-procedure Synchronization Difficulty in execution	Longer working time Mastery of the relief technique There may be compression of the marginal gingival tissue
Advantages	Less steps Less material Less time Dimension of marginal gingival tissue	2 hand-procedure Better predictability Less stress during the procedure

Figure 10.1: Difference in tray loading with dense material: (left) complete loading for the double impression technique and (right) half of tray for simultaneous technique.

Figure 10.2: Difference in visualization of the appearance of the fluid material: (left) fully covered surface for the double impression technique and (right) partially covered surface for the simultaneous technique.

Gingival tissue displacement techniques

In the case of working impressions of indirect restorations in which the cervical end is positioned low (subgingival) or at the height of the gingival margin, the gingival tissue must be displaced in order to allow the impression material to penetrate this region and to be thick enough to copy this area without tearing when the tray is being removed. The most common techniques involve the use of retraction cords, astringent substances, and caskets. The most common techniques involve the use of retraction cords (Table 10.3), which act by temporarily stretching the fibers surrounding the periodontal ligament.

Table 10.3: Characteristics of different gingival tissue displacement techniques using retraction cords.

	One cord traditional	One cord subgingival	Double cord
Cord selection	Thickness that promotes vertical and horizontal displacement	Thinnest thickness capable of promoting vertical and horizontal displacement	1st cord: really thin and only promotes vertical displacement 2nd cord: thicker- promotes horizontal displacement
Cord suggestion *	cords #0 or #1	cord #00	cord #000 (1st cord) cord #0 (2nd cord)
Cord positioning	It should be viewed over the entire length of the tooth and have an external portion that helps its removal	Must be viewed and have the exact length of tooth extension	1st cord: should be completely hidden beneath in the gingival sulcus 2nd cord: It should be viewed over the entire length of the tooth and have an external portion that helps its removal
Cord removal for impression	The whole cord should be removed	Cord should not be removed during the impression: either it sticks to the impression or it is removed later	Only the 2nd cord should be removed (Note: the 1st one should be removed after the impression)

* Thicknesses based on Ultrapak cords (Ultradent)
* Cord thicknesses is defined according to the gingival phenotype and the position of the cervical end in relation to the gingival margin; this is merely a suggestion based on the frequency of use by the authors.

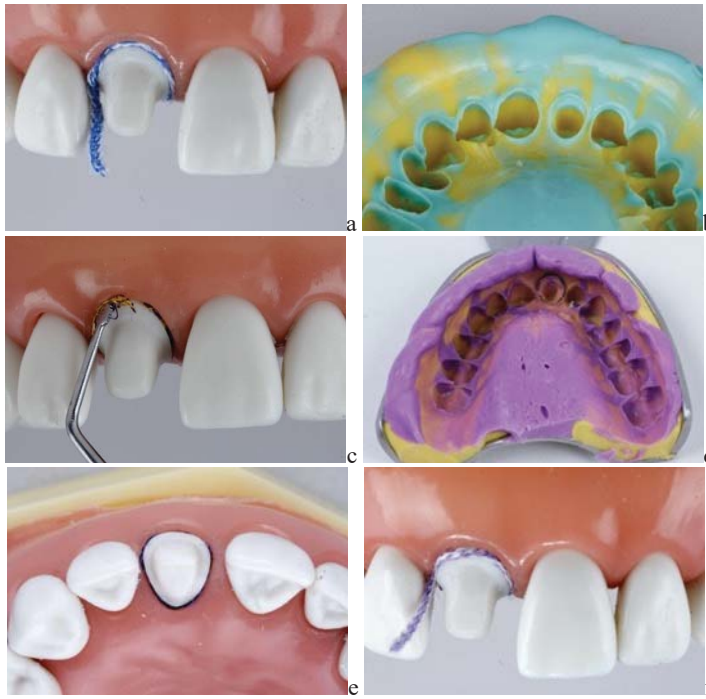


Figure 10.3: (a) Conventional single cord technique. (b) Conventional single cord working impressions. (c) Subgingival single cord technique. (d) Working impression using the single subgingival cord technique. (e) 1st cord placed in the double cord technique. (f) 2nd cord installed in the double cord technique.

Other displacement techniques can be done without the use of retracting cords, such as the use of caskets and displacement pastes (Figure 10.4).

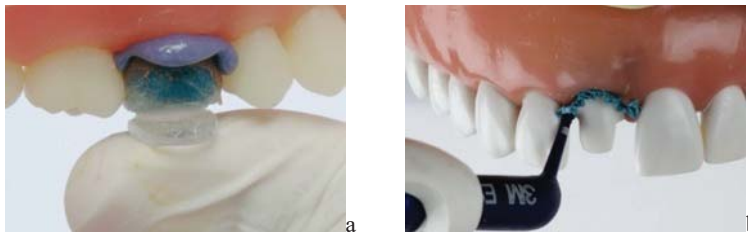


Figure 10.4: (a) Gingival tissue displacement with the impression casket technique and (b) with the use of displacement paste.

List of materials used in this chapter

- Rigid metallic
- Peripheral wax or utility wax
- Godiva plates or sticks
- Utility knife
- Cord packer instrument
- Retraction cord, all sizes (suggestion: Ultrapak)
- Addition silicone (putty and light)
- Impression material dispensing gun
- Mixing tips (Mixpac Sulzer)
- Intraoral tips (IOT) (Mixpac Sulzer)
- Tray adhesive (for silicone)
- Gouge-like instrument for groove making (putty-cut)
- Small alveolotome

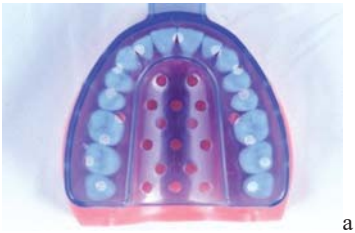
TECHNIQUE STEPS:

1. Tray Selection

Technique: The ideal tray for precision impression should be rigid, should provide retention for the impression material, and should act as an efficient "carrier" of the impression material. Regarding size, the tray should cover all the surfaces of all of the teeth and should allow a corridor of at least 3.0 mm between its edges and the oral tissues in order to allow the correct flow of the impression material's excess.

Objective: To provide conditions that allow for a favorable result, thereby facilitating the tray insertion technique.

Rationale: Promote sufficient support to accommodate the impression material and prevent distortion due to improper material leakage or displacement from the impression tray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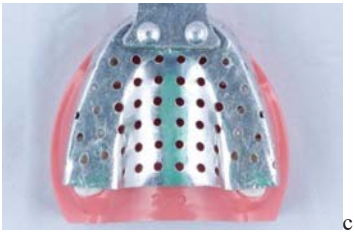
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Figures 10.5: (a-b) Properly selected trays covering all teeth. (c-d) Improper tray selection, since it does not cover all teeth either vertically or horizontally.

2. Tray preparation

Technique: In case the selected impression tray does not completely cover all dental surfaces (loosely), its size must be increased, while individualizing it according to the patient's characteristics. When there is a need for an enlargement in the posterior region, the same should be done with a godiva bar. In cases of enlargement in the anterior teeth, this individualization can be performed with peripheral or utility wax.

To avoid displacing the impression material of the tray, the use of tray adhesives is recommended.

Objective: Having the tray ready for the impression procedure.

Clinical Tip: As the ideal setting time for the tray adhesive varies from 7 to 15 minutes, ideally the tray should be selected and prepared at the beginning of the clinical session, before removing the provisional or before tooth preparation, for example.

Rationale: The tray individualization allows for an easier insertion technique, thereby enabling a good impression and decreasing the chances of hurting the patient during the procedure.

Figure 10.6: Tray adhesive application on a stock tray

3. Material manipulation

Technique: The handling of the addition silicone varies according to the consistency. Dense material must be manipulated manually in a 1:1 ratio of both pastes. Handling must be done with vinyl or nitrile gloves (latex gloves interfere with the polymerization of this type of material) for 1 minute, leaving 30 seconds to fill the tray and take it to the mouth (these times are valid for Panasil—for other commercial brands, consult the manufacturer's recommendations in the product's instructions).

As for the fluid material, it should be manipulated with the use of a 1:1 or 1:2 silicone gun dispenser with a mixing tip according to the consistency of the material

Objective: To prepare the material in order to achieve its best properties.

Clinical Tip: For dense material, the ideal ratio is 1:1, so weighing each paste ensures that ratio is accurate.

For the fluid material, the selection of the mixing tip must be made according to the color code of the packaging lid. It is also advisable to dispense with the start of each cartridge.

Rationale: Getting the best possible performance out of the selected material.

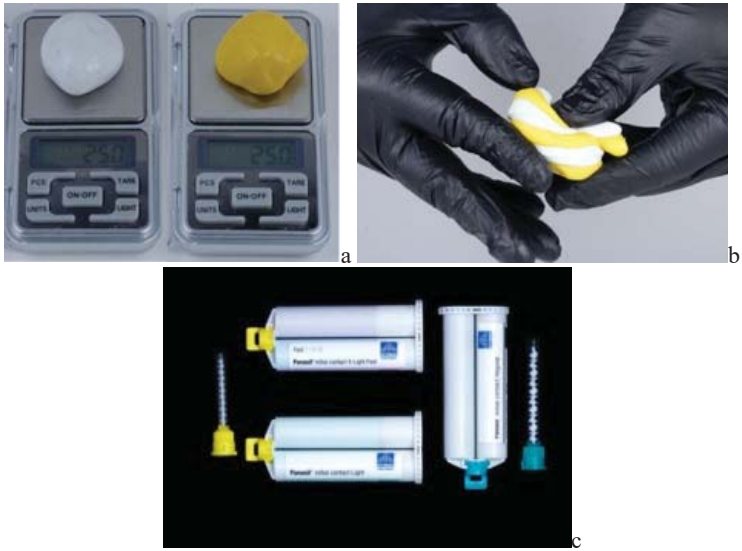


Figure 10.7: (a) Weighing of dense material pastes. (b) Handling of dense material with nitrile glove. (c) Color code of the mixing tip with the fluid material packaging lid.

SIMULTANEOUS TECHNIQUE

1. Tray filling

Technique: In the simultaneous impression technique, two factors are important in relation to filling the tray with impression material: the amount of dense material and the final polymerization time of both consistencies. Regarding the amount of dense material, ideally it should fill half of the tray (Figure 10.1A). The amount of material directly influences the flow of the fluid material, which, due to its viscosity, flows in all directions, which in turn can promote distortions in the impression.

As for the setting time, in the simultaneous technique, it is ideal that both materials polymerize at the same time or at least that the dense material polymerizes minimally before the fluid material to avoid distortions ("tight areas") in the impression. Thus, it is recommended to first place the fluid material in the tray and then in the mouth (which has a higher temperature).

Objective: To correctly fill the tray within the handling time to facilitate the insertion step in the mouth.

Rationale: To allow the correct flow of the fluid material.

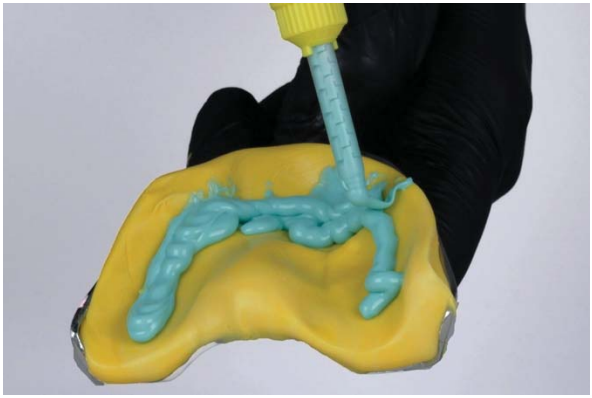


Figure 10.8: Tray filling with dense material occupying half the height of the vertical walls and the dispersed fluid material in the shape of a horseshoe.

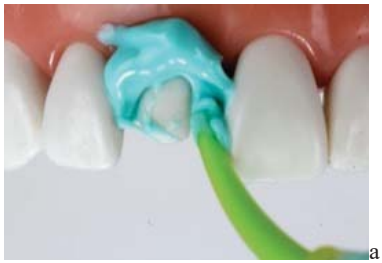
2. Placement of the fluid material in the subgingival region at the cervical end

Technique: The placement of fluid material in the gingival sulcus should ideally be performed after loading the tray and as soon as possible after removing the retraction cord. It is performed with the aid of an intraoral tip (IOT) coupled with the mixing tip or using a hummingbird type mixing tip, which promotes more accurate placement when inserting the material.

Objective: To optimize the reproduction of the subgingival region in the impression.

Clinical Tip: The use of air from the triple syringe assists in the flow of the fluid material into the gingival sulcus.

Rationale: To allow a better reproduction of the subgingival region, directing the flow of the fluid material in an appropriate way.


a


b

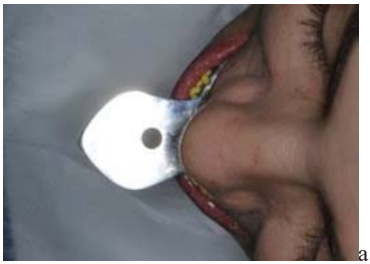
Figures 10.9: (a) Placement of fluid material within the gingival sulcus with an intraoral tip (IOT) attached to the mixing tip. (b) The air from the triple syringe assists by directing the material into the gingival sulcus.

3. Tray insertion

Technique: Initially, the correct position of the tray must be determined according to the dental arch, ideally by aligning the tray handle with the patient's midline. After determining the correct position, the tray must be pressed against the dental arch in a single movement and in a single direction. It is important to pay attention to the working time of the material so that the insertion is done within the working time.

Objective: To optimize the copy of the impression, thereby obtaining the best possible result.

Rationale: To direct the flow of the different consistencies by directing it in the best possible way, thus reducing the possibility of impression distortions.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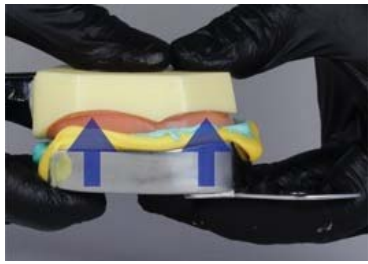

b

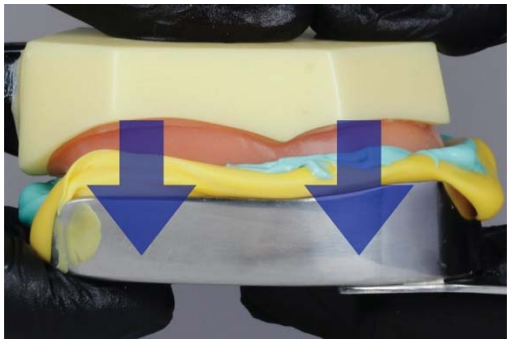
Figures 10.10: (a) Tray positioned according to the arch and the patient's face. (b) Tray insertion technique in a single movement and in a single direction.

4. Tray removal

Technique: After the setting time of the selected material, remove the impression tray from the mouth with the reverse sequence of that used for insertion that is: first remove it from the dental arch in a single movement and in a single direction and, later, remove it from the oral cavity.

Objective: To properly remove the tray in order to prevent distortion.

Rationale: The removal in several movements or directions can deform the impression material or delay the recovery time of the impression.



Figures 10.11: Tray removal in a single movement and in a single direction

DOUBLE IMPRESSION TECHNIQUE

1. Tray filling

Technique: In the double impression technique, the first impression aims to individualize the stock tray. This first impression is only made with dense material. The amount of material placed in the tray must be sufficient to determine the correct position of the tray in the second impression, which allows the entire arch (and the hard palate in the upper impressions) to be copied. Thus, the amount of dense material must be adequate for such a maneuver, being ideal that it fills the entire tray (Figure 10.1A)

Objective: To individualize the stock tray with high viscosity material.

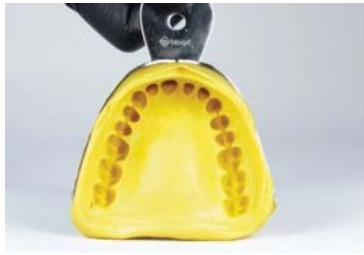
Rationale: To facilitate the second impression, giving predictability to the final impression.

Figure 10.12: Complete filling of the tray with dense material

2. Insertion and removal of the tray from the mouth

Follow the instructions from Steps 3 and 4 for simultaneous impression.

a



b

Figures 10.13: (a) Dense material involving the entire dental arch to the bottom of the vestibule. (b) Appearance of the preliminary impression (1st impression).

3. Space making

Material used: Utility knife and gouge-like instrument for groove making (Putty-cut). As a suggestion, the use of a small alveolotome may be a time-saver.

Objective: Prepare the individual tray for the second impression in order to obtain the same position of the tray in both impressions. To do this, it is necessary to selectively remove part of the dense material to obtain space for the fluid material with escape areas that allow its flow so that the position of the tray is exactly the same in both steps.

Rationale: To make the second impression viable, giving predictability to the final impression.

Figures 10.14: Material used for the space making

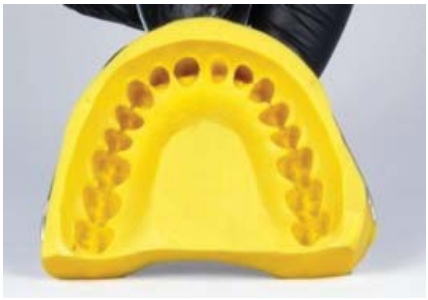
3.1. Removal of retentive areas

Technique: With the utility knife, remove all retentive areas (such as the fornix region on the vestibular area in patients with bone exostosis).

Figures 10.15: Cut out retentive areas with the utility knife

3.2. Cut out the upper part of the palatal area

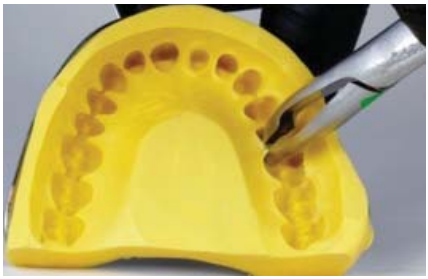
Technique: Using a knife, remove a piece of the upper portion of the palatal area.



Figures 10.16: Final aspect of the removal of the upper part of the palatal area with a utility knife

3.3 Removal of interproximal regions

Technique: Removing the interproximal regions of the teeth allows for an easier insertion of the tray and can be performed with the finer tip of the Putty cut. However, this maneuver is easier and faster with the use of an alveolotome.



Figures 10.17: Removal of interproximal areas using an alveolotome

3.4. Making escape grooves

Technique: With a putty cut groove maker, create grooves from the teeth region to the palatal area of the impression and to the buccal region of the teeth. Ideally, these grooves should be made alternately in the palatal and vestibular regions.

Clinical Tip: In the prepared teeth (target teeth) do not make a groove or, if you do, stay clear about 3mm from the end of the preparation so that the

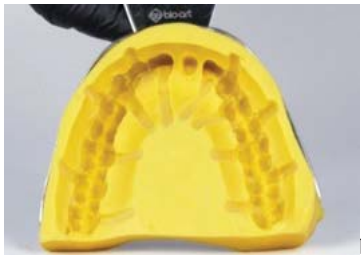
dense material helps to push the fluid material into the gingival sulcus, which facilitates a good result of this critical area of the impression.

Figures 10.18: Escape groove making with a gouge-like instrument (putty-cut)

3.5. Assessment of the created space

Technique: As the purpose of creating the extra space is the to correctly position of the tray for the second impression, it is recommended to test (train) the insertion of the tray in the mouth to check if it is adequate or if there is a need for extra relief. It is essential that the impression is well washed and dried, so adhesion between the fluid material and the dense material previously executed can be achieved.


a


b

Figures 10.19: (a) verification of the correct insertion of the tray. (b) Final appearance of the primary impression after the space making.

4. Impression with the fluid material

Technique: The fluid material must be placed initially over the impression, filling the entire area of the teeth. Then, the material must be placed in the subgingival region of the prepared teeth (see Step 2 of the simultaneous technique).

Objective: High fidelity impression of details/

Rationale: The fluid material is responsible for the reproduction of details and should also present a sufficient flow that allows its penetration into the gingival sulcus.


a


b

Figures 10.20: (a) Filling of the fluid material in the impression. (b) Placement of fluid material in the subgingival region (aided by an air flow).

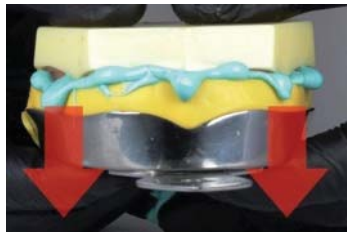
5. Tray insertion and removal

Technique: As already mentioned, the tray must enter in a single insertion axis and should have a single position (the same previously defined). This is the greatest advantage of the double impression technique, as the position is defined in the first impression with the second being responsible for the flow of the fluid material (well directed), which gives excellent predictability to the process.

Objective: To obtain a faithful and detailed negative copy in a predictable way.

Rationale: The double impression technique allows to control the flow of the fluid material.


a


b

Figures 10.21: (a) Insertion of the tray in a single insertion axis previously defined. (b) Removal of the tray in a single movement and in a single direction.

IMPRESSION ASSESSMENT

6. Tray filling

Technique: The evaluation of the impressions is done visually (magnification helps this process) after washing and drying them.

A working impression for indirect restorations should have the following characteristics:

- Absence of air bubbles in the teeth region
- Adequate gingival displacement
- Tray cannot appear in the occlusal region of the teeth
- Uniform flow of impression material (without “dragging” areas)
- No tearing of the impression material

Objective: To make sure that the procedure was successful in order to send a quality information to the dental laboratory.

Rationale: An inadequate impression will prevent a good working model (or scanning) to be obtained, generating an unsatisfactory indirect restoration. The repetition of prosthetic work is much more expensive than a new impression!

Figures 10.22: Impressions finished and cut to show the uniformity and relationship of the materials to each other. (left) Double impression technique and (right) Simultaneous technique.

7. Impression disinfection

Technique: The impression must be disinfected according to the type of material and the manufacturer's recommendations. In the case of addition silicones, 0.2% peracetic acid, 2% glutaraldehyde, or 1% sodium hypochlorite can be used. Initially, the impressions should be washed under running water to remove saliva and secretions (blood, for example) and dried. Subsequently, the impressions must be handled according to the manufacturer's standards.

Objective: To allow the safe handling of the material during the entire production chain of indirect restorations.

Rationale: To avoid cross-contamination of the professionals, from the dental team to the prosthesis laboratory.

DIRECT DIGITAL CAPTURE

Impression digitalization process: Intraoral scanners allow the capture of an extremely accurate image of the oral cavity, thus accelerating the laboratory and clinical workflow.

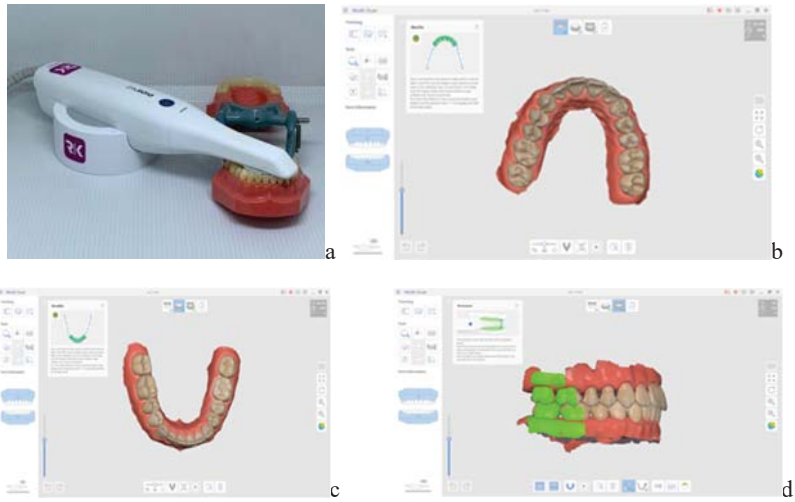
1. Dental arch scanning technique

Technique: Teeth should be thoroughly dried. Scanning should start at the occlusal surface of the most posterior tooth of the arch going towards to the

last tooth on the opposite side; scan the lingual surface of all the teeth and then finish the scan by capturing the buccal surface of all the teeth. Ask the patient to occlude the teeth and scan the buccal surface of the teeth to capture the Occlusal Registry.

Objective: to avoid image distortions and superposition.

Rationale: To optimize the scanning process.



Figures 10.23: (a) Intraoral Scanner. (b) Capture of the upper arch. (c) Capture of the lower arch. (d) Registration of MI (maximum intercuspal position)

2. Tooth preparation scanning technique

Technique: Displace the gingival tissue as previously described. Adjust the scanner in the high-resolution image capture mode (HD). Block the images of the teeth adjacent to the preparation. After making adjustments to the software, the retraction cord should be removed, and the image should be captured.

Clinical tip: Remove the retraction cord only after making all the adjustments in the scan, blocking the adjacent areas, and erasing the scanned preparation area.

Objective: To copy the preparation margins.

Rationale: The intraoral scanner will only be able to identify the margins of the preparation if they are visible.

Figures 10.24: (a) Target tooth: right upper first molar. (b) Block the images of the adjacent teeth. (c) Erase the image of the preparation with the retraction cord. (d) Capture the preparation in high resolution. (e) Registration of MI (maximum intercuspal position).

3. IMAGE CAPTURE ASSESSMENT

Technique: The evaluation of the image capture is made by visual inspection in the intraoral scanner software.

The captured image must have the following characteristics:

- Adequate gingival displacement with a clear visualization of the margins of the preparation.
- Absence of image overlap.

Objective: To make sure that the procedure was satisfactory and to send good quality images (e.g., *.stl*, *.ply*, or *.obi*) to the dental laboratory.

Rationale: An inadequate image will prevent a good virtual model of work from being generated, thus leading to an unsatisfactory indirect restoration.

CHAPTER 11

FRAMEWORK TRY-IN

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Marcelo Sperandio
André Antonio Pelegrine
Marcelo Lucchesi Teixeira

INTRODUCTION

The framework (FW) try-in aims to primarily verify the adaptation between the copings and the prepared teeth. Adjustment is a crucial factor for the long-term success of the restorations since maladjusted pieces are associated with thick layers of luting cement, which is soluble in the oral environment and serves as a potential niche for bacterial proliferation.

Historically, ceramics have always been considered materials of adequate esthetics and with little mechanical resistance due to their friability. Metal alloys, in turn, have always been regarded as excellent materials from the mechanical point of view, though esthetically unsatisfactory. Thus, in order for the prosthetic parts to function together, both elements must be fused to combine esthetics and excellent mechanical properties. From this viewpoint, most prosthetic pieces have a metal FW for mechanical support of the esthetic ceramic cover. As all laboratory processes have dimensional changes (alterations of the impression material, stone, wax, coating, metallic alloy, and finishing). It is essential to prove the adaptation of the infrastructure to the prepared teeth since the final result will be unsatisfactory.

Nowadays, however, the FW try-in step is becoming increasingly rare, since surveys carried out in prosthesis laboratories show that more ceramic crowns are made than ceramometal restorations. The new materials and techniques allow the use of monolithic ceramic crowns (without any kind of framework), which, therefore, do not require this clinical stage. Thus, the FW try-in stage has been limited to cases of prosthetic pieces that contain a

FW, are made of either metal or zirconia, and are for both single and multiple-unit prostheses that need the application of feldspathic ceramics using the slip-cast method.

The FW try-in session includes the evaluation of the prosthetic piece to the prepared tooth in terms of the adaptation to the cervical finish, intermaxillary registration, and the transfer impressions of the FW, which provide laboratory technicians with invaluable information regarding the relationship between the FW and the adjacent tissues.

If a metal FW does not fit adequately, it may be cut and rejoined to improve the fit, thus optimizing the adaptation of the appliance.

Materials used in this chapter

- Solid petroleum jelly
- 02 brushes number 2
- Self-polymerizing acrylic resin powder
- Self-polymerizing acrylic resin liquid
- 02 Dappen's dishes
- Clinical kit containing a fine-tip probe, clinical tweezers, and a dental mirror
- A die
- Straight handpiece
- Carborundum disk mounted on a mandrel
- Carbide or diamond burs
- A Hollenback spatula
- Pumice stone
- Set of cleaning brushes
- Stock trays
- Putty/wash impression silicone (light and heavy)
- Metal adjustment kit

1. Removal of the temporary restoration and cleaning the preps

Technique: The removal of provisional can be made with pliers (single crowns) or bridge removal tools (for multiple prostheses), which move the temporary in the reverse direction to the insertion axis. Excess cement can be removed with a Hollenback spatula, and the final cleaning of the prep can be achieved with a mixture of pumice and water with a low-speed prophylaxis brushlet.

Objective: Ensure the adequate fit of the FW.

Rationale: Leftover cement may interfere with the adaptation of the FW.

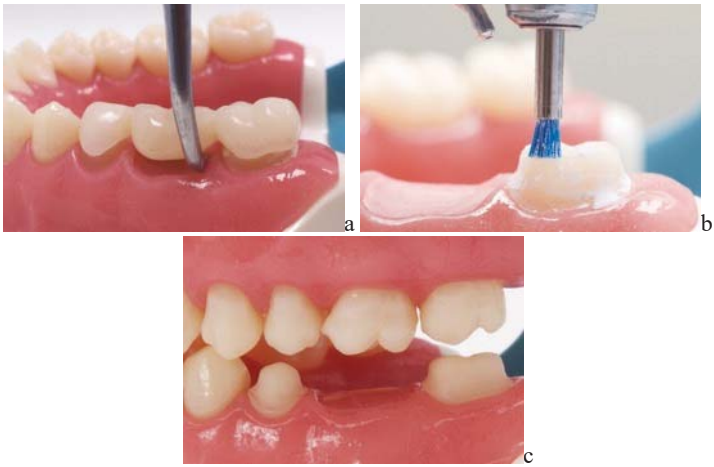


Figure 11.1: (a) Removal of the provisional. (b) Cleaning of the preps. (c) Abutments ready for the FW try-in.

2. External evaluation of FW

Technique: The FW should be evaluated externally in two situations: against the working model and in its internal surface. The evaluation of the cast should be done by checking if the FW has the cervical contour adapted to the die and also for areas of wear in the model that suggest a possible discrepancy with the tooth prep. The evaluation of the inner aspect of the FW should also be done to check for the presence of positive bubbles.

Objective: Anticipate problems that may occur in the FW try-in session and to also check for areas that need special attention.

Rationale: Internal bubbles and wear of the model prevent the correct seating of the FW.

Figure 11.2: Internal view of the FW.

3. Evaluation of FW fit

Technique: Place the FW over the abutment applying gentle finger pressure. With the probe at 45-degrees to the long axis of the tooth, inspect the fit using vertical movements from the root to FW throughout the cervical extension of the tooth. In the case of bridges, one retainer must be supported while the other is inspected. The recommended situation occurs when there is a continuity solution between the framework and the abutment. In cases where this does not happen, it is important to evaluate the cause and correct it properly (see Possible Adaptation Errors and Troubleshooting)

Objective: Evaluate the adaptation of the FW clinically.

Rationale: The FW must be well adapted (passively during insertion and movement-free once in place) to the abutment to ascertain the longevity of the prosthetic work.

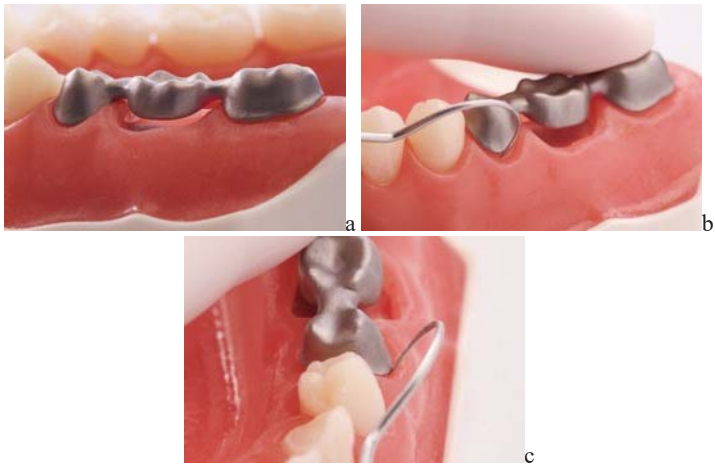


Figure 11.3: (a) FW seated. (b) Probing one of the abutments with finger gentle pressure applied onto the other retainer. (c) Probe at 45-degrees position to check misfit.

Possible adaptation errors and troubleshooting

A vertical misfit may be caused by inadequate seating of the FW. In such cases, occlusion spray should be used to unveil possible imperfections on the inner aspect of the FW. During insertion, the FW may be gently knocked into place using the handle of a dental mirror so that the FW slots in further. After this maneuver, make the appropriate internal adjustment using carbide or diamond burs. This maneuver must be repeated until the piece can be entirely passively inserted.

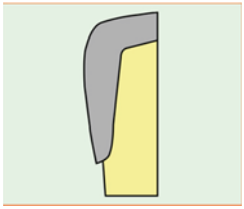
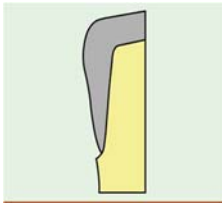
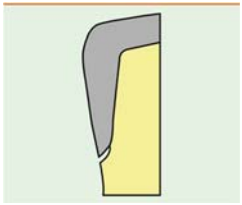

a


b


c

Figure 11.4: (a) Occlusion spray on the inner surface of the FW. (b) Adaptation of the FW with gentle knocks for seating. (c) FW internal adjustment with carbide or diamond burs.

Table 11.1: Classification of misfit.

Overhang	*Ledge on tooth*	*Vertical maladaptation*
An over-contour of the FW is characterized by a positive step. Slight adjustments may be made on the external cervical portion of the FW (always against the die). Care must be taken not to leave the FW too thin in this region.	This defect is characterized by insufficient material concerning the contour of the cervical finish. New impressions should be taken using appropriate gingival retraction techniques.	A vertical misfit is characterized by a gap between the FW and the cervical finish line. New impressions should be taken using appropriate gingival retraction techniques.
		

Welding Removal

Technique: Welding is indicated when the FW does not fit adequately over the prepped teeth, despite internal adjustments. In these cases, the FW should be sectioned diagonally from mesial to distal using a carborundum disc. Both retainers should then be adjusted individually until they are correctly fitted. Both parts can subsequently be rejoined with self-polymerizing acrylic resin (AAR) according to the Nealon technique. To prevent positional changes during FW removal, an adapted die may be attached to the two parts with AAR, which also follows the Nealon technique.

Objective: Join the sectioned parts together in the correct position where both retainers are fitted.

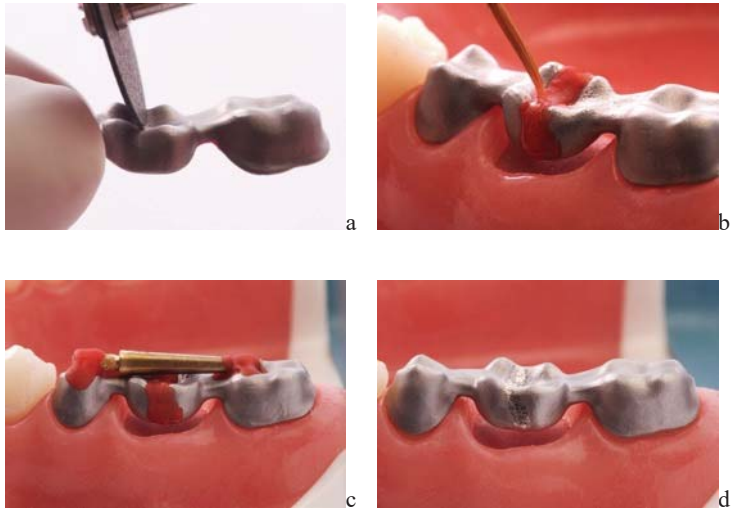


Figure 11.5: (a) FW sectioning with carborundum disc from mesial to distal. (b) AAR bonding using the Nealon technique. (c) Securing the die, joining both parts of the sectioned FW. (d) Welded FW try-in (another session).

4. Intermaxillary record

(In the same FW try-in session, provided no welding was needed, or in the next session when welding was done.)

Technique: First, the antagonist teeth must be lubricated with solid petroleum jelly or lubricating gel. The AAR should be positioned on the occlusal surface (either by manipulation or by the Nealon technique) and ask the patient to bite down gently.

Objective: To ensure efficient communication with the lab staff regarding occlusion.

Rationale: The registration must be done with a small amount of AAR so that it does not invade retentive areas, which could adversely affect the FW removal during transfer impression taking.

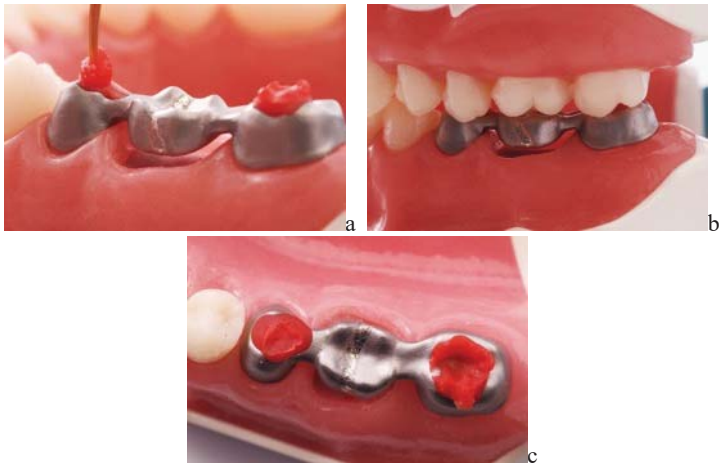


Figure 11.6: (a) SCAR positioned using the Nealon technique. (b) Ask the patient to occlude gently. (c) The final aspect of the intermaxillary record.

5. Transfer impression

Technique: With the FW correctly in place over the abutment teeth and with the intermaxillary registration attached to the occlusal surface, a silicone impression should be taken using the single-stage technique.

Objective: To ensure efficient communication with the lab staff regarding the relationship between the prosthesis and the surrounding tissues.

Rationale: Since the working model usually is trimmed at the die stage, the lab staff should be informed of the relationship between the prosthesis and the gingival tissue.


a


b


c


d

Figure 11.7: (a) Transfer impression using the one-stage technique. (b) Transfer impression. (c-d) Example of the aspect of the FW in a transfer impression of monocomponent silicone.

CHAPTER 12

CERAMIC ADJUSTMENT

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INTRODUCTION

Ceramic adjustment involves the establishment of the external morphology of the prosthesis; therefore, it is fundamental to define the volume of the prosthesis as well as its functional and esthetic characteristics. The ceramic adjustment session aims to ensure that the prosthesis is adequately fitted, features good marginal adaptation, allows sufficient room for biofilm control and health maintenance around adjacent structures (contiguous teeth and gingival tissue), ascertains adequate occlusal contacts, and achieves good esthetics.

Ceramic adjustment is based on wear, finishing, and polishing surfaces and, in some cases, the orientation of areas where needs of augmentation (which can be achieved by adding wax or composite resin to guide the dental technician). Technically, because ceramics are generally quite brittle, a uniform pattern of movement and care to avoid overheating during the trimming procedures should be exercised, as they may induce microcracks, which could significantly reduce the strength of the prostheses. Specific burs must be used for the type of selected ceramic (feldspathic, vitreous, or polycrystalline), preferably at low speed. The use of high-speed handpieces is not desirable and should be limited to particular situations and under copious irrigation.

After all wear has been performed, the prostheses must be protected from microcracks produced during adjustment. It is therefore essential that it is sent back to the laboratory for glazing (vitrification), or that meticulous finishing and polishing using sequential abrasive rubbers is carried out.

Both approaches can seal such cracks, thus reducing biofilm adhesion and minimizing the wear of the antagonist's teeth.

In the cases for which the framework try-in step was performed, one already has a useful reference regarding the adaptation and seating of the prosthesis; therefore, at this stage, the same fitting ought to be achieved. In the case of monolithic ceramics, this provides the first opportunity to verify the adaptation and seating of the prosthesis.

The ceramic is adjusted following three basic steps:

1. Adjustment of the fit and relationship with adjacent tissues
2. Occlusal adjustment
3. Esthetic adjustment

Once the prosthesis is received, the first thing to do is to evaluate the fit, and it is often found that the outcome is not satisfactory. Adjustment for fitting should be performed in a sequence of steps, such as those suggested below, to avoid any unnecessary wear:

1. Adjusting interproximal contacts
2. Internal adjustment of the prosthesis
3. Adequacy of the emergence profile
4. Adaptation of the pontic to the mucosa

Occlusal adjustment is indicated, which is discussed in Chapter 13 and, therefore, it will not be approached in this chapter. It is recommended, however, to always perform it before esthetic adjustment.

The esthetic adjustment of the ceramic must be made in order to promote an appearance of mimicking natural teeth. So, this is perhaps the essential part of obtaining the desired esthetic since the human eye has a higher perception of contour and texture than shade or color. Therefore, provided that the correct morphology and texture are achieved, even if the shade is not perfect, there is a higher chance of success. The technique indicated for this should be sequential according to the following steps:

1. Adjustment of the contour (including cervical and incisal interspaces)
2. Drawing of the primary light reflection area (in the anterior teeth, this region is known as the flat area)
3. Establishing macrotexture
4. Refining the microtexture
5. External polishing

I. FUNCTIONAL ADJUSTMENT

Adjustment of the fit and relationship with adjacent tissues

1. Removal of the temporary restoration and cleaning of the preparation

Technique: Use pliers to remove the provisionals (single crowns) or bridge removal tools (for fixed partial denture (FPD) interim), which move the temporary in the reverse direction to the insertion axis. Excess cement can be removed with a Hollenback spatula, and the final cleaning of the preparation area can be achieved with a mixture of pumice and water on a low-speed brush.

Objective: ensure the adequate fit of the FPD.

Rationale: left-over cement may interfere with the final adaptation of the FPD.

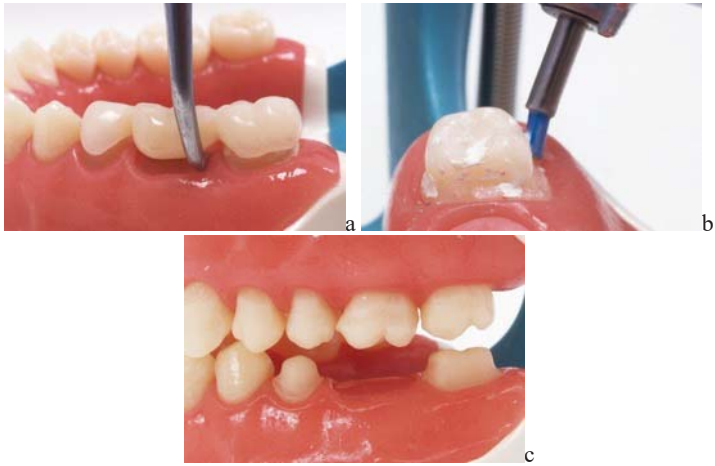


Figure 12.1: (a) Interim FPD removal. (b) Debris removal/prep cleaning. (c) Abutments ready for FPD try-in.

2. Fit and adaptation of the FPD

Technique: Place the prosthesis over the abutments applying gentle finger pressure. With the probe at 45 degrees to the long axis of each tooth, inspect the fit using vertical movements from the root to the prosthesis along with

all the cervical extension of the tooth. In the case of bridges, one retainer must be supported while the other is inspected. If adaptation is not adequate, it is necessary to identify which part of the prosthesis is preventing it.

Objective: Certificate the fit of the prosthesis clinically.

Rationale: The prosthesis must be adapted and allow passive insertion, with no rocking and no pressure on the gingival tissue.

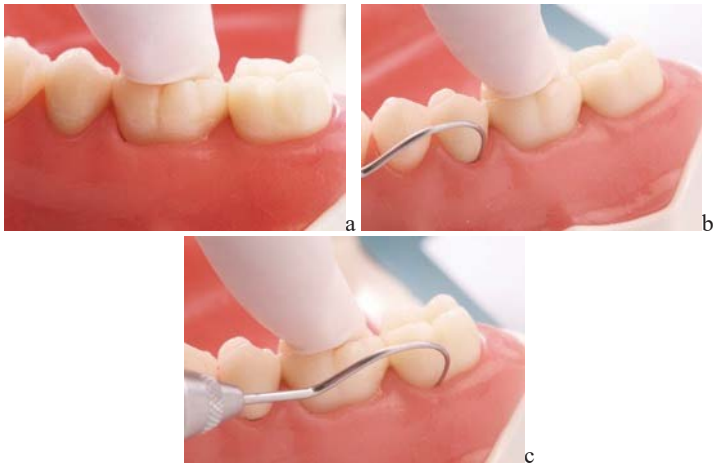


Figure 12.2: (a) Restoration try-in under finger pressure. (b-c) For probing both retainers, gentle finger pressure is applied to the pontic and the probe is positioned at 45º.

3. Anatomical and volumetric conformation of the prosthesis

Technique: The prosthesis must follow the buccal, lingual, and occlusal alignments of the remaining teeth in the dental arch. These correct alignments help to establish whether the volume of the prosthesis is adequate, thereby preventing occlusal overload. If such alignments are incorrect, wear adjustment can be made with Dura Green mounted stones, diamond burs, and/or abrasive rubbers. If there is a need for augmentation, this may be mocked up using wax or composite resin in order to guide the technician to the necessary adjustments. It is also essential that any external surface of the prosthesis is convex, so that complete removal of biofilm can be achieved.

Objective: To determine harmonic prosthesis anatomy with the stomatognathic system.

Rationale: Correct alignment of the prosthesis facilitates occlusion adjustments of guidance movements and minimizes possible overload on the prosthesis. The presence of concave areas prevents proper removal of the biofilm, allowing bacterial accumulation.

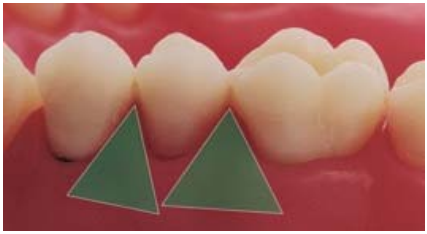


Figure 12.3: Interproximal niches in a triangular shape to facilitate sanitization.

4. Verification of interproximal contacts

Technique: When the initial adaptation of the crown is unsatisfactory, the first aspect to be evaluated is the interproximal contacts. For this, a shimstock-film (or highspot indicator, or occlusion spray) may be used in the interproximal area. If there is a contact area as opposed to a contact point, adjustment is needed, which can be made using Dura Green-type stones, diamond tips, or abrasive rubbers. The relationship between the crown and adjacent teeth can be verified using dental floss, which should go through both points of contact with only slight resistance.

Objective: To establish an adequate relationship between the crown and the adjacent teeth.

Rationale: The presence of adequate interproximal contacts is essential for the gingival health of the interproximal area (papillae) and for the correct distribution of the tensions along the dental arch.

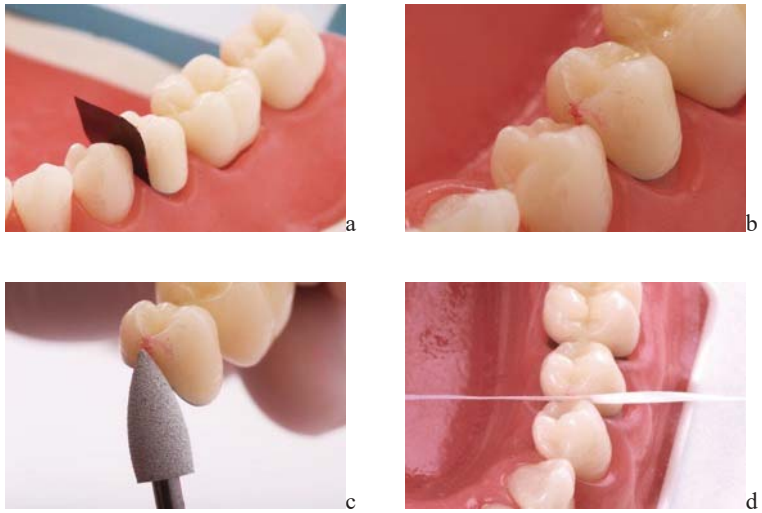


Figure 12.4: (a) Placement of the shimstock-film in the interproximal region. (b) Marking of the contact area. (c) Adjusting the contact area into a contact point. (d) Verification of interproximal contact with dental floss.

5. Adjusting the inner aspect of the prosthesis

Technique: This step is required only when the prosthesis remains maladjusted even after adjusting the interproximal contacts. In such cases, occlusion-spray, or the highspot indicator, should be used on the inner surface of the prosthesis to highlight the areas to be adjusted in order to allow passive seating. Marked areas should be removed with diamond burs, or carbide burs, at low speed. Furthermore, it is essential to first examine whether the misfit is not caused by an excessive volume of the pontic against the alveolar mucosa.

Clinical tip: In the case of lithium disilicate crowns (E-max), it is advisable to use fluid A-silicone instead of marking liquid and to also make slight adjustments on the tooth rather than the prosthetic piece because of its brittleness.

Objective: To facilitate the adaptation of the crown to the preparation.

Rationale: Although uncommon, ceramic material, or even some other type of residue, may be present in the inner portion of the prosthesis. It must be

removed; otherwise, it prevents correct seating or the passive adaptation of the prosthesis.

Figure 12.5: Occlusion-spray applied onto the inner surfaces of the retainers.

6. Adjusting the relationship between the prosthesis and the gingival tissues

Technique: With the bridge in position and using finger pressure, the relationship between the prosthesis and the gingival tissues should be evaluated. Excessive pressure from the prosthesis against the gingiva would become evident from ischemia of the surrounding soft tissues. When ischemia is transient in the pontic, this area should be tested by leading a piece of dental floss under the pontic, which should pass through easily (if the pontic offers resistance to flossing, it should be reduced, while always maintaining a convex form).

The cause for any ischemia at the edges of the gingival margins needs to be confirmed by probing and flossing from one niche to another; if the pontic is too bulky, the ischemia will be detrimental, and a reduction in volume using abrasive rubbers is paramount.

Objective: To establish an adequate relationship between crown and gingival tissue, favoring periodontal health.

Rationale: Excessive pressure against the gingival tissues prevents adequate bacterial elimination and favors chronic inflammation.

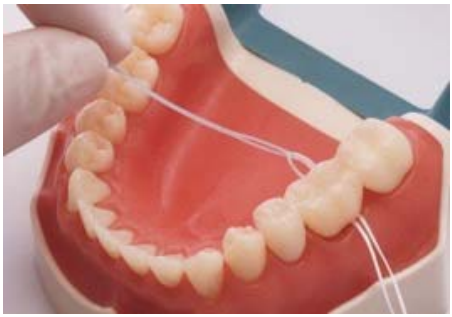


Figure 12.6: Confirmation of pontic volume concerning the gingival tissue.

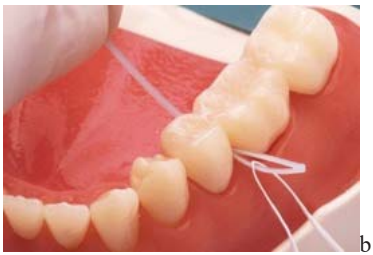
7. Ensuring adequate space for hygiene

Technique: In the case of crowns, the entire length of the prosthesis should be accessible for cleaning using brushes and dental floss. The restoration should, therefore, have convex surfaces and no pressure spots against the gingivae. In cases of bridges, the interproximal areas should allow the passage of interdental brushes or at least floss threaders. The interproximal niches should, therefore, will enable the passage of cleaning instruments with ease, which can be achieved by adjusting them using diamond discs.

Objective: To facilitate hygiene.

Rationale: Biofilm control is essential for the success of the prosthesis in the long term.

a



b

Figure 12.7: (a-b) Interproximal spaces for hygiene.

II. OCCLUSAL ADJUSTMENT (SEE CHAPTER 13)

III. ESTHETIC ADJUSTMENT

1. Incisal alignment

Reference: Incisal alignment of the target tooth should follow the adjacent teeth in relation to the facial and labial reference points for esthetic harmony.

• *Central incisors:* Mirroring the image of the homologous tooth and based on the face analysis

• *Lateral and canine incisors*: Labial curvature and/or facial alignment

• *Posteriors:* According to the curve of Spee

Tool: Disc-shaped abrasive rubbers. If there are specific incisal features, these can be imitated by sculpting the restoration using diamond tips or discs.

Objective: To promote esthetic harmony in relation to the face and mouth.

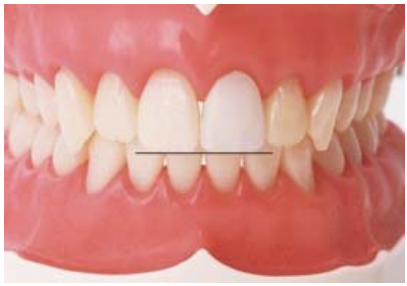


Figure 12.8: The incisal alignment of the central incisor should be performed according to the adjacent tooth.

2. Painting of the homologous tooth

Technique: With aniline powder (food coloring) gently brush the homologous tooth.

Objective: To facilitate the assessment of volume and texture of the reference tooth.

Rationale: Good visualization of the anatomical surface facilitates the execution and a good outcome.


a

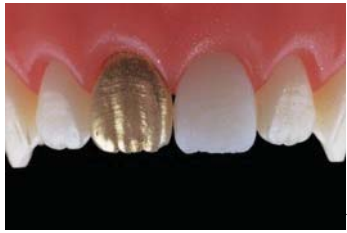

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Figure 12.9: (a) Brushing the reference tooth with aniline powder. (b) Evidence of vthe olume and texture of the reference tooth.

3. Determination of the flat area (primary reflection area)

References:

• *A central incisor:* homologous tooth.

• *Two central incisors:* zenith area, face shape.

• *Lateral incisors:* zenith and transition between CI and canines.

• *Canines:* zenith and transition between anterior and posterior teeth.

• *Subsequent:* transition in perspective from the anterior teeth.

Clinical tip: Drawing the flat area helps enormously in determining the area of the target tooth. When using a watercolor (except brown) pencil at an angle, the most convex area of the tooth delimits the flat area (using another type of pencil could risk impregnating and irreversibly pigmenting the ceramic). The suggestion is to use two colors: red for determining the current flat area and blue to draw the desired flat area. This makes it easier to guide adjustments.

Tool: Cylindrical diamond burs, abrasive discs, or Dura Green-type mounted stones are used to establish the primary reflection plane area and the slope of the outer area.

Objective: To determine the area of highest light reflection (prompt visualization) and the transition between this area and those of the adjacent teeth.

Rationale: The correct plane area is crucial to obtain good outcome within the optical illusion parameters.

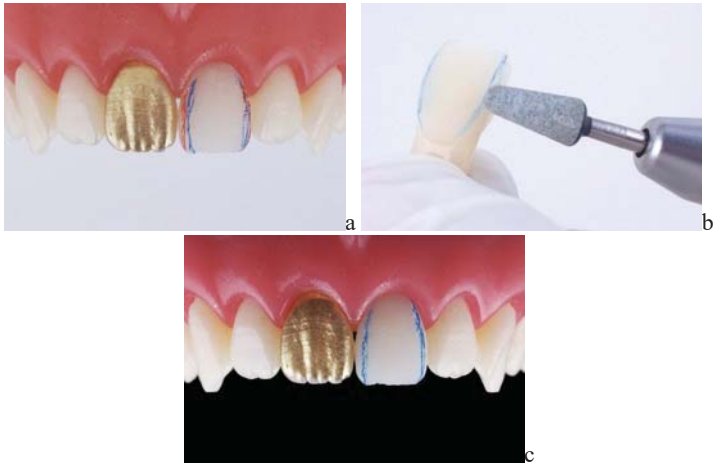


Figure 12.10: (a) Determination of the current flat area with a red pencil and the desired area with a blue pencil. (b) Wear adjustment of the outer area using Dura Green stone. (c) Final aspect after adjusting the flat area, with only the blue markings remaining.

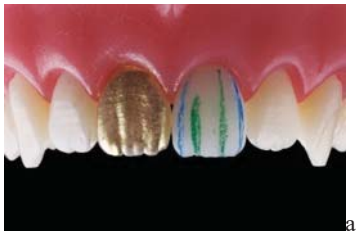
4. Macrotexture

References:

• Homologous tooth.

Tool: Conical or cylindrical fine diamond burs positioned according to the inclination of the tooth. At this stage, considerable wear must be carried out, often more in-depth than what is perceived as sufficient, as the ceramic will still undergo a polishing process using abrasive rubbers.

Objective: To work the reflection of the light according to the irregularities of the reference teeth, which affects the clarity (and shade) of the tooth.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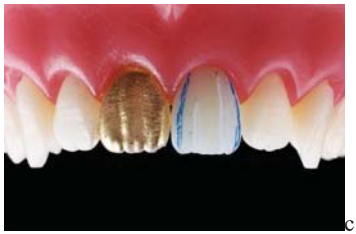
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Figure 12.11: (a) Determination of macrotexture areas to facilitate the adjustment. (b) Macrotexture wear change using diamond burs. (c) Final appearance after macrotexture adjustment.

5. Microtexture

References:

• Homologous tooth.

Clinical tip: The use of diamond-tipped ultrasound (CVDentus) is more practical and faster than conventional burs, yielding an exceptional texturing effect.

Tool: Disc-shaped diamond burs or sharp-angled burs positioned according to the inclination of the tooth.

Objective: To work the reflection of light, making it diffuse, similar to that of a natural tooth.

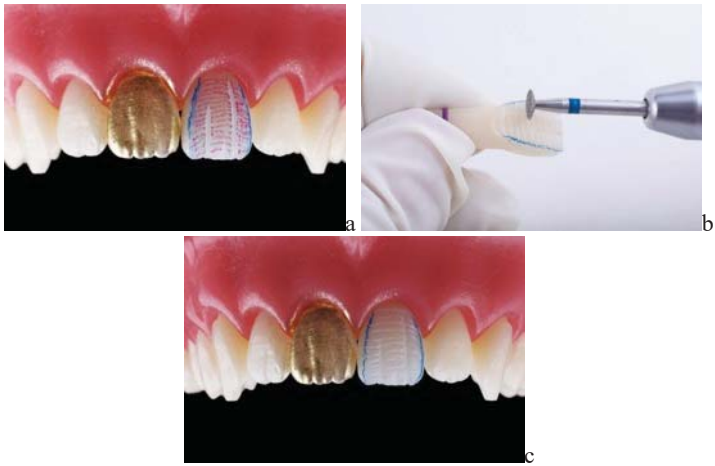

Figure 12.12: (a) Determination of the microtexture lines to facilitate wear. (b) Wear of the microtexture with a disc-shaped diamond bur. (c) Final appearance after the microtexture adjustment.

Ceramic polishing

Ceramic polishing technique

Technique: A straight handpiece, disc, or flame-shaped rubbers can be used, according to the area to be polished and in a decreasing grain order (from coarse to fine): (1) white; (2) pink; (3) gray; and (4) high-polish gray. Whenever higher brightness is required, the piece must be returned to the laboratory for new glazing.

Objectives: To soften texturization to optimize esthetics, increase the mechanical strength of the ceramic, and to inhibit biofilm accumulation.

Rationale: To promote the esthetics and the essential aspects relating to the longevity of the restoration.

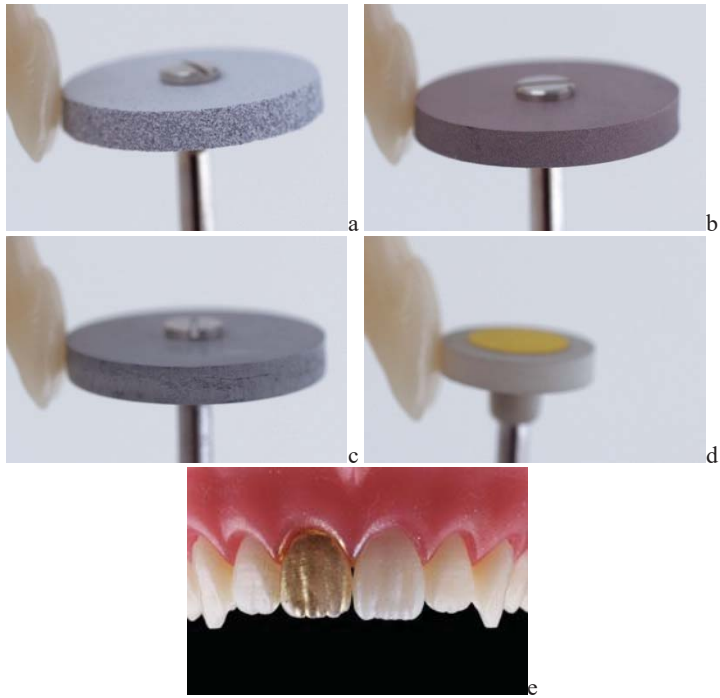

Figure 12.13: (a) Initial polishing with white abrasive rubber (coarse grain). (b) Intermediate polish with pink abrasive rubber (medium grain). (c) Fine polish with gray abrasive rubber (fine grain). (d) Abrasive rubber to enhance gloss (if necessary). (e) Final appearance after esthetic adjustment (highlighted white aniline for didactic effect).

CHAPTER 13

OCCLUSAL ADJUSTMENT FOR TOOTH-SUPPORTED AND IMPLANT-SUPPORTED PARTIAL PROSTHESES

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INTRODUCTION

All types of restorative treatments may potentially fail. Such failures may be due to biological factors, which has bacteria as a causative agent (caries, gingival inflammation, loss of pulp vitality, mucositis, peri-implantitis, among others), or technical or mechanical factors. Mechanical failures have occlusal loads as the main culprit, i.e., they occur due to overload (ceramic fractures or cracks, screw loosening, loss of bone support, and loss of osseointegration, among others). There are still failures of esthetic origin, which can be prevented by following techniques that ensure a predictable outcome.

From this perspective, the success of prosthetic treatments in the long term basically depends on three factors:

- *Adequate technical execution:* This is determined by preparation of the restoration(s) within the technical characteristics of each material and according to the situation of the supporting tissues.
- *Microbiological control:* This must be observed during the entire the treatment, from decontamination prior to teeth preparation through to subsequent sessions after fitting the restorations, in order to avoid inflammatory and infectious conditions.
- *Control of occlusal forces:* Control of occlusal forces is performed primarily by a suitable occlusal design for each individual case, as

well as a knowledge of the concepts of occlusion, the principles of biomechanics of each type of prosthetic restoration, and the factors that alter occlusal forces, such as parafunction.

Occlusion can be defined according to its functional status into ideal occlusion, physiological occlusion, and non-physiological occlusion. The term ideal occlusion was proposed in the 1920s and has been modified regarding its definition over time. Nevertheless, for whatever definition, the prevalence of an "ideal occlusion" in the population has always been negligible. If this prevalence is so low in the population, why then define an ideal occlusion?

The ideal occlusion is not a concept expected to be found in the general population. Instead, it serves as the basis for dental rehabilitation procedures. Therefore, understanding the ideal occlusion is fundamental for the clinical execution and the mock-up from a simple restoration to complex rehabilitations. In order to avoid confusion, it is good to ensure that such concepts are only followed for the restored tooth (or teeth) and not for the whole mouth. Interventions involving the whole mouth need to be planned and executed within the principles of oral rehabilitation, which are much more complex than localized treatment and should, therefore, follow a different approach.

Table 13.1: Principles of an ideal occlusion

1. Maximum intercuspation (MI) coincides with centric relation (CR)
2. Bilateral simultaneous and stable posterior contacts (mutually protected occlusion)
3. Occlusal load directed to the long axis of the posterior teeth (contact between the tip of the cusps and the deep aspect of the occlusal fossae)
4. Disocclusion of the posterior teeth by anterior guidance during protrusion and canine guidance during lateral movements
5. Physiological vertical dimension of the occlusion

From the criteria for an ideal occlusion, the first four parameters should be obtained locally for all restorative treatments, while the fifth should be used

as a diagnostic tool to determine the complexity of the case and also as an ideal occlusion parameter for cases requiring full mouth rehabilitation.

THE TECHINIQUE

The technique for making localized adjustments is based on the identification and interpretation of occlusal contacts obtained from the markings coming from occlusal articulating paper. Thus, it is necessary to know the characteristics of the different occlusal articulating paper to select the best option for each case.

Occlusal articulating paper can be classified according to the material of their composition (film or paper) and their thickness (Table 13.2).

Table 13.2: Characteristics of the different types of articulating paper with their respective indications

Classification	Thickness	Material	Usual color	Indication
Fine	12 µm	Film	Black/red	Adjustment of all cases Occlusal plates Two-phase technique
Medium	40 µm	Paper	Blue/red	Adjustment of all cases Occlusal plates Two-phase technique
Thick	100 µm	Paper	Blue	Implant-supported prostheses Two-phase technique
Extra thick	200 µm	Paper	Blue	Initial adjustment in the installation of prostheses Chewing assessment Two-phase technique

* Product used as reference: Bausch

In order to perform the procedures described herein adequately, the articulating paper should be secured using Miller's forceps, which have been designed to avoid mechanical interference with mandibular movements or with the intra and perioral structures. It is recommended that two forceps

be used simultaneously so that occlusal registration occurs for the whole mouth with the same articulating paper color, as this will prevent the patient from being conditioned to occluding only on the side of the articulating paper. This may happen when using just one pair of forceps to mark one side of the mouth at a time. (Figure 13.1).

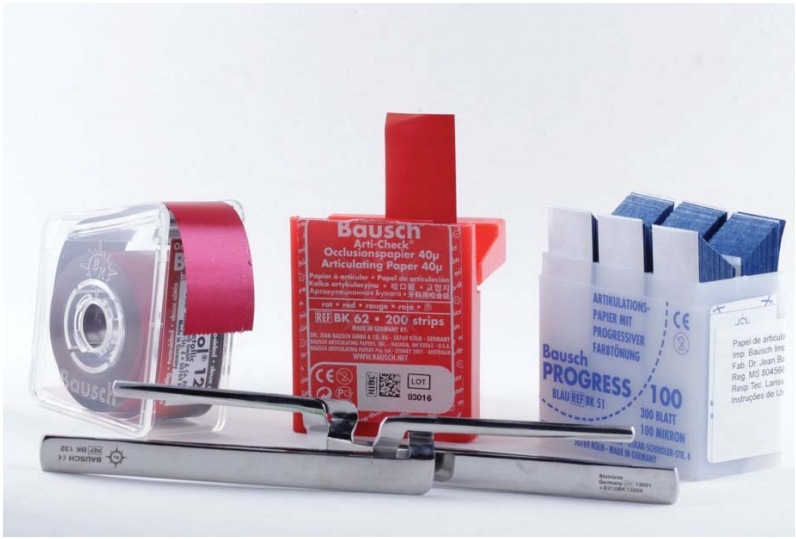


Figure 13.1: Materials used in this chapter: Thick and thin articulating paper and two Miller forceps, which must be used simultaneously.

The use of articulating paper allows the intensity of the contacts to be established, which is fundamental for executing this technique adequately, because the contacts should be uniform in terms of size and intensity. However, it is important to note that any articulating paper may fail to mark contacts, either due to humidity or overuse. It is therefore recommended that the situation of the tooth be assessed by observing the sound it makes upon repeated occlusion hits to ascertain that it not overloaded compared to the remaining occluding teeth.

It is desirable that occlusal adjustments to restorations (direct or indirect) are carried out to achieve an adequate occlusal relationship by using burs that match the shape and coarseness of the surface to be worn down. It is essential that they are finished/polished to safeguard the longevity of the opposing teeth and/or restorations.

Materials used in this chapter

- Two Miller forceps
- Two-color double-sided thin marking paper (black and red) (12µm), Bausch
- Thick blue marking paper (100µm), Bausch
- Fine diamond burs
- Tungsten burs
- Polishing kit according to the restorative material
- Gauze swabs

OCCLUSAL ADJUSTMENT TECHNIQUE FOR POSTERIOR TEETH

The occlusal adjustment technique for posterior teeth will be demonstrated on a temporary crown of tooth 46 (lower right first molar). It consists of 6 steps:

1. Baseline occlusal checks in MI and excursion
2. Marking the occlusal contact points (MI), black markings
3. Marking contacts during excursion movements, red markings
4. Final verification of occlusal contacts in MI and excursions
5. Checking for occlusal according to the fremitus
6. Polishing the occlusal surface

1. Baseline occlusal checks in MI and excursions

Material: Fine articulating paper (12µm).

Technique: Prior to commencing the restoration procedure or crown fitting, ask the patient to bite (MI) on the articulating paper (black side towards the target teeth). Then, using the red articulating paper toward the target teeth, ask the patient to move their jaw firmly sideways and forward.

Objective: Verify the baseline occlusal contact points prior to preparing the tooth for the restoration.

Rationale: In the case of direct or indirect partial restorations, the identification of occlusal contacts helps to determine the outline of the preparation.

a b

Figure 13.2: (a) Baseline occlusal markings on all teeth (without the temporary restoration). (b) Outline of the preparation margins encompassing or avoiding occlusal contacts.

2. Marking the occlusal contact points (MI)

Material: Thin articulating paper (12µm) with the black side towards the target tooth.

Technique: Once the restoration is ready, ask the patient to bite down (MI) ensuring that the black side of the articulating paper is pointing to the target tooth. Once inadequate contact areas are identified, adjust them by wearing (or adding) to obtain a balanced distribution of the occlusal contacts. This maneuver/adjustment is done as many times as necessary—you should only move on to the next step after reaching this step's objective.

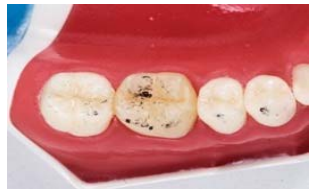
Distribution of markings: The contacts obtained must fulfil two criteria: (1) similar intensity to the existing posterior teeth; (2) be located at the tip of the cusp and/or bottom of the occlusal pits.

Objective: To prevent interference with occlusal movement (premature iatrogenic contact) and to ascertain compatible occlusal load throughout the existing teeth, without overloading any of them.

Rationale: Fulfill the ideal occlusion requirements: 1, 2, and 3

✓	1. MI coinciding with CR
✓	2. Bilateral, simultaneous, and stable posterior contacts
✓	3. Occlusal force directed to the long axis of the posterior teeth
✗	4. Disocclusion on the anterior teeth, lateral movement on the canines
---	5. Physiological occlusal vertical dimension


a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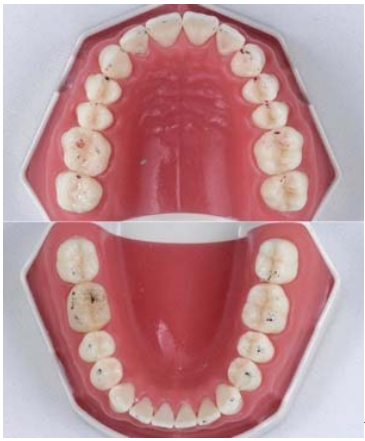
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Figure 13.3: (a) Temporary crown on tooth 46. (b) Marking the occlusal contacts on all teeth using the black side of the articulating paper to the target tooth. (c) 1st markings after making the temporary restoration. (d) 2nd marking after the initial adjustment. (e) 3rd marking after further adjustments: objective achieved*

* The yellow circle shows a cusp-tip contact against the bottom of the occlusal pit on three points.

3. Marking contacts during excursion movements

Material: Fine articulating paper (12μm), red side towards the target tooth.

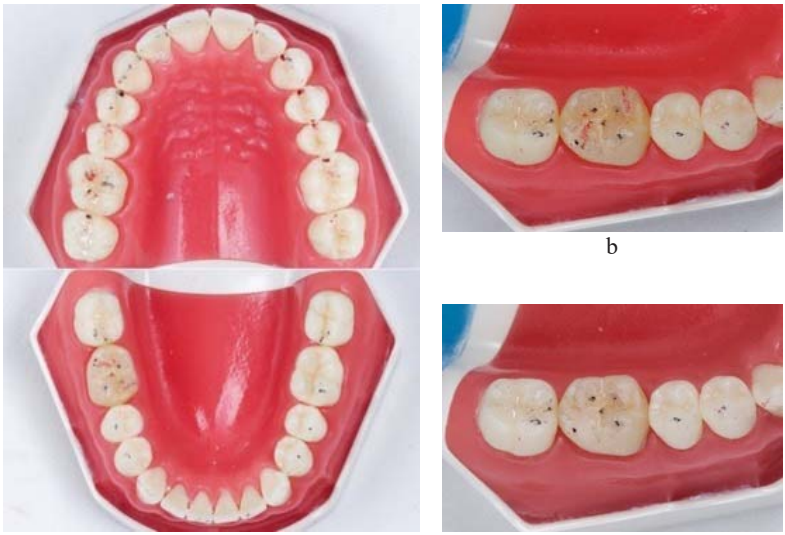
Technique: Once the ideal contact points are obtained in MI, now using the red side of the articulating paper toward the target tooth, ask the patient to bite down and slide their jaw firmly sideways and then forward. If there are red markings outside the black points, they must the adjusted down. This maneuver/adjustment is repeated as many times as necessary—you should only move on to the next step after reaching this step's objective.

Distribution of markings: There should be no red markings on the target tooth (except the ones that overlap the previous black dots).

Objective: To prevent the restoration from interfering with the jaw's excursive movements (avoiding occlusal interference).

Rationale: Fulfill the requirements for an ideal occlusion: #4

✓	1. MI coinciding with CR
✓	2. Bilateral, simultaneous, and stable posterior contacts
✓	3. Occlusal force directed to the long axis of the posterior teeth
✓	4. Disocclusion on the anterior teeth, lateral movement on the canines
---	5. Physiological occlusal vertical dimension



a b c

Figure 13.4: (a) Marking the occlusal contacts on all teeth using the red articulating paper faced to the target tooth. (b) 1st marking prior to adjustment. (c) 2nd marking after removal of the red marks.

4. Final verification of occlusal contacts in MI and excursions

Material: Fine articulating paper (12µm).

Technique: If the articulating paper strips are worn out or no longer fit for purpose, replace them with fresh ones. Then, with the red side facing the target tooth, ask the patient to firmly move their jaw sideways and forward. Now, ensuring that the black side of the articulating paper is facing the target tooth, ask the patient to open and bite down. Check if the contact markings on the target tooth are adequate.

Objective: To ensure that the ideal occlusion requirements for the target tooth (black contacts on the tip of the cusp/bottom of the pitz and no red markings) have been achieved.

Rationale: The final check with new articulating paper is important to quality ensure that no flaws have been carried over due to the articulating paper.

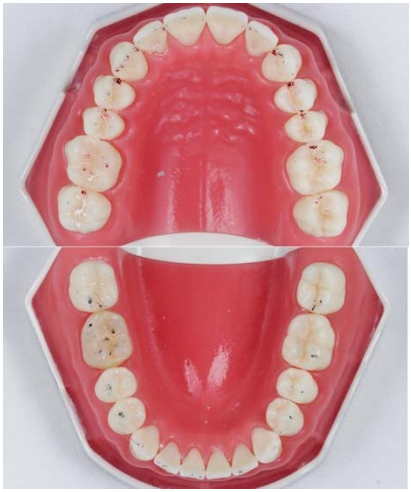


Figure 13.5: Marking all teeth upon completion of occlusal adjustments to ensure that the objectives have been achieved.

5. Checking occlusal according to the fremitus

Technique: Place a finger gently on the cervical aspect of the target tooth making sure that it does not interfere with the patient's occlusion and ask the patient to bite down and slide their jaw sideways watching out for thudding or creaking (trepidation) on the target tooth. This maneuver should also be performed on neighboring teeth for comparison. If such signs are stronger on the target tooth, the contacts must be marked with articulating paper again and adjusted accordingly.

Objective: To prevent the target tooth from occlusal overload, which could make it more susceptible to failure.

Rationale: Quality assurance of the articulating paper steps for effectiveness in detecting inadequate forces and thus ascertaining an adequate distribution of occlusal loads.

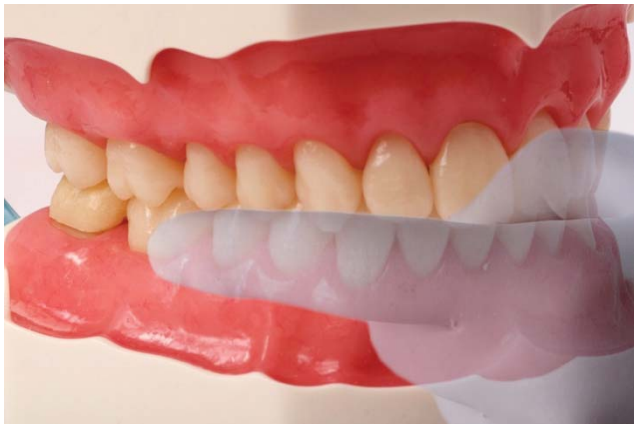


Figure 13.6: Check for the presence of occlusal overload via dull thuds and/or trepidation by placing a fingertip on the cervical aspect of the target tooth and asking the patient to bite down and slide sideways.

6. Polishing the occlusal surfaces

Technique: Observing the method indicated for each restorative material used (acrylic resin, composites, or ceramics), polish the occlusal surface of the adjusted teeth, according to the manufacturer's protocol. If possible, stay clear of the adequate contact points marked as black dots.

Objective: Create a smooth occlusal surface.

Rationale: Polished surfaces reduce excessive wear on the opposing teeth and increase the longevity of the restoration.

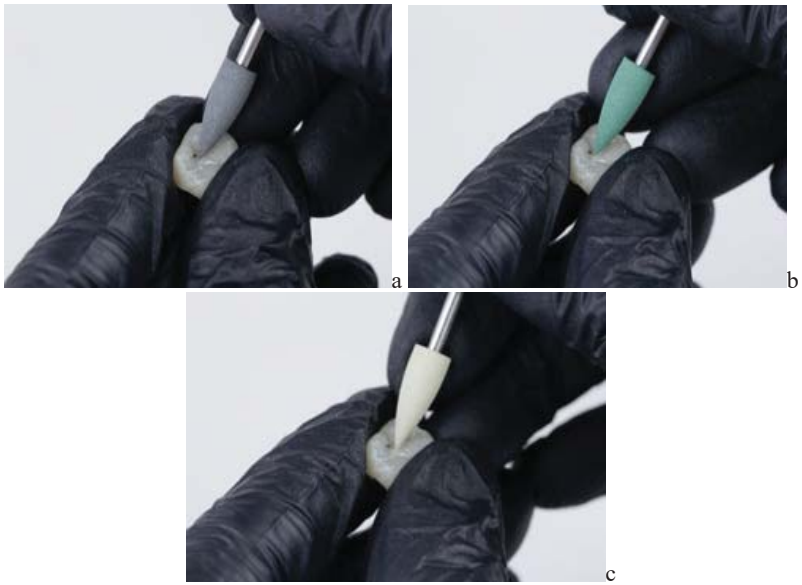


Figure 13.7: (a-c) Polishing technique for acrylic resin performed outside the mouth prior to cementation.

OCLUSAL ADJUSTMENT TECHNIQUE FOR IMPLANT-SUPPORTED POSTERIOR TEETH

The occlusal adjustment technique for implant-supported posterior crowns is the same used in the sequence for provisional tooth-supported crowns, but one step longer. Thus, it consists of 7 Steps:

1. Baseline occlusal checks in MI and excursion
2. Marking the occlusal contact points (MI), black markings
3. Marking contacts during excursion movements, red markings
4. Marking contacts on clenching in MI (thick articulating paper)
5. Final verification of occlusal contacts in MI and excursions
6. Checking for occlusal according to the fremitus on the opposing tooth
7. Polishing the occlusal surface

1. Baseline occlusal checks in MI and excursion

Technique: Follow step 1 from the tooth-supported crown method.

2. Marking the occlusal contact points (MI), black markings

Technique: follow step 2 from the tooth-supported crown method.

3. Marking contacts during excursion movements

Technique: Follow step 3 from the tooth-supported crown method.

4. Marking contacts on clenching in MI (thick articulating paper)

Material: Thick articulating paper (100μm) and fine articulating paper (12μm).

Technique: Using thick blue articulating paper, ask the patient to clench their teeth together. Then, using thin articulating paper (black side facing the target tooth), ask the patient to bite down (MI). After obtaining the contacts on the occlusal surface, remove any blue markings surrounding the black spot. This maneuver/adjustment is performed as many times as necessary—you should only move on to the next step after reaching the objective of that step.

Distribution of markings: The black contact points obtained in Step 1 must be maintained, i.e., (1) to be of similar intensity to those on the existing posterior teeth and (2) be located at the tip of the cusp and/or bottom of the occlusal pit.

Objective: To distribute occlusal loads, compensating for the difference in micromovement behavior between the teeth and implants.

Rationale: Teeth feature a shock absorbing system provided by the periodontal ligament (approximately 100μm intrusion), which is much more flexible than the intrusive micromovement observed for an implant-supported crown (approximately 5μm). Using thick articulating paper helps to compensate for such differences.

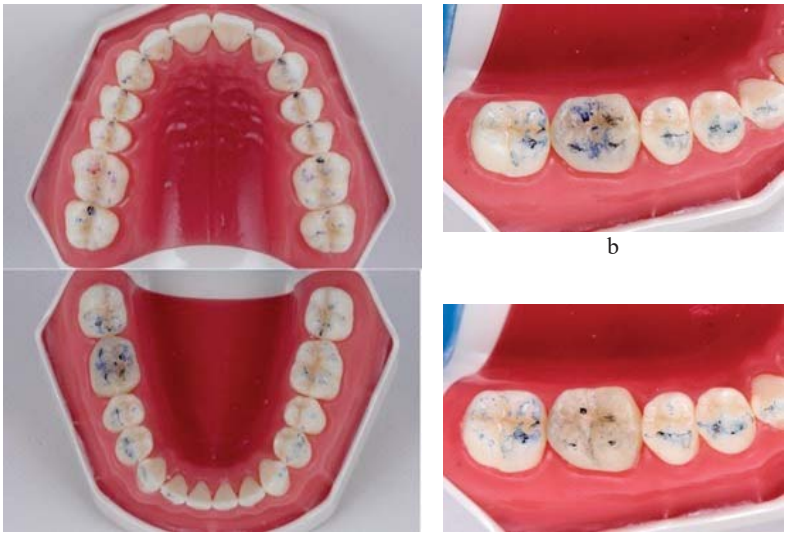


Figure 13.8: (a) Marking of occlusal contacts on all teeth using thick articulating paper and fine articulating paper (two-stage technique). (b) 1st marking with thick articulating paper, areas marked in blue. (c) Final appearance after removing the blue marks outside the black dots on the target tooth.

5. Final verification of occlusal contacts in MI and excursions

Technique: Follow Step 5 from the tooth-supported crown method.

6. Checking for occlusal with fremitus on the opposing tooth

Technique: Place a fingertip on the cervical aspect of the opposing tooth/teeth ensuring no interference with the patient's occlusion and ask the patient to bite down and slide their jaw sideways while checking for dullness according to the fremitus (“trepidation”). This maneuver should also be performed on neighboring teeth for comparison aiming to detect possible occlusal overload. If such sounds/sensations are greater on the target tooth, the contacts must be marked with articulating paper again and adjusted accordingly.

Objective: To prevent the target tooth from overload or from overloading the opposing tooth/teeth.

Rationale: Quality assurance of the articulating paper steps for effectiveness in detecting inadequate forces and thus ascertaining the adequate distribution of occlusal loads.

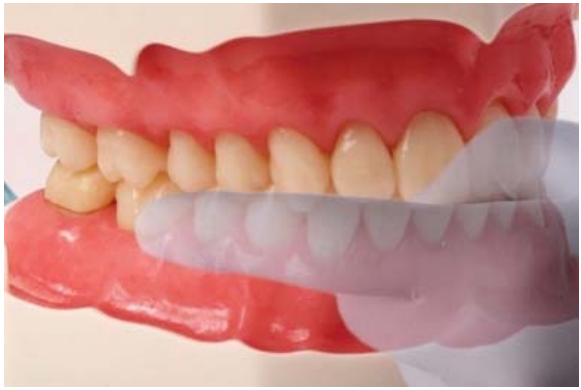


Figure 13.9: Check for the presence of occlusal overload via fingertip sensations of thudding and creaking from the target tooth by asking the patient to bite down and slide their jaw sideways.

7. Polishing the occlusal surfaces

Technique: Follow Step 7 from the tooth-supported crown method.

OCLUSAL ADJUSTMENT TECHNIQUE FOR ANTERIOR TEETH

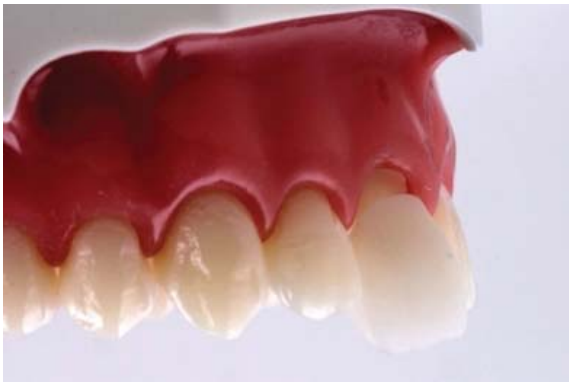


Figure 13.10: Crown of tooth 11

The occlusal adjustment technique for anterior teeth will be demonstrated in a temporary crown of tooth 11. It consists of 7 Steps:

1. Baseline occlusal checks in MI and excursion
2. Marking the occlusal contact points (MI) with black markings
3. Marking contacts during excursion movements with red markings
4. Marking the protrusion path with red markings
5. Final verification of occlusal contacts in MI and excursions
6. Checking for occlusal according to the fremitus on the opposing tooth
7. Polishing the occlusal surface

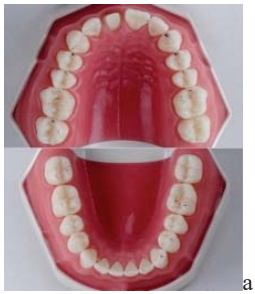
1. Baseline occlusal checks in MI and excursions

Technique: Prior to making the restoration, ask the patient to bite down (MI) with the black side of the marking paper facing the target tooth. Then, using the red side, ask the patient to make the lateral and protrusion movements.

Objective: Verify the baseline occlusal contact points prior to preparing the tooth for the restoration.

 ***Clinical Tip:*** It is not uncommon for lower anterior teeth to be invading the space of an anterior tooth that needs to be restored (either by crowding or extrusion). It is therefore important to establish this possible diagnosis and, if necessary, make the necessary adjustments to the lower anterior dentition.

Rationale: Predetermine the shape of the restoration and help define the outline of the tooth preparation.



a

b

Figure 13.11: (a) Initial occlusal markings on teeth (without the temporary crown). (b) Verification of the space to be restored (check that the opposing tooth did not invade that space, also during mandibular excursions)

2. Marking the occlusal contact points (MI)

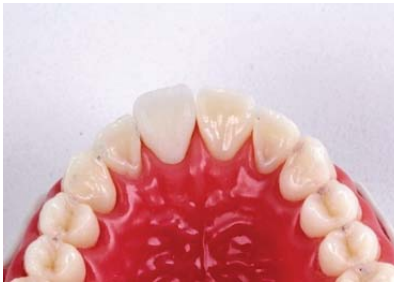
Material: Fine articulating paper (12µm) with the black side towards the target tooth.

Technique: Upon completion of the restoration, the black side of the articulating paper should be used facing the target tooth to register the contacts in MI. The contacts on the anterior teeth must be of the "all or nothing" type—i.e., there should either be equivalent contacts throughout the anterior teeth or no contact at all. In case of contact with all anterior teeth, they must be punctate in shape and “intensity”. If unfavorable contacts are identified on the palatal aspect, adjust them to obtain an even distribution of occlusal contacts. This maneuver/adjustment is performed as many times as necessary—you should only move on to the next step after reaching the objective of this step.

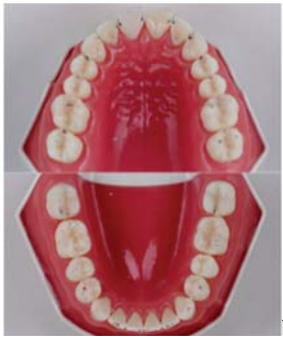
Distribution of markings: The contacts obtained must fulfill two criteria if there is contact with the remaining anterior teeth: (1) be similar in intensity to the posterior teeth, and (2) be located at medial ridge (area of greatest resistance). However, when using fine articulating paper, no contact with the anterior teeth is desirable.

Objective: To prevent the restoration from interfering with mouth closing, which would otherwise overload the restored tooth.

Rationale: Complete the ideal occlusion requirements for 1, 2, and 3 because the posterior teeth protect the anterior teeth on mouth closing.



a



b

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d

Figure 13.12: (a) Temporary crown on tooth 11. (b) Marking of the occlusal contacts on all teeth (black side facing the target tooth). (c) 1st marking after making the temporary. (d) Marking after adjustments (objective achieved).

3. Marking contacts during lateral movements

Material: Fine articulating paper (12µm); the red side towards the target tooth.

Technique: After obtaining the ideal contacts in MIH, ask the patient to perform lateral movements firmly (for both sides). If red markings (point or dash) are detected, they must be removed (except those that are superimposed to the previously obtained black dots). This maneuver/adjustment is performed as many times as necessary—you should only move on to the next step after reaching the objective of this step.

Distribution of markings: There should be no red markings on the target tooth.

Objective: To prevent the restoration from interfering with the excursive movements of the mandible (avoiding anterior occlusal interference during lateral excursions).

 ***Clinical Tip:*** As lateral movements should only be done on canines, if any canine is the target tooth, the path of disocclusion must be determined by testing it on all existing teeth.

Rationale: Complete the ideal occlusion requirements for #4, because the lateral movements should only be done on canines.

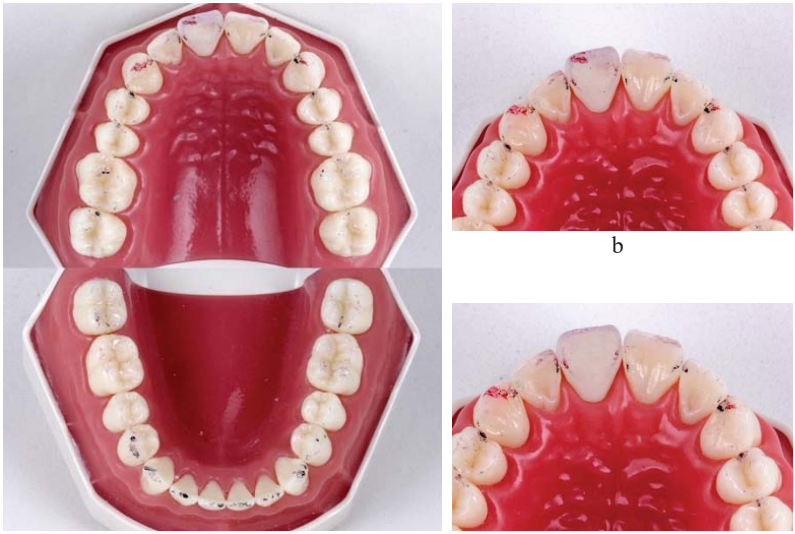


Figure 13.13: (a) Marking of the occlusal contacts on all teeth using the red side towards the target tooth. (b) 1st marking prior to adjustments. (c) 2nd marking after adjusting the red marks

4. Marking the protrusion path

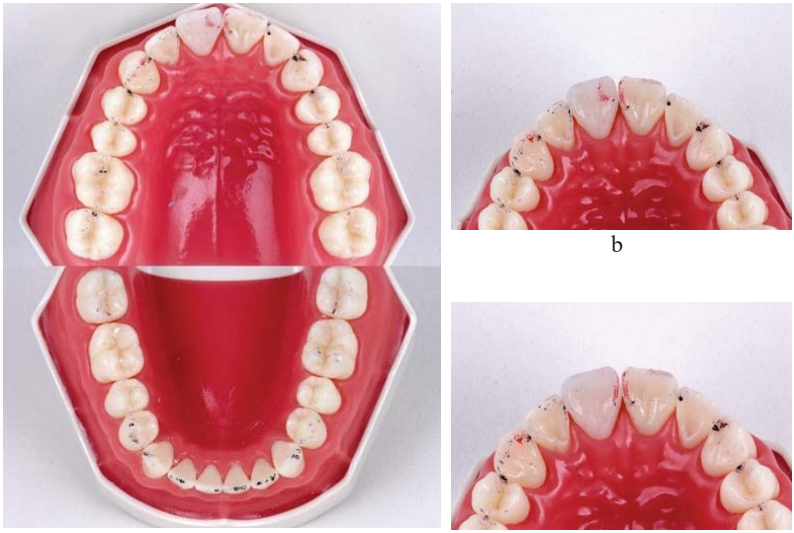
Material: Fine articulating paper (12µm), with the red side towards the target tooth.

Technique: With the red articulating paper facing the target tooth, ask the patient to firmly slide their jaw forward. The desired markings should be in the shape of a line and be interpreted in comparison to the markings on tooth 21 (upper left central incisor) and also to the baseline contacts (step 1). The target tooth marking should be similar to that of the other central incisor without altering the trajectory verified before the restoration was made. Any unwanted red marks (either in area, in direction, or extra) must be removed. This maneuver/adjustment should be performed as many times as necessary—you should only proceed to the next step after fulfilling the objective of this step.

Distribution of markings: There should be a red trail along the target tooth, ideally on the medial palatal ridge. This trail must be straight, continuous, and a similar intensity to the contralateral tooth (in this case, tooth 21)

Objective: To guide (along with tooth 21) the protrusion movement, disoccluding the posterior teeth.

Rationale: Fulfill the ideal occlusion requirement # 4, establish the safe disocclusion of posterior teeth, and respect the mutual protection principles of occlusion.



a b c

Figure 13.14: (a) Marking of the occlusal contacts on all teeth with the red side of the articulating paper facing the target tooth. (b) 1st marking before adjustments. (c) 2nd marking after adjusting the red markings

5. Final verification of occlusal contacts in MI and excursions

Material: Fine articulating paper (12μm).

Technique: Using new strips of articulating paper, ask the patient to firmly slide their jaw sideways and forward, with the red side of the articulating paper facing the target tooth. Then, using the black side of the articulating paper facing the target tooth, ask the patient to open and bite down. Check if the markings on the target tooth are adequate.

Objective: To ensure that the ideal occlusion requirements for the target tooth have been reached and that the trajectories are adequate by fine articulating paper as a parameter.

Rationale: The final check with new articulating paper is important to ensure that no flaws have been carried over due to worn articulating paper. The incisors must actively participate in the protrusion trajectory without interfering with the harmony of this movement and also by protecting the posterior teeth.

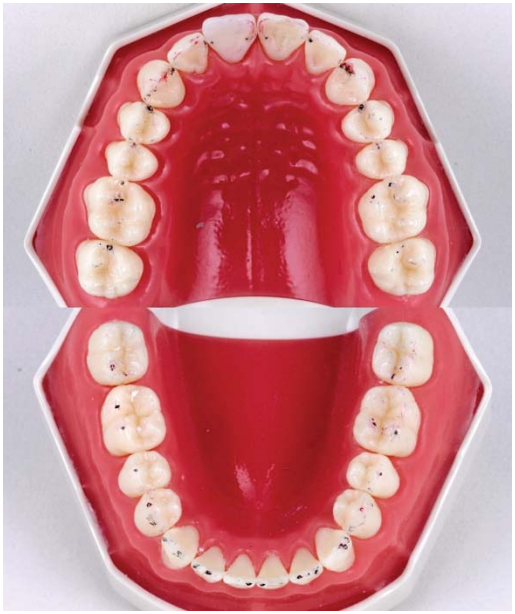


Figure 13.15: Marking all teeth after completing the adjustments will ensure that the objectives have been achieved.

6. Checking for occlusal according to the fremitus

Technique: Place a finger gently on the cervical aspect of the target tooth making sure that it does not interfere with the patient's occlusion and ask the patient to bite down and slide their jaw sideways watching out for thudding or creaking (trepidation) on the target tooth. This maneuver should also be performed on neighboring teeth for comparison. If these signs are

stronger on the target tooth, the contacts must be marked with articulating paper again and adjusted accordingly.

Objective: To prevent the target tooth from occlusal overload, which could make it more susceptible to failure.

Rationale: Quality assurance of the articulating paper steps for effectiveness in detecting inadequate forces and thus ascertaining adequate distribution of occlusal loads.

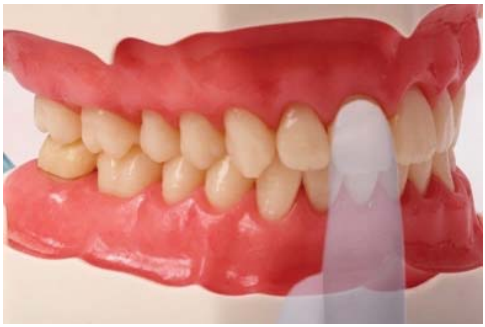


Figure 13.16: Check for the presence of occlusal overload via dull thuds and/or trepidation by placing a fingertip on the cervical aspect of the target tooth and asking the patient to bite down and slide sideways.

7. Polishing the palatal surface

Technique: Observing the method indicated for each restorative material used (acrylic resin, composites, or ceramics) and polish the occlusal surface of the adjusted teeth, according to the manufacturer's protocol. If possible, stay clear of the adequate contact points marked as black dots.

Objective: Create a smooth palatal surface.

Rationale: Polished surfaces reduce excessive wear on the opposing teeth and increase the longevity of the restoration.

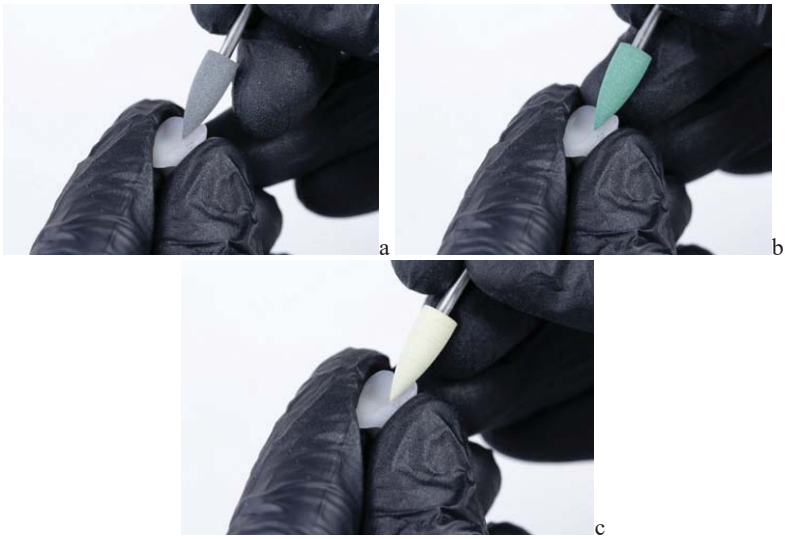


Figure 13.17: (a-c) Polishing technique for indirect temporary restorations made from acrylic resin performed outside the mouth prior to cementation.

OCLUSAL ADJUSTMENT TECHNIQUE FOR IMPLANT-SUPPORTED ANTERIOR CROWNS

The occlusal adjustment technique for implant-supported anterior crowns is similar to the sequence described for temporary tooth-supported crowns. In the former, an important adaptation in the procedure is needed due to the manufacturing stage.

Immediate loading with provisional

The aims of immediate loading in anterior teeth are related to fill the esthetic requirements, filling the space from the lost tooth, and designing the gingival margin with the promotion of biological sealing. However, the occlusal load can disturb the osseointegration. So, it is mandatory to avoid them during the interim phase. In these cases, it is recommended to eliminate every articulating paper mark in the target tooth.

Occlusal adjustment in osseointegrated implants

The occlusal adjustment technique for an implant-supported anterior crown in osseointegrated implants is almost the same as the one used in the sequence for provisional tooth-supported crowns. However, during the

protrusion movement, it is necessary to use two different thicknesses for the articulating paper. The occlusal adjustment technique for anterior teeth will be demonstrated in tooth 11's temporary crown 11. It consists of 7 Steps:

1. Baseline occlusal checks in MI and excursion
2. Marking the occlusal contact points (MI), black markings
3. Marking contacts during lateral movements, red markings
4. Marking contacts during protrusion movement, red markings
5. Marking the protrusion path, red markings (medium articulating paper + fine articulating paper)
6. Final verification of occlusal contacts in MI and excursions
7. Polishing the palatal surface

1. Baseline occlusal checks in MI and excursion

Technique: Follow Step 1 from the tooth-supported crown method.

2. Marking the occlusal contact points (MI)—black markings

Technique: Follow Step 2 from the tooth-supported crown method.

3. Marking contacts during lateral movements

Technique: Follow Step 3 from the tooth-supported crown method.

4. Marking contacts during protrusion movements

Technique: Follow Step 4 from the tooth-supported crown method.

5. Marking the protrusion path with fine and medium articulating papers

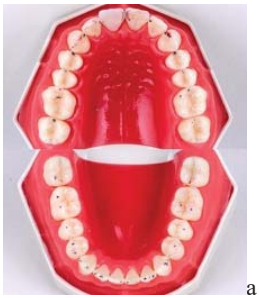
Technique: With the red face of the medium articulating paper facing the target tooth, ask the patient to firmly slide his jaw forward. The desired markings should be in the shape of a line and be interpreted in comparison to the markings on tooth 21 (upper left central incisor) and to the baseline contacts (Step 1). The target tooth marking should be similar to that of the other central incisor without altering the trajectory verified before the restoration was made. Any unwanted red marks (either in terms of area, direction, or extra marks) must be removed. This maneuver/adjustment should be performed as many times as necessary—you should only proceed to the next step after fulfilling the objective of this step.

After this, with the black face of the fine articulating paper facing the target tooth, the patient should repeat this maneuver, marking over the previous marks. It is necessary to remove the red path in the target tooth, while maintaining the black path.

Distribution of markings: There should be a black trail along the target tooth, ideally on the medial palatal ridge and the red and black path on the adjacent central incisor. Such trails must be straight, continuous, and of similar intensity.

Objective: To guide (along with tooth 21) the protrusion movement and distribute the load unequally between the implant-supported crown and the tooth with a periodontal ligament. This movement must disclose the posterior teeth.

Rationale: Fulfill the ideal occlusion requirement # 4, establish the safe disocclusion of posterior teeth, respect the mutual protection principles of occlusion, and protect the implant-supported crown.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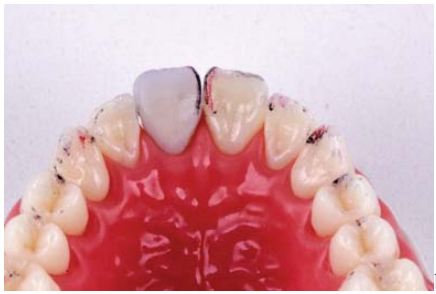
b

Figure 13.18: (a) Full-mouth. (b) Final aspect after the adjustment of the implant-supported crow.

6. Final verification of occlusal contacts in MI and excursions

Technique: Follow Step 5 from the tooth-supported crown method.

7. Polishing the palatal surface

Technique: Follow Step 7 from the tooth-supported crown method.

CHAPTER 14

EFFECTIVE LUTING

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Marcelo Lucchesi Teixeira

INTRODUCTION

Dental cement aims to fill the space between the indirect restoration (metal, composite, ceramometal, laminate veneers, glass-fiber post, and cast post-and-core) and the abutment (tooth or implant), thereby creating an interface that avoids the restoration displacement during mastication. It also strengthens the mechanical properties of the indirect restorative materials.

The properties for the ideal cement material include physical, mechanical, biological, and esthetical requirements, such as biocompatibility with the tooth and gingival tissues; providing an excellent marginal seal to prevent marginal leakage; resistance to dissolution in saliva; adhesion; optical properties; good thermal and chemical resistance; high strength in tension, shear, and compression to resist stress at the interface between the tooth and the restoration; easy to manipulate; adequate working and setting time; good flowability; low film thickness; easy to remove excess; and low cost. It is important to note that none of the products available on the market fills all of these requirements. Hence, the election of the cementing agent depends on the clinical situation (restorative material and the substrate), the expertise of the operator, and the patient's demands.

The types of cement usually used on indirect restorations are zinc phosphate, resin-modified glass-ionomer modified, and resin cements. The cementation can be classified in conventional (just mechanical retention) or adhesive (mechanical and chemical retention).

CONVENTIONAL CEMENTATION

Conventional cementation is historically well described and reported. It relates to "non-adhesive materials", such as metallic alloys and polycrystalline ceramics (represented by tetragonal zirconia polycrystals stabilized by yttria, Y-TZP). The most common conventional cements are zinc phosphate cement and resin-modified glass-ionomer cement. But it is important to note that self-adhesive resin cement can also be used for conventional cementation.

The oldest cement used in the dentistry field is the zinc phosphate cement, which has an enormous number of reports about its effectiveness, and it is now available with good outcomes.

The resin-modified glass-ionomer cement is a hybrid material, including the addition of composite resin to the conventional glass-ionomer cement, which allows a quick polymerization of the resin phase and a slow polymerization of the glass-ionomer phase through an acid-basic reaction that takes a long time.

The indications, contra-indications, advantages, and disadvantages are described in Table 14.1, and the clinical sequence of a ceramometal crown is described in Table 14.2.

Table 14.1: Characteristics of the conventional blocks of cement

	Zinc phosphate	Resin modified glass ionomer
Indications	Prosthesis with metallic internal surface (ceramometals and cast post-and-core) Polycrystalline ceramics (Y-TZP)	
Contra-indications	Glass-matrix ceramics Resin-matrix ceramics	
Advantages	Relatively high compressive strength, low tensile strength, rigid material, low cost, simplicity of use, easy excess removal	Ease of handling, less soluble, self-etch

Disadvantages	Low resistance to solubility in an acidic environment, post-cementation sensitivity and low tensile strength (depends on mechanical retention on uneven substrates)	Passive to water sorption, degradation by matrix metalloproteinases (MMP), hygroscopic expansion capacity

SEQUENCE OF CEMENTATION OF A CERAMOMETAL CROWN

Table 14.2: Clinical sequence to cementing a ceramometal crown

	Zinc phosphate	Resin modified glass-ionomer	Self-adhesive resin
Product images	Figure 14.1		
Crown conditioning	Aluminum oxide sandblasting (Figure 14.2)		
Tooth conditioning	Pumice with brushlet at low speed. Rinse and quickly dry (Figure 14.3)		
Cement application	About 1/3 of the height of the inner axial walls (Figure 14.4)		
Crown insertion	Seating and maintenance with digital pressure to avoid crown displacement (Figure 14.5)		
Pre-photopolymerization	—	5 sec (Figure 14.6)	2 to 3 sec (Figure 14.6)
Excess removal	(Figure 14.7)		
Final curing	Initial: 12 min Final: 24 hours	6 min	6 min

a


b


c

Figure 14.1: (a) Zinc phosphate cement. (b) Resin modified glass-ionomer cement. (c) Self-adhesive resin cement.

Figure 14.2: Aluminum oxide sandblasting.

Figure 14.3: (a) Pumice with brusshlet in low speed. (b) Abundant rising. (c) Brief drying.

Figure 14.4: Insertion of the cement about 1/3 of the inner walls' height.

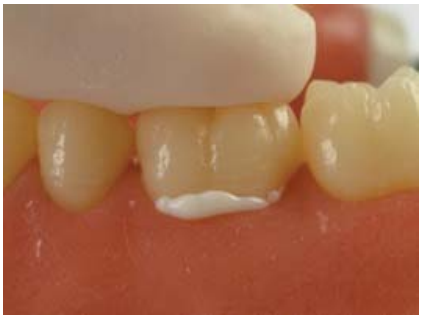


Figure 14.5: Seating the crown with digital pressure until setting time.

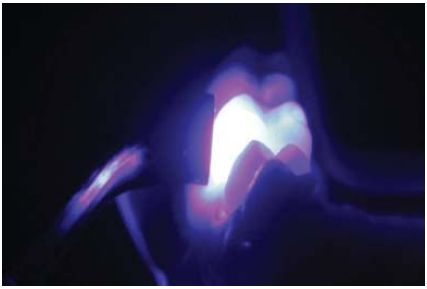


Figure 14.6: Pre-photopolymerization.

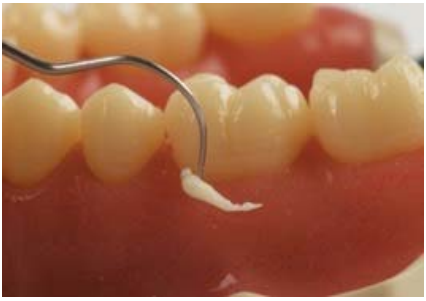


Figure 14.7: Excess removal.

ADHESIVE CEMENTATION

To be considered as an adhesive cementation, the substrate and the indirect restorative material should be passive in their chemical and mechanical adhesion to each other, with an interface promoted by cement, which must be adhesive. Thus, the materials that fill these requirements are glass-matrix ceramics, resin-matrix ceramics, composites, and glass-fiber post. "Adhesive" substrates are tooth tissues and composites.

Resin cements can be classified according to the polymerization mechanism (in light-cured, dual-cured, or self-etch) and are also based on the adhesion mode (in conventional, self-adhesive, and self-etching). The characteristics of these cements are presented in Table 14.3.

Table 14.3: Advantages and disadvantages of resin cements

Advantages	Disadvantages
High tensile and compressive strength, low solubility, lower sorption value, high fracture toughness, best marginal seal, and increase in mechanical properties of ceramics	Technique-sensitive and passive to degradation by MMPs, high cost

- ***Conventional resin cements:*** They previous acid etching with phosphoric acid is associated with 3-step adhesive systems (Adper Scotchbond Multi-purpose, 3M Espe) or a 2-step adhesive system (Single Bond II, 3M Espe).
- ***Self-adhesive cements:*** They dispense the use of previous phosphoric acid etching and also the use of primer and adhesive because of the presence of methacrylate monomers which contain phosphoric acid in their composition. These monomers etch the dentin with a low risk of post-cementation sensitivity (RelyX U200 or U100 2).
- ***Self-etching cements:*** They must be used with self-etching adhesive systems or specific universal systems (Single Bond Universal, 3M Espe). As the adhesive system that etches the substrate, there is no

reason to use phosphoric acid prior to the cementation (RelyX Ultimate, 3M Espe).

The cementation process is key to the clinical success of the restorative treatment. It is a critical factor because of its importance and operative complexity. The complexity is related to the execution itself because of the number of details and steps evolved but, especially, because of the enormous variables related to the cement brands and adhesive systems available on the dental market. So, it is a good strategy to use materials from the same system (removing the risk of problems caused by compatibility) and also simplified processes (reducing the odds of clinical mistakes). Therefore, the clinical sequences described in this chapter were selected based on RelyX systems (3M Espe). It is crucial to note that different brands have different protocols, which could vary the necessary steps and procedures.

In relation to the adhesive cementation, there are three fundamental factors:

1. Selection of the resin cement system according to the restorative material and also according to the substrate.
2. Internal conditioning of the selected material.
3. Substrate conditioning according to the elected cement system.

SEQUENCE FOR AN ADHESIVE CEMENTATION OF A CERAMIC CROWN

1. Internal conditioning of the crown

Table 14.4: Adhesive cementation technique according to the ceramic matrix

	Glass-matrix ceramic (Feldspathic / Lithium disilicate)	Resin-matrix ceramic
Crown conditioning	Aluminum oxide sandblasting (Figure 14.8)	
Rinse with air-water spray	Figure 14.9	

Drying with air	Figure 14.10	
Fluoric Acid (HF) etching	Feldspathic: 60 seconds Lithium disilicate: 20 seconds (Figure 14.11)	HF 5% 60 seconds (Figure 14.11)
Abundant rinse with water	Time: 30 seconds (Figure 14.12)	
Drying with air	Time: 15 seconds (Figure 14.13)	
Clean the ceramics after HF etching	Rubber phosphoric acid for 30 seconds + rinse with abundant water (Figure 14.14 A-B) OR ultrasound cleaning for 3 minutes (Figure 14.14 C)	
Drying with air	Figure 14.15	
Silane	Active apply (wait 2 min) + dry with air (Figure 14.16)	
Adhesive	Active apply (wait for 20 seconds) + dry with air (removing the excess) (Figure 14.17)	

Figure 14.8: Aluminum oxide sandblasting.

Figure 14.9: Rinse with air-water spray.

Figure 14.10: Drying with air.

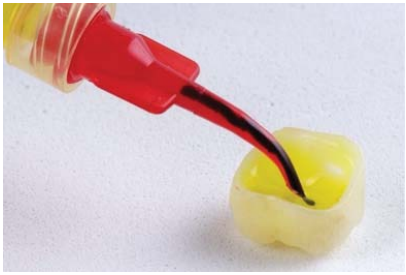


Figure 14.11: Fluoric Acid (HF) etching.

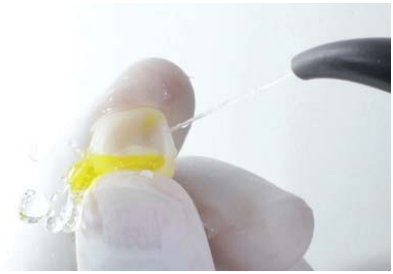
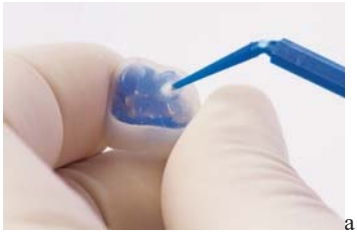


Figure 14.12: Abundant rinse with water.

Figure 14.13: Drying with air.


a


b


c

Figure 14.14: (a-b) Rubber phosphoric acid for 30 seconds + rinse with abundant water OR (c) OR ultrasound cleaning for 3 minutes.

Figure 14.15: Drying with air.

a

b

Figure 14.16: (a-b) Silane with active applying + Drying with air.

a

b

Figure 14.17: (a-b) Adhesive with active applying + Drying with air

2. Tooth Surface Etching and Crown Placement

Table 14.5: Clinical features of different resin cements

	Self-etching resin cement	Self-adhesive resin cement
Product images	Figure 14.18	
Cleaning the substrate	Pumice with brushlet in low speed + clean with air-water spray + air drying (Figure 14.19)	
Selective Acid etching*	Only over enamel for 15 seconds + rinse with water + brief drying	--------
Adhesive	Active apply of Single Bond Universal (wait for 20 seconds) + dry with air (removing the excess) (Figure 14.20)	---------
Applying cement into the crown	About 1/3 of the height of the inner axial walls (Figure 14.21)	
Crown insertion	Seating and maintenance with digital pressure to avoid crown displacement (Figure 14.22)	
Excess removal	Removal with a flat brush OR pre photopolymerization for 2 seconds to set the cement in a gel phase and removal with a dental probe (Figure 14.23)	
Photopolymerization	Light-cure each face for 40 seconds (Figure 14.24)	

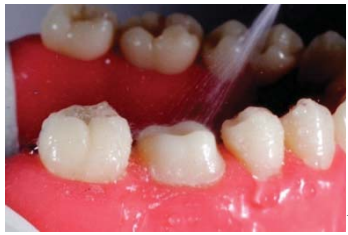
* Indicated only in cases of partial coverage


a


b

Figure 14.18: (a) RelyX Ultimate. (b) RelyX U200.


a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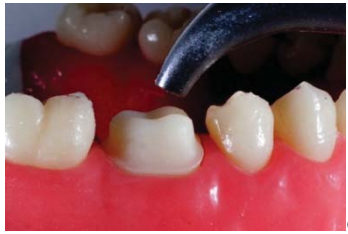
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Figure 14.19: (a-c) Pumice with brushlet in low speed + clean with air-water spray + air drying

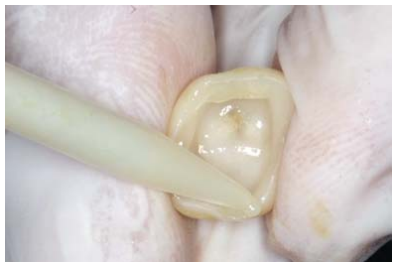
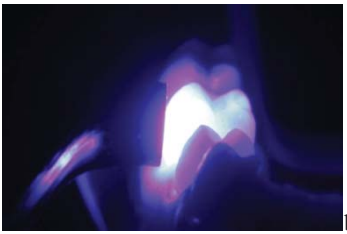


Figure 14.20: Active apply of Single Bond Universal (wait for 20 seconds) + dry with air (removing the excess)—ONLY for RelyX Ultimate.

Figure 14.21: Seating the crown with an ultrasound to optimize the flowability of the luting material.


a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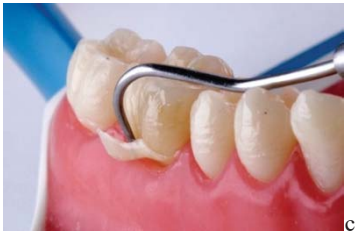
c

Figure 14.22: (a) Removal with flat brush OR (b-c) pre-photopolymerization for 2 seconds to set the cement in a gel phase and removal with a dental probe.

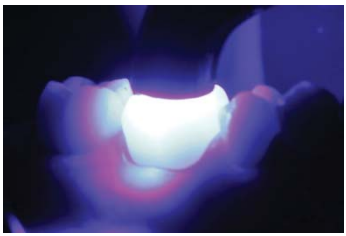

Figure 14.23: Light-curing.

CHAPTER 15

CERAMIC VENEERS

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INTRODUCTION

Ceramic veneers are thin restorations used to cover the buccal aspect of teeth completely. They are usually made with glass-matrix ceramics (the base of lithium disilicate, Emax Press or Emax Cad; or zirconia reinforced lithium silicate, Vita Suprinity or Celtra Duo), which allow adhesive cementation. The use of ceramic veneers is only possible once bonding techniques are mastered. Thus, tooth preparation for ceramic veneers should ideally be surrounded by enamel, which is one of the main factors for treatment success.

Due to the ceramic thickness, as well as the need for conservative preparation, enamel wear is facilitated and kept to a minimum when the final volume of the restored tooth is known beforehand (Reverse engineering). Therefore, a mock-up of the final restored tooth using temporary materials is highly indicated for procedures involving ceramic veneers.

Another critical factor of veneer-based restoration relates to the role of the tooth substrate on the final esthetics of the case. Because they are fragile, veneers allow the passage of the light and are, therefore, affected by the background. In such cases, darkened teeth need careful consideration since they may make the elimination of the influence of the substrate on the final esthetic outcome considerably more difficult. For this reason, the choice of cement is paramount to treatment success.

Veneers must be cemented with light-curing (non-dual) resin cements, which must be tested for color effect, using Try-in pastes, which simulate

the final color of the cement after polymerization and, therefore, have an influence on the esthetic outcome.

The technique presented in this chapter is not the easiest to execute and yet it is entirely based on PREDICTABILITY. We believe that this is one of the primary factors to achieve successful veneers since this "predictability test" with the due acceptance by the patient greatly aids in controlling expectations.

Materials used in this Chapter

- Casts with esthetic wax-ups
- Bisacrylic resin (Protemp 3M)
- Dispenser for bisacrylic resin with mixing tips
- Tweezers
- Hollenback spatula
- Pumice stone
- Dappen's dishes
- Prophylaxis brushlet
- Dental floss
- Addition Silicone (putty and light)
- Blue and red pencils
- Set of burs for veneer preparation
- Abrasive rubber tips (white, pink and blue)
- Hydrofluoric acid
- 37% Phosphoric acid
- Glue stick
- Smile Lite Polarizer (Smile Line)
- Teflon tape
- Retractor cords 00, 0
- Universal Single Bond
- RelyX Veneer cementation kit with respective Try-in pastes (3M Espe)
- Ultrasonic diamond tips for preparation (CR1, CR4, CR4-U, CH4-M, CH4-D): (CVDentus)

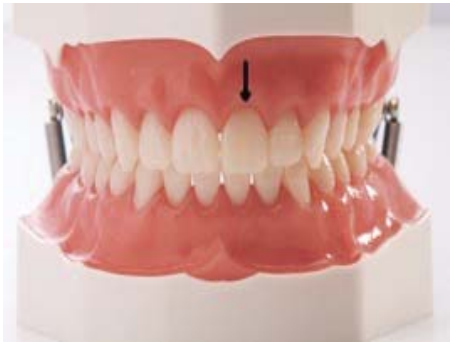


Figure 15.1: Target tooth: Left central incisor.

1. The mock-up

Technique: The mock-up is a diagnostic technique that simulates the final appearance of the restored tooth/teeth and it also can perform as a temporary restoration. Mock-ups can be performed directly (with composite resin applied applied directly on the tooth and/or without acid etching) or indirectly (using bisacrylic resin from a mold obtained from the wax-up cast). In the latter scenario, the esthetic wax-up should be made from a silicone mold (preferably taken without an impression tray and using a rigid, dense silicone putty and a fluid wash with a two-stage approach), which serves as a reservoir for a bisacrylic resin filling.

Clinical tip: Cutting around the gingival margin of the mold facilitates the removal of excess material before the final polymerization of the resin, which is time-efficient and avoids patient discomfort.

Objective: To determine the final volume of the restored tooth.

Rationale: Allow minimal (conservative) reduction of healthy tooth tissue.

Figure 15.2: (a) Esthetic wax-up of teeth 11 and 21. (b) Heavy and light silicone impression with gingival margin cutout. (c) Fill the mold with bisacrylic resin (note that the dispenser tip must be in contact with the deepest aspect of the mold throughout). (d) excesses removal with Hollenback spatula. (e) Final aspect of the indirect mock-up.

2. Silicone indexes

Technique: Using putty silicone without trays, make two impressions from the esthetic wax-up or the direct mock-up. Cut one of the silicone indexes cross-sectionally and then cut two longitudinal sections in the second silicone index to divide the tooth into thirds (cervical, middle, and incisal).

Clinical tip: Leave the buccal aspect of the silicone index plentifully thick and make sure that the impression material is encouraged into the deepest aspect of the buccal sulcus.

Objective: To check the amount and pattern of enamel reduction to accommodate the ceramic veneer.

Rationale: Establish adequate room to provide esthetics and resistance to the ceramic piece with maximum preservation of tooth tissue.

Figure 15.3: (a-b) Making the silicone indexes without an impression tray. (c) Longitudinal sections to evaluate the preparation in thirds (incisal, medial, and cervical). (d) Sagittal section to evaluate the prep buccally.

3. Establishment of the flat area for preparation

Technique: Using a permanent marker, draw the flat area (see ceramic adjustment, Chapter 12).

Objective: To determine the areas that will require the most considerable enamel reduction (interproximal).

Rationale: Outline the preparation so that all edges remain in enamel, allowing the ceramic veneer to be uniform in thickness, which favors the strength of the material.

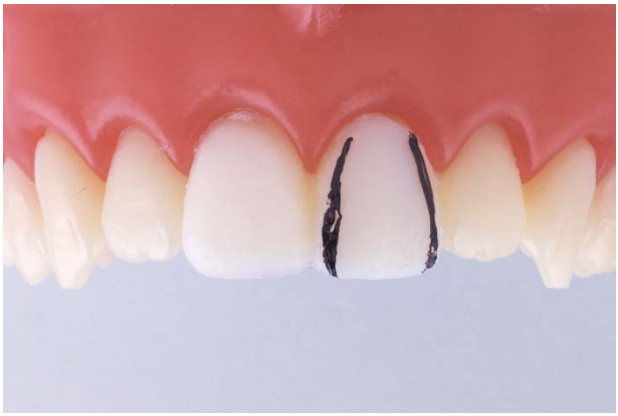


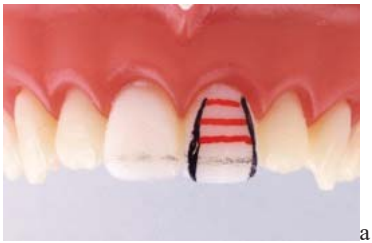
Figure 15.4: Demarcation of the buccal flat area.

4. Outlining the translucent area and establishing the thirds of the final preparation

Technique: Using a pencil, determine the area of translucency for the final restoration (the height of the preparation is limited by the area of translucency). The body of the preparation should be divided into thirds, according to the inclinations of the buccal surface of the tooth. This should be done by drawing three horizontal lines, which will direct the inclination of the thirds of the tooth. This marking should only be done within the predetermined flat area.

Objective: To determine the height of the preparation to establish the inclinations of the buccal surface.

Rationale: The translucent area of the tooth is only composed of enamel and, therefore, must be removed so that the technician can make an esthetic characterization.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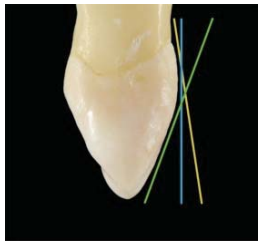

b

Figure 15.5: (a) Demarcation of the area of translucency and division of the height of the preparation into thirds. (b) Buccal wall planes, which must be followed during the preparation.

5. Cervical orientation groove

Drill: A ring-shaped diamond bur with an active depth of 0.3 mm.

Depth: 0.3 mm (all active area).

Inclination: Perpendicular to the cervical plane (1st inclination).

Clinical tip: As the preparation is completed on the bisacrylic resin of the mock-up, it should be limited to enamel area.

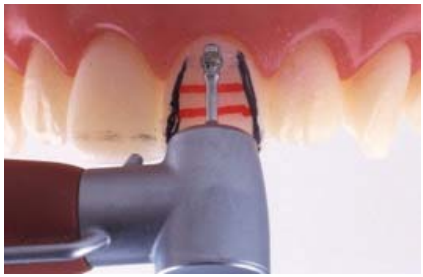


Figure 15.6: Orientation groove in the cervical third.

6. Orientation grooves of the middle third

Bur: A ring-shaped diamond bur with an active depth of 0.5 mm.

Depth: 0.5 mm.

Inclination: Perpendicular to the middle third (2nd inclination).

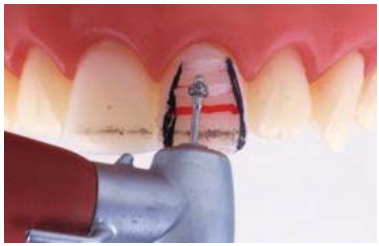


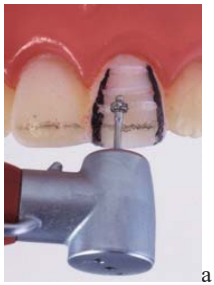
Figure 15.7: Orientation groove in the middle third.

7. Orientation groove of the incisal third

Drill: A ring-shaped diamond bur with an active depth of 0.5 mm.

Depth: 0.5 mm.

Inclination: Perpendicular to the middle third (3rd inclination).



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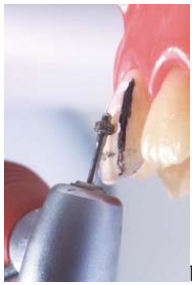


b

Figure 15.8: (a-b) Orientation groove in the incisal third in frontal and lateral views.

8. Joining the orientation grooves together

Bur: A cylindric with a rounded edge diamond bur (G882.314.014).

Depth: According to the orientation grooves.

Inclination: Three inclinations (cervical, middle, and incisal).

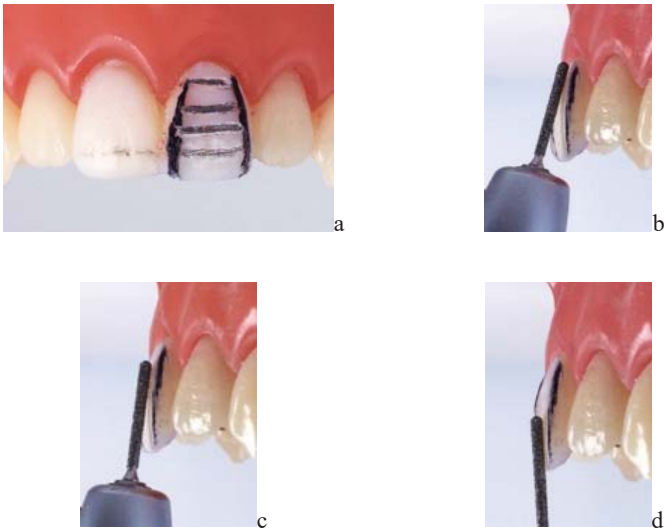


Figure 15.9: (a) Demarcation of the orientation grooves in pencil. (b–d) Merging the orientation grooves according to the three inclinations defined above. The reduction must only be performed within the flat area.

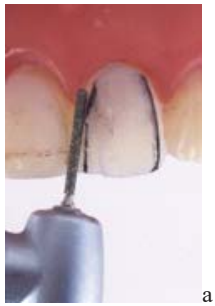
9. Preparation of interproximal areas

Bur: A cylindric with a rounded edge diamond bur (G882.314.014) or ultrasonic diamond tips (CH4-M and CH4-D).

Depth: 1/2 bur.

Inclination: Three inclinations (cervical, middle, and incisal).

Clinical tip: Interproximal tooth reduction can be completed using an ultrasonic diamond tip to prevent damaging the adjacent teeth.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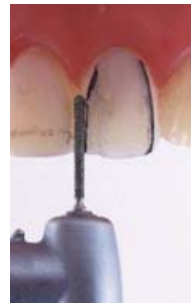
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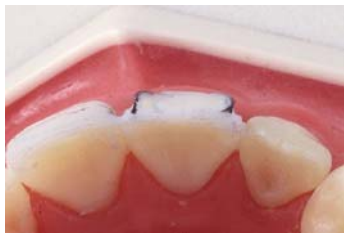
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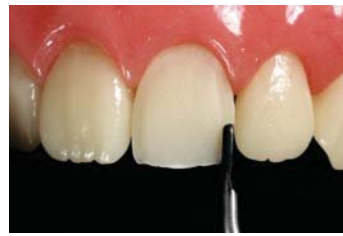
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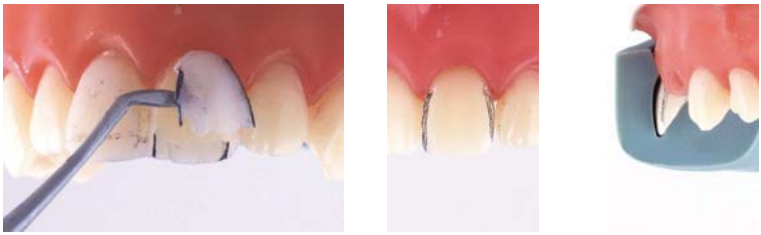
Figure 15.10: (a) Reduction of the proximal area,1st inclination. (b) Reduction of the proximal area 2nd inclination. (c) Incisal view of the proximal reduction. (d) Ultrasonic preparation using a diamond tip specific for proximal areas.

10. Assessing the remaining tooth structure

Technique: The evaluation of the remaining tooth structure is performed by marking the prepared areas directly on the mock-up and also by measuring the thickness of the reduction using the silicone index.

Objective: To direct the areas needing further reduction and those that must be preserved.

Rationale: In order for the treatment to be successful, the boundaries of the preparation must be surrounded by enamel; however, the restoration should have sufficient space to characterize the esthetic area (especially in the middle and incisal thirds).



a b c

Figure 15.11: (a) Mock-up removal. (b) Marking of the reduced areas on the tooth tissue. (c) Assessing the buccal reduction.

11. Cervical and proximal margins

Bur: A cylindric with a rounded edge diamond bur for finishing (C882.314.014) or an ultrasound diamond tip (CR1).

Depth: 1/3 of the bur.

Inclination: According to the long axis of the tooth (buccal view) and -15º (proximal view).

Clinical tip: The area of the cervical margin naturally has a very thin layer of enamel; therefore, tooth preparation should be done very sparingly in this region—just enough to accommodate the restoration for cementation.

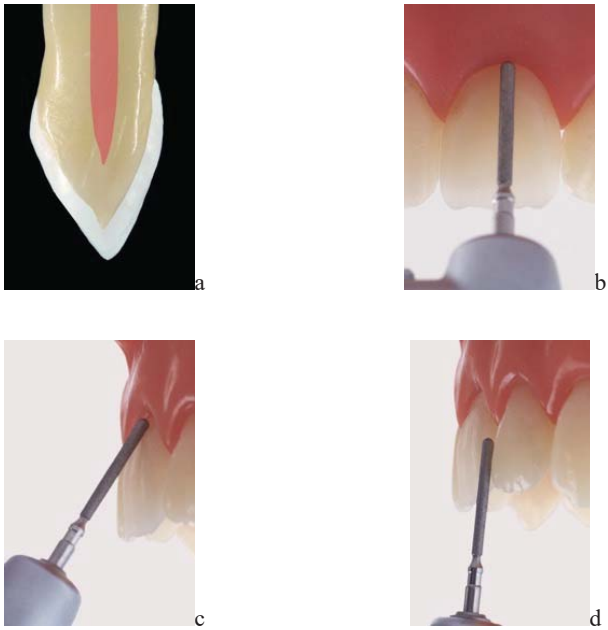


Figure 15.12: (a) Enamel thickness throughout the tooth (note that it is very thin in the cervical region). (b) Frontal view of cervical reduction. (c) Inclination of the diamond bur for the cervical finish line. (d) Inclination of the diamond bur for preparation of the proximal areas.

12. Determining the thickness and length of the preparation

Technique: After preparing the margins, the thickness and the height of the preparation must be defined, which vary according to the type of restoration (Figures 15.3 A and B). Enamel reduction can be done with a cylindric with a round edge diamond bur (C882.314.014) against the buccal aspect of the tooth (usually only the incisal third is enough) and height reduction can be completed using abrasive rubbers or Sof-lex discs; the aim is to obtain rounded edges.

Objective: To determine the final form of preparation.

Rationale: Outline the preparation to ensure that all margins are left on enamel and tooth reduction is performed according to the inclinations of the original tooth surface, thereby yielding a veneer with uniform thickness, thus favoring ceramic strength.

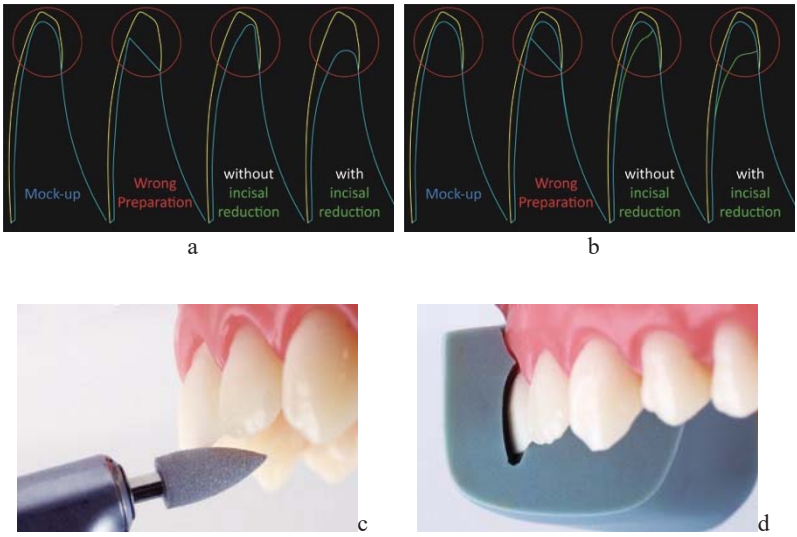


Figure 15.13: (a) Preparation diagram for conventional (feldspathic) or pressed ceramics (Emax Press). (b) Preparation diagram for ceramics obtained by milling. (c) Incisal reduction using abrasive rubber at a right angle with the long axis of the tooth. (d) Evaluation of the thickness and height of the preparation.

13. Confirming the position of the preparation in relation to the final thickness of the ceramic veneer

Technique: The silicone templates obtained in Step 2 (page 350) should be positioned against the target tooth to verify that the preparation is suitable for a ceramic veneer of uniform thickness. Ideally, this should be evaluated from interproximal and occlusal perspectives, where the latter should be divided into cervical, middle, and incisal thirds (according to the three inclinations of the tooth).

Objective: To evaluate the preparation according to the position of the final restoration to verify the uniformity of thickness throughout the tooth.

Rationale: A blade with uniform thickness presents greater resistance and also keeps the passage of light uniform throughout the tooth, which makes a more natural esthetic aspect possible.

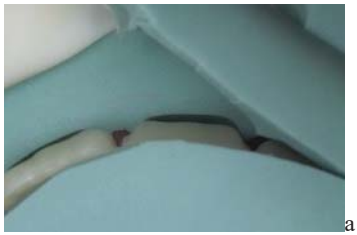

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Figure 15.14: (a–c) Evaluation of the space for the ceramic veneer in the occlusal view, in the cervical, middle, and incisal thirds. (d) Evaluation of the space in the proximal view.

14. Finishing and polishing

Technique: Polish the entire preparation using abrasive rubbers in a decreasing grain.

Objective: To facilitate impressions, adaptation of the ceramic, and cement flow.

Rationale: Adhesive cementation has replaced the need for the rough tooth surfaces that were once needed to increase frictional retention.

Figure 15.15: (a) White coarse-grained abrasive rubber. (b) Medium-grained pink abrasive rubber. (c) Blue fine-grained abrasive rubber.

15. Rounding the interproximal angles and rectifying the incisal edge

Technique: Using flexible discs in decreasing grain, work to round the edges at the interproximal angles as well as the buccal-incisal angle. Rectification of the incisal edge should also be performed.

Objective: To facilitate veneer adaptation and create conditions for favorable stress distribution.

Rationale: Live angles make it difficult to take impressions, complicate laboratory work, and favor the accumulation of tensions, which can adversely affect the mechanical aspects of the restorative system.

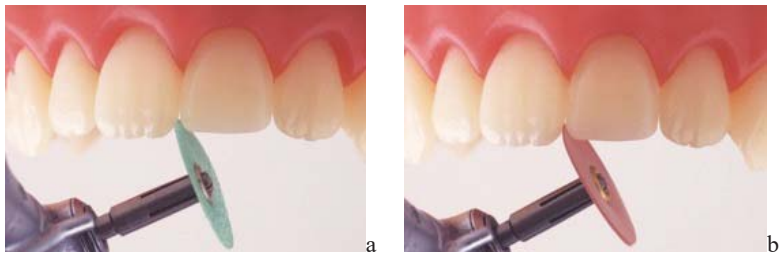


Figure 15.16: (a) Rounding of the distal angle with a coarse-grained disc. (b) Rounding of the distal angle using a fine-grained disc.

16. Removal of unsupported enamel prisms from interproximal areas

Technique: Using a polyester abrasive strip (3M) placed in the interproximal space in the shape of an S, slide the strip back and forth on both sides (mesial and distal).

Objective: To remove unsupported enamel prisms from the interproximal margins of the preparation

Rationale: Unsupported enamel prisms tend to fracture over time, thereby generating an area of maladaptation.

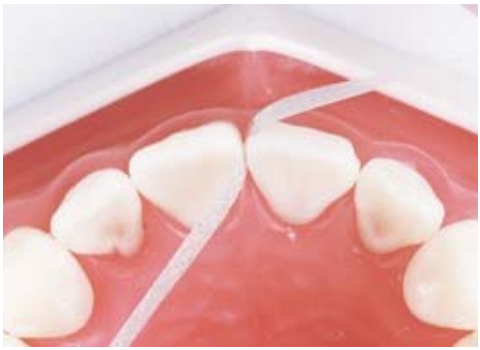
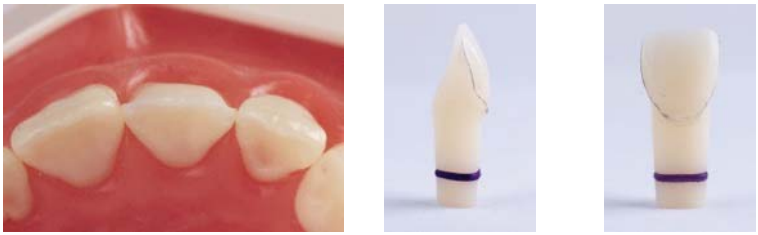


Figure 15.17: Position of the sandpaper strip in occlusal view for removal of unsupported enamel prisms.

Final Aspect of the Prepared Teeth

- The entire area of the preparation must be finished in enamel
- Mild cervical finish line
- The cervical-proximal angle should be placed in an area that can be concealed by the adjacent tooth
- The interproximal prep should be the most pronounced
- Incisal reduction at a 45° angle and depth defined by the translucent area of the remaining anterior teeth



a b c

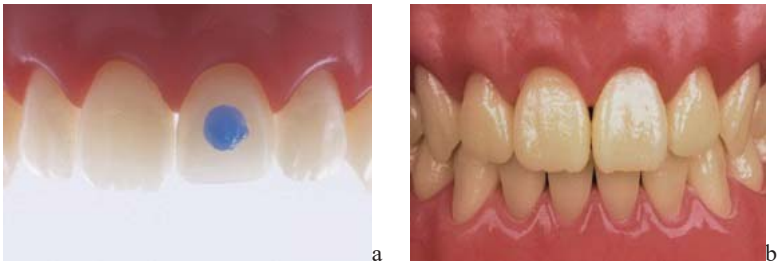
Figure 15.18: (a) Pronounced proximal reduction. (b) Side view of the prepared tooth. (c) Frontal view of prepared tooth.

17. Temporization

Technique: Temporization must be done in the same way as the mock-up (step 1, page 350). However, in order for the interim to adhere to the tooth properly without compromising the prep during temporary removal, a selective acid etching approach should be performed in the center of the tooth (37% phosphoric acid for 30 seconds, copious water rinsing and subsequent drying).

Objective: To protect the prepared tooth and provide adequate esthetics during the process.

Rationale: Esthetics and comfort are paramount to maintain the patient's quality of life between visits.



a b

Figure 15.19: (a) Selective acid etching. (b) Final appearance of the provisional bisacrylic resin.

2nd session

18. Interim removal and prep cleaning

Technique: The temporary veneer should be broken off using a Hollenback spatula (see step 10, page 357). The prep should be cleaned with pumice and water at a low speed using prophylaxis brushlet (page 284).

Objective: Permit the precise adaptation of the ceramic veneer.

Rationale: The elimination of any residue/debris from the temporary restoration is fundamental for the adaptation of the veneer.

19. Veneer dry try-in

Technique: Dry proofing of the ceramic veneer is carried out by checking the adaptation of the piece to the prepared tooth. The veneer must be positioned very carefully over the prepared tooth (the ceramic piece is very fragile). Check the adaptation using a dental probe along the length of the marginal joint between the tooth and the veneer (wherever the probe can reach); also, use dental floss for the interproximal regions. In the case of maladaptation, do not force the veneer against the prep, as it may easily crack.

Objective: Check veneer adaptation.

Rationale: Maladapted veneers lead to biofilm accumulation and pigmentation.

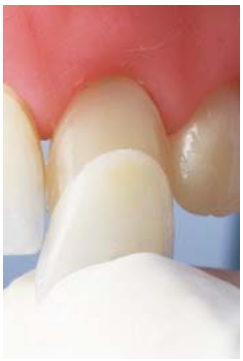


Figure 15.20: Ceramic veneer try-in.

19. Try-in using light silicone

(Only to be carried out if the previous step proved unsatisfactory)

Technique: In cases where there is a misalignment of the ceramic part, it is necessary to check which area is preventing the correct adaptation. To do this, the piece is placed using X-light A-silicone as a "cementing agent film" to check what area must be removed. It is important to note that all wear and tear must be done on the tooth structure and not on the ceramic (which is very fragile at this stage).

Objective: To identify areas that impede a fine adaptation of the ceramic veneer onto the prepared tooth.

Rationale: Fluid addition silicone forms a film similar to that produced by the luting/adhesive cement when the restoration is placed against the tooth.

Figure 15.21: Ceramic veneer try-in using X-light A-silicone.

20. Checking morphology and alignment

Technique: In order to check esthetics and speech relating to the ceramic veneer to be fitted, the ceramic must be positioned in a stable way to the prepared tooth. The veneer is glued to the tooth using any ordinary firm glue (glue sticks). At this stage, esthetic parameters should be assessed, such as shape, alignment, and texture (except the shade of the restoration), as well as speech. The glue should be removed from both the ceramic veneer and the tooth using gauze, wet cotton wool, or rotatory brushes.

Objective: To evaluate the esthetics and speech.

Rationale: Stick glue stabilizes the veneer temporarily and is easy to clean off.


a

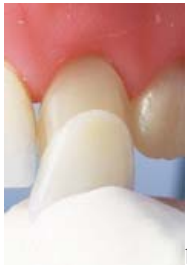

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Figure 15.22: (a) Stick glue used for the mock cementation of the ceramic veneer. (b) Veneer in place for esthetic and phonetic evaluation.

21. Determining the final shade of the ceramic veneer

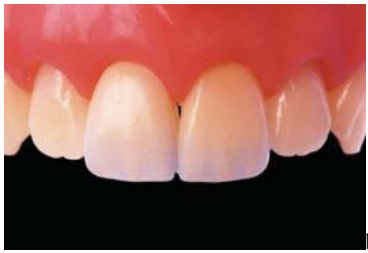
Technique: The cements used for ceramic veneers usually contain try-in pastes in the kit to simulate the final shade of the cured cement. It is essential to select the most suitable cement shade.

Clinical tip: Smile Lite filters are extremely useful to establish the final shade of the restoration, as they facilitate this crucial try-in step and optimize the chances of esthetic success.

Objective: Determine the final shade of the ceramic restoration.

Rationale: The final restoration shade is greatly affected by the luting agent, as ceramic veneers tend to be very thin and, therefore, translucent.

a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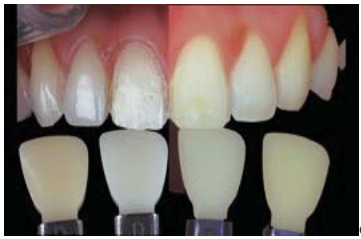
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Figure 15.23: (a) Try-in paste on the ceramic veneer. (b) Shade aspect of the ceramic restorations with different try-in pastes in a clinical case (tooth 11, white opaque shade; tooth 21, shade A1). (c) Use of a polarizing filter to assess the influence of the cement on the final shade of the restoration. (d) Appearance of the tooth without (tooth 11) and with (tooth 21) the use of a polarizing filter.

22. Preparation of the ceramic veneer for cementation

Technique: The steps of ceramic conditioning, washing, surface cleaning, washing, drying, and silane application (bonding agent) must be done according to the type of ceramic used (page 246).

Objective: Promote adhesion between the ceramic and the tooth.

Rationale: Feldspathic and vitreous ceramics allow adhesive cementation and, for this reason, they must be conditioned to promote a chemical bond between the cementing agent and the tooth structure.


a


b


c


d

Figure 15.24: (a) Aluminum oxide sandblasting. (b) Hydrofluoric acid etching the ceramic veneer according to the manufacturer recommendations. (c) Cleaning of the ceramic veneer by rubbing phosphoric acid gel. (d) Ceramic silanization with Universal Single Bond adhesive (do not photopolymerize).

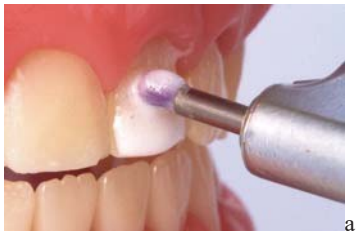
23. Preparation of tooth structure for cementation

Technique:

- Cleaning with pumice with a prophylaxis brushlet at a low speed;
- Place the gingival retractor chord;
- Isolation of the adjacent teeth with PTFE tape;
- 37% phosphoric acid etch for 30s;
- Rinsing and drying;
- Application of Universal Bonding Agent and dry, removing the adhesive excess.

Objective: To enable ceramic adhesion to the tooth structure.

Rationale: Feldspathic and vitreous ceramics allow adhesive cementation and, for this reason, must be conditioned to promote a chemical bond between the cementing agent and the tooth structure.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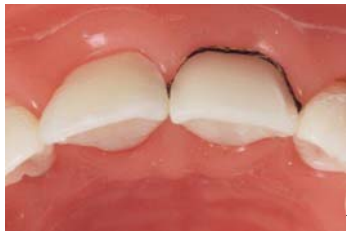
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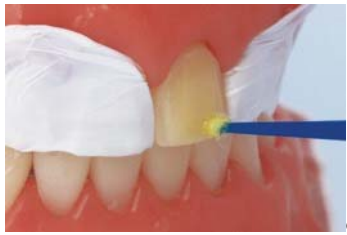
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Figure 15.25: (a) Cleaning of the tooth with pumice and water. (b) Installation of the retractor chord to protect the gingival sulcus. (c) Phosphoric acid etching. (d) Application of the bonding agent (Single Bond Universal).

23. Luting

Technique:

- Apply the cementing agent (RelyX Veneer) to the inner aspect of the veneer;
- Place the ceramic veneer onto the tooth;
- Clean the cement excess with a brush (optional);
- Pre-polymerization (5 seconds);
- Removal of excess cement;
- Final polymerization (40 seconds each surface);
- Removal of the retractor chord and isolating tape;
- Polishing with abrasive rubbers.

Objective: To promote effective adhesion between the ceramic and the tooth.

Rationale: Cementation of ceramic veneers should be completed with a light-curing cement, as dual polymerization cements may undergo color change over time. Self-etching cements are not suitable for cementing veneers.

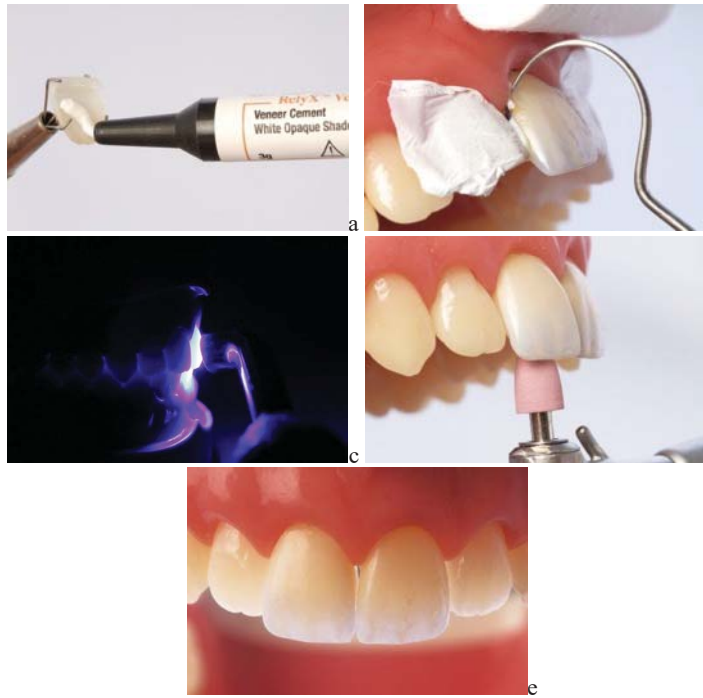

Figure 15.26–Figure 15.26: (a) Application of the RelyX Veneer cement. (b) Excess cement removal after pre-curing. (c) Light curing; (d) Polishing of the ceramic/tooth interfaces using abrasive rubbers. (e) Final outcome.

PART 3

PROCEDURES FOR IMPLANT-SUPPORTED PROSTHESES

Part 3 of this manual is intended to describe the step-by-step clinical procedures for implant-supported prostheses by the EPPIC team (a Portuguese acronym for Campinas' Periodontics, Implantology, and Prosthodontic Team). This subject is so extensive that many textbooks have been specifically written for this topic alone.

To facilitate comprehension, this part has been divided into only three chapters, which have been classified according to the extension of the restoration: single unit, multiple unit fixed prostheses, and complete dentures.

The first parameter to be evaluated for the preparation of the prostheses is the connection of the prosthetic components with the implant. It is fundamental to know the implant model and the implant dimensions in relation to the diameter of the implant platform and, especially, the type of connection (see Table below).

Table 1: Position and design of the connection areas between the implant and the prosthetic components, followed by some trademarks available in the market

CONNECTION	TYPE	EXAMPLES
External	Hexagonal	Nobel (Brånemark standard)
Internal	Triangular	Nobel Replace
	Hexagonal	3i
	Octagonal	Straumann
	Conical Type Connection	Nobel CC
	Morse taper	Bicon

The current trend is that the diameter of the implants should not interfere significantly with the seating platforms. Implant manufacturers are, therefore, concentrating efforts on standardizing implant components, regardless of the diameter. However, it is important to know the system well, since many have specific components for narrow platforms (NP), regular platforms (RP), or wide platforms (WP). Choosing the right family of components is fundamental for making the prosthesis. In this manual, the selection of components according to the diameter or type of connection will not be addressed. Instead, it will focus on the factors relating to the intrinsic aspects of the prosthetic.

Regarding the selection of the components, implant-supported restorations may vary between screw-retained or cemented prostheses, according to the type of retention of the prosthetic parts. Therefore, the chapters on single unit and multiple unit prostheses describe examples from both types of retention.

It is important to emphasize, once again, that this manual simply aims to describe the step-by-step technique, without focusing on the parameters relating to the indication or the biomechanical or planning characteristics of the clinical cases, which should be researched using additional sources of information.

For the preparation of implant-supported prosthesis, a set of prosthetic keys that include a torque wrench is essential (Figure 1).

Figure 1: Prosthetic kit with a torque wrench.

CHAPTER 16

SINGLE UNIT RESTORATIONS

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André Antonio Pelegrine
Peter Karyen Moy
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INTRODUCTION

Single unit implant-supported restorations differ from conventional single unit crowns in some key respects. From a technical point of view, the former is easier to make because they do not require preparation, and the adaptation of the prosthesis is facilitated because it requires prefabricated components, as opposed to fully custom prostheses. However, there are two major factors that require knowledge and skills to prevent failure in the long term: stress distribution and gingival esthetics.

The difference in stress distribution relates to the lack of a periodontal ligament, which acts as a shock absorber for the stomatognathic system and, therefore, occlusal adjustments are much more complex in implant-supported restorations than in tooth-supported crowns. The occlusal adjustment for an implant-supported crown is described in Chapter 13, while the stabilization of the interproximal contacts requires that the time and control of the temporary restoration phase be even greater in implant-supported crowns than in conventional tooth-supported crowns.

The other major difficulty relates to esthetics, especially the emergence profile of the crown in relation to the gingival tissue (red esthetics). This complicating factor has great weight in the anterior teeth, as it affects few cases of teeth in the posterior region. Thus, the planning of implant-supported restorations in the anterior region must be capriciously cautious, since the long-term success of cases depends not only on the coronal restoration, but also on what is done before and during implant installation.

Retention of prostheses to implants can be achieved either by screwing or by cementation, which may also play a role in subsequent approaches to manufacturing the prosthesis.

Therefore, the present chapter illustrates three different situations involving implant-supported crowns: a single unit in the anterior region (with esthetic appeal) and two single unit crowns on posterior teeth (one cemented and the other screw-retained).

In this chapter, the steps are divided according to clinical sessions. However, it is relatively easy to reduce the number of sessions if the practitioner has a reasonable arsenal of prosthetic components in stock so that component selection and installation may take place in the same clinical session. Nonetheless, for the purposes of this chapter, the number of sessions for each procedure was calculated assuming that the professional has little experience and no stock of components.

Instruments and materials used in this Chapter

- Prosthetics kit
- Periodontal probe
- Abutments
- Component selection kit
- Transfers
- Analogs
- Marten hair paintbrushes # 0 and # 00
- Pattern Resin GC acrylic resin, powder + liquid
- 03 Dappen's dishes
- Spatulas # 72 and LeCron
- Temporary cylinder
- Set of plastic stock impression trays (DHPro)
- Maxicut drills
- Impression material dispensing syringe
- Addition or condensation silicone
- Silicone for registration
- High-speed handpiece + set of metal adjustment burs
- Motor + straight handpiece + contra-angle (or electric motor)
- EPPIC - DHPro Metal Finish Kit
- EPPIC - DHPro Ceramic Finishing Kit
- Occlusion marking paper (suggestion: Accufilm II or Bausch double-sided and double-colored)
- Miller Tweezers
- Clinical kit containing probe, mirror, and clinical tweezers

THE SINGLE UNIT PROSTHESIS IN AN ESTHETIC AREA WITH AN INTERNAL MORSE CONNECTION IMPLANT

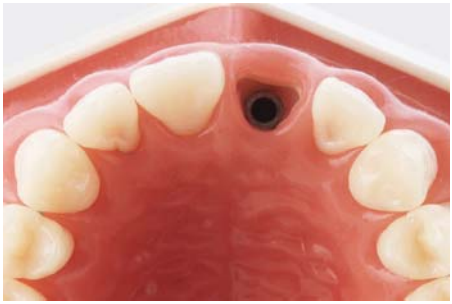


Figure 16.1: Target tooth: 21; Connection used: Conical Type Connection.

1st session

1. Selection of the prosthetic component

Technique: The selection of the most suitable prosthetic component for each case can be performed at the moment of implant installation (see Chapter 1) or after reopening (see Chapter 3). The component selection for implants with Conical Type Connection (for cemented prosthesis) is made based on four parameters (Table 16.1).

Clinical Tip: To verify whether there is sufficient space between the component and the opposing dentition, the evaluation should be carried out with the teeth in occlusion and also during excursion movements.

Objective: To select the component that provides the best esthetic and mechanical results for the final prosthesis.

Rationale: Components that need adjusting to ascertain adequate space for esthetics may be weakened and also loose reversibility.

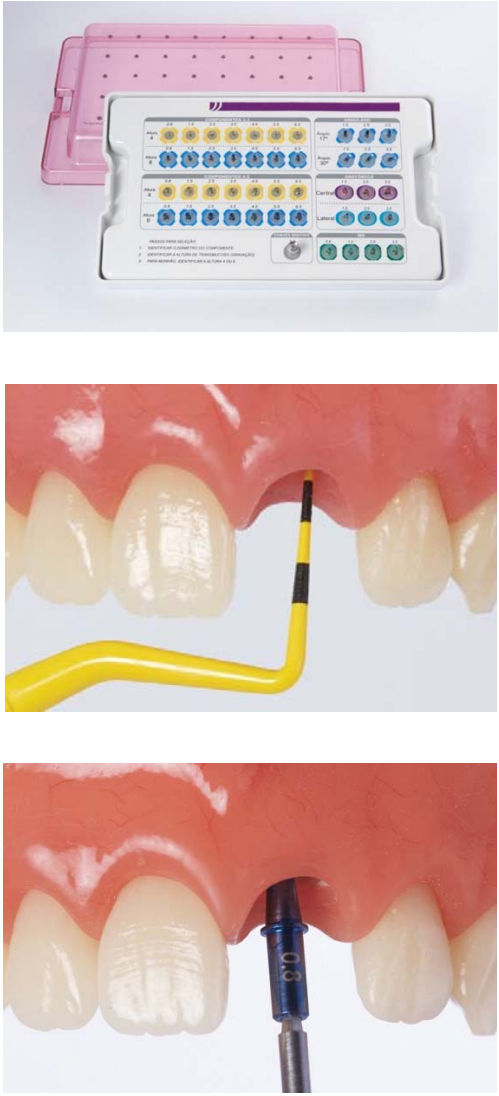


Figure 16.2: (a) Component selection kit for conical type connection implants. (b) Measuring the height between the implant platform and the gingival margin (from the lowest aspect of the gingival margin). (c) Fitting the selected component using a hexagonal key.

Table 16.1: Parameters for the selection of the universal abutment for Conical Connection implants.

	Options (mm)	Reference	Comments
Implant diameter	—		The diameter of Conical Connection implants does not interfere with component selection, since all of them are designed with an internal thread of 1.8 mm.
Transmucosal height (A)	0.8, 1.5, 2.5, 3.5, 4.5, 5.5, 6.5	Gingival Margin	The transmucosal region of the implant ends at the base of the abutment supra structure, which should be positioned 1mm below the lower aspect of the gingival margin to prevent interference with the esthetic appearance.
Component Diameter (B)	3.3 and 4.5	Region (anterior or posterior)	The diameter of the component may interfere in two ways: 1) space for the esthetic characterization of the restoration and 2) stress distribution from occlusal forces. Generally, the ideal diameter is 3.3 mm for anterior teeth and 4.5 mm for posterior teeth.
Abutment height (C)	4.0 and 6.0	Opposing tooth/teeth	The height of the abutment is calculated from its seating base to the edge of the opposing tooth. It is advisable to also evaluate this space during mandibular excursion movements.

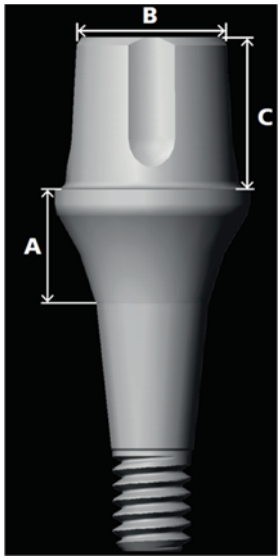


Figure 16.3: Universal abutment for cemented single-unit crowns.

2nd session

2. Installation of the prosthetic component

Technique: The selected component must be installed with a screwdriver hexagonal using the torque recommended by the manufacturer (32N.cm) measured by the torque wrench itself (Note: always refer to the torque recommended by the manufacturer).

Objective: To install the component so that long-term risk of abutment loosening is minimized.

Rationale: The long-term stability of the component depends on two factors: installation torque and the occlusal contacts.

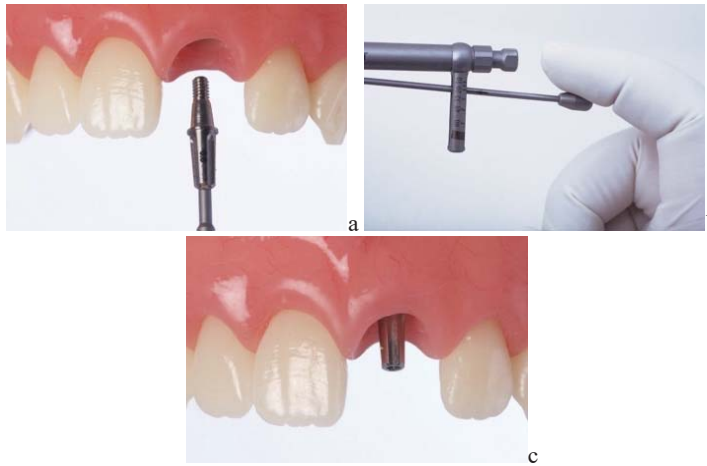


Figure 16.4: (a) Installation of the universal abutment with a screwdriver hexagonal. (b) Torque used for component stabilization. (c) Abutment installed.

3. Preparation of an immediate temporary (at implant placement or reopening)

Technique: After selecting the component (in this case, 3.3x4x1.5 universal abutment), place the temporary cylinder into the implant to make a temporary crown using a stock tooth as a base veneer (see Chapter 9).

Objective: Preparation of an immediate temporary crown to provide esthetics and function.

Rationale: The immediate temporary aims mainly to establish the emergence profile, guiding gingival healing according to the esthetic characteristics of the tooth.

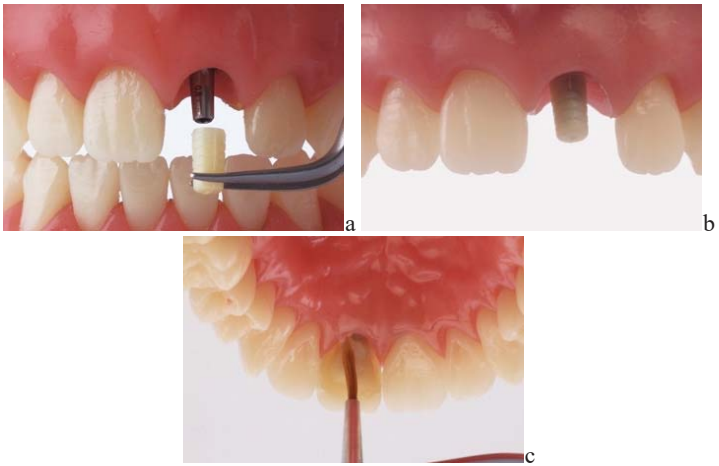


Figure 16.5: (a) Installation of the cylinder for the temporary crown according to the selected abutment. (b) Temporary cylinder in place. (c) Preparation of the temporary crown using the facet technique of stock tooth.

Treasure map: Designing the emergence profile

Technique: During the preparation of the immediate temporary, the references to determine the morphology of the cervical region of the crown do not exist; therefore, it is a priority that the temporary design is based closely on the root shape to establish a smooth tooth-gingival transition similar to the neighboring teeth, which should look as natural as possible. Thus, after establishing the gingival margin outline, the circumference of the cervical region should be increased with acrylic resin and with the temporary outside the mouth; subsequently trim it to the volume and shape of the root, which should be as close as possible to those of the target tooth (e.g., an upper central incisor has a triangular cross-section root in this region). Since this region will require direct healing, it is essential that it is well polished (see Chapter 9).

Clinical Tip: Knowing the anatomy of the cervical junction is very useful to optimize esthetics. Suggestion: Go back to dental anatomy books and revise this subject, whose importance is regrettably underestimated in the context of tooth-supported crowns.

Objective: To provide emergence profile esthetics.

Rationale: One of the major esthetic problems with implants in the anterior region relates to an unsatisfactory emergence profile.

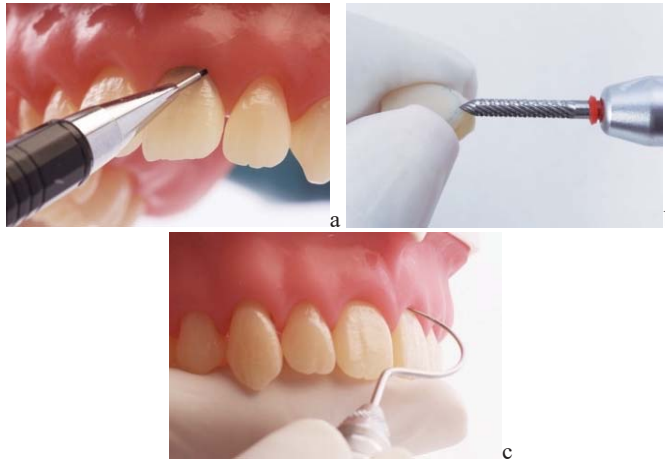


Figure 16.6: (a) Design of the gingival margin. (b) Acrylic resin trimming at the cervical region. (c) Survey to assess the transition at the emergence profile region.

4. Temporary crown cementation

Technique: Immediate temporary cementation risks inadequate removal of excess cement. To avoid this, it is important to lubricate the outer aspect of the restoration as well as the surrounding tissues with solid Vaseline or a water-based lubricant gel. Easy-to-remove temporary cements are preferable and using a universal abutment analog to remove gross excess of temporary cement prior to taking the temporary restoration to the mouth may greatly facilitate the process.

Objective: Effective removal of excess cement.

Rationale: Removal of excess cement is a difficult task in custom abutments, especially those with a platform positioned well below the gingival margin. Cement residue may greatly affect gingival healing, induce bone loss, and even cause abscesses.

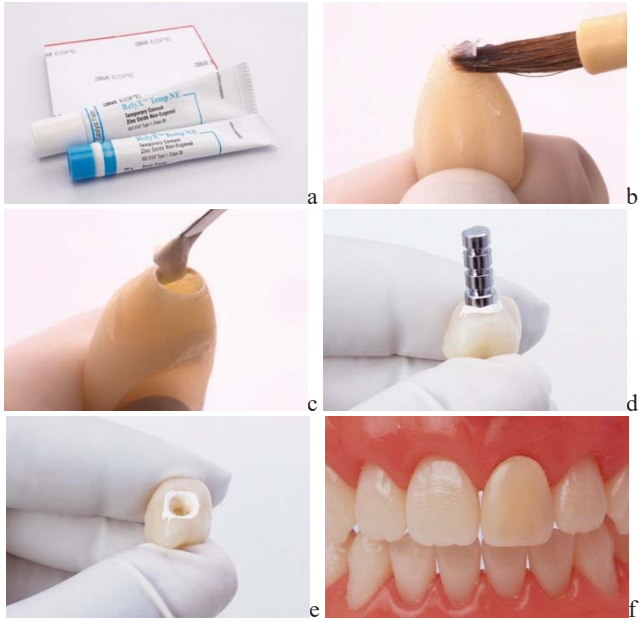


Figure 16.7: (a) Temporary cement (Rely Temp NE, 3M). (b) External lubrication. (c) Cement insertion. (d) Removal of the excess cement in the analog of the universal abutment. (e) Cleaning the excess cement should be performed with gauze. (f) Final aspect of the cemented temporary crown.

3rd session

5. Pick-up impressions (transfer impressions) and customize the emergence profile

Technique:

- Demarcation of the gingival margin with the temporary restoration in place;
- Fit the temporary set over the universal abutment analog;
- Make an impression of the temporary-analog set into a Dappen's dish using heavy putty (respecting the demarcated gingival margin);
- Provisional removal;
- Position the transfer into the analog within the impression;
- Fill the empty space with Duralay-type acrylic resin following the Nealon technique;
- Place the pop-on transfer *in situ*;

- Transfer the impression with silicone using the one-stage technique with a closed tray.

Objective: To transfer the position of the implant in relation to the surrounding intraoral tissues and, especially, to the emergence profile developed at the temporization phase.

Rationale: When the temporary crown is removed, the surrounding gingival tissue will begin to wilt, thereby causing the conventional transfer technique to fail to reproduce the emergence profile.

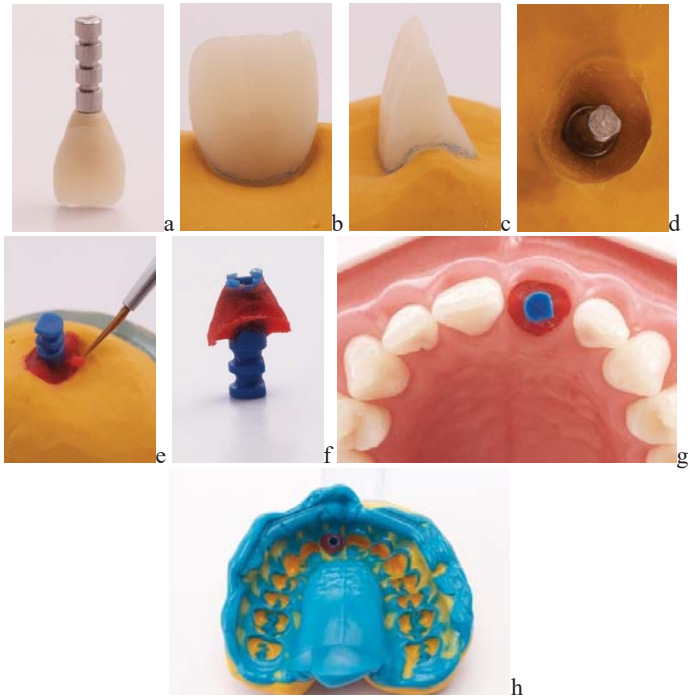


Figure 16.8: (a) The temporary adapted to the analogue. (b-c) Impression of the temporary-analog set according to the demarcated gingival margin. (d) Template of the emergence profile in relation to the analog. (e) Fill in the surrounding empty space with Duralay-type Acrylic Resin. (f) Transfer including the individualization of the emergence profile. (g) Transfer fitted in the mouth. (h) Detail of the impression obtained.

4th session

6. Installation of the ceramic crown

Technique: The installation session includes procedures for adjusting the ceramic (see Chapter 12) and occlusal adjustments (see Chapter 13), which have been mentioned in previous chapters. The cementing technique should be performed as per step 4, but with the cement chosen by the dentist (our team suggests the use of temporary cement, as it has the benefit of reversibility, but the selection of the luting agent varies according to the philosophy of each professional).

Objective: Installation of the ceramic crown to provide superior esthetics and function.

Rationale: Ceramic restorations are superior in terms of esthetic and longevity, but with the detriment of little room for adjustments, so they should only be installed after both the patient and dentist are satisfied with the adaptation of all tissues to the temporary restoration.

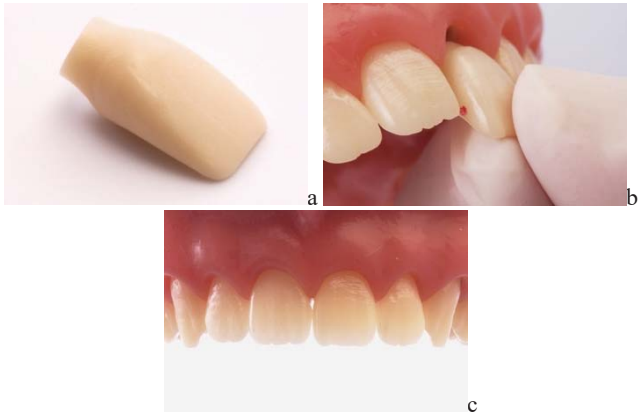


Figure 16.9: (a) Zirconia coping used in full ceramic crowns. (b) Esthetic and secondary adjustment of the ceramic. (c) Ceramic crown fitted.

SINGLE-UNIT CROWNS IN THE POSTERIOR REGION OVER THE IMPLANT WITH INTERNAL HEXAGONAL CONNECTION

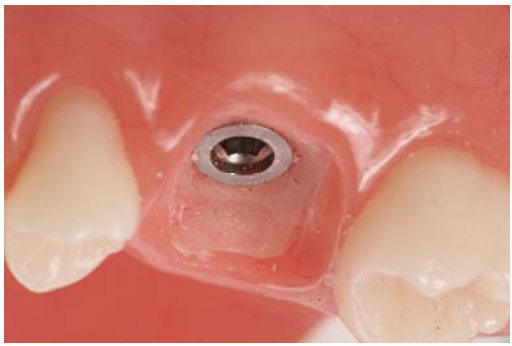


Figure 16.10: Target tooth: 26; Connection used: Internal Hexagon Connection.

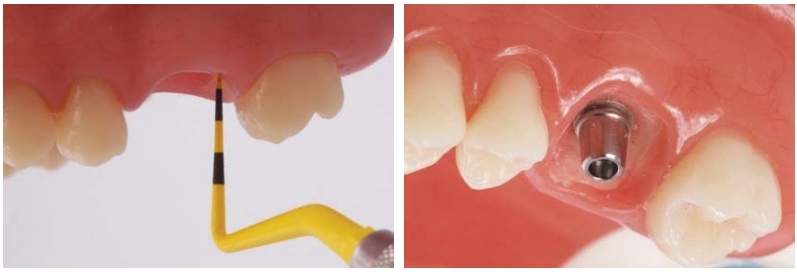
1st session

1. Selection of the prosthetic component

Technique: The selection of the prosthetic component of implants placed in the posterior region can be completed at the moment of implant installation, reopening, or after the stabilization of the gingival tissue with healing abutments. The selection technique is the same as the one used in the esthetic area (pages 377, 378 and 379). For internal hexagon implants, however, most companies do not provide a kit with a variety of components, so the selection is performed by measuring the distance from the implant platform to the gingival margin.

Objective: To find the component that will provide an adequate mechanical outcome for the final prosthesis.

Rationale: The component platform should be 1mm from the gingival margin to hide the interface and allow the excess cement to be cleaned.



a b

Figure 16.11: (a) Measurements for the implant platform at the gingival margin with a millimeter probe. (b) Component platform placed 1 mm below the gingival margin.

2nd session

2. Installation of the prosthetic component

Technique: The selected component (universal abutment) must be installed with a hexagonal screwdriver using the torque recommended by the manufacturer (20N.cm) and a torque wrench. After the torque, the screw passage must be sealed for protection. The orifice may be filled with TPFE tape (condensed down) and finalized with composite resin for coronal seal.

Objective: To install the component and prevent long-term loosening of the abutment.

Rationale: A lack of adequate seal allows the penetration of food debris (particularly in the case of lab-made temporaries) and luting cement, which may prevent the reversibility property of the prosthesis.

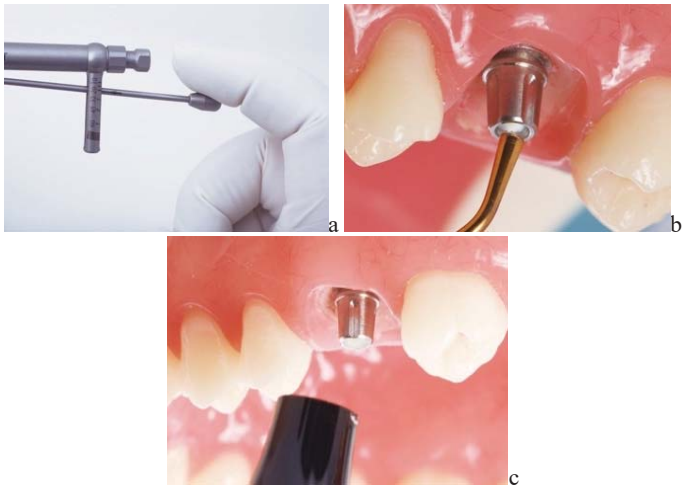


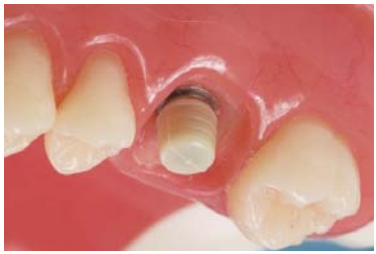
Figure 16.12: (a) Installation of the universal abutment with a wrench and 20N.cm of torque. (b) Filling and condensation of the PTFE tape. (c) Finishing of the seal with temporary light-curing resin.

3. Installation of the temporary crown

Technique: A temporary crown can be made directly in the mouth, using the temporary abutment cylinder and acrylic resin following the negative impression sculpting approach (shown in Chapter 9) or indirectly (made in the laboratory) from the transfer impression. In both cases, cementation should include the analogue to remove excess cement (page 383).

Objective: To accommodate the temporary crown in relation to both adjacent and opposing teeth.

Rationale: Implant-supported single crowns in the posterior region often cause interproximal spaces to open after some time. It is recommended that the temporary should be maintained until stability is achieved in relation to neighboring teeth before making the ceramic crown.



a

b

Figure 16.13: (a) Temporary cylinder in place. (b) Removal of excess cement in the analog.

3rd session

4. Pick-up (transfer) impression

Technique:

• Installation of the pop-on transfer in the mouth;

• Impression tray try-in;

• Transfer impression with addition silicone (simultaneous technique) and closed tray.

Objective: To transfer (shape) the position of the implant in relation to the other oral structures.

Rationale: In the posterior region, it is rarely necessary to distinguish the emergency profile, so the impression can be done in a simplified and, therefore, much faster way.

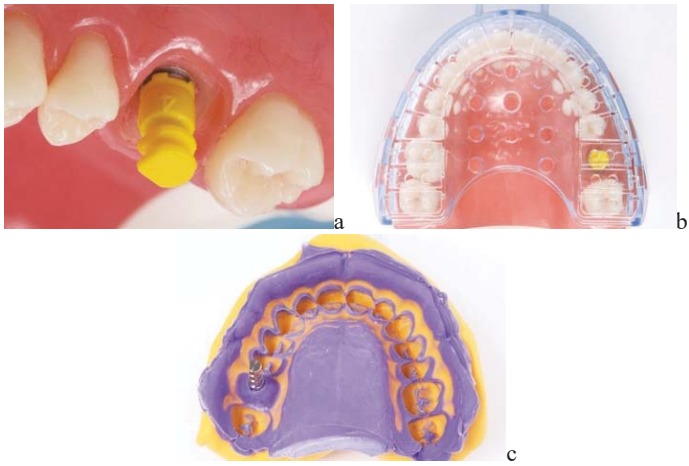


Figure 16.14: (a) Transfer installed in the mouth. (b) Impression tray try-in (see Chapter 6). (c) Detail of the impression obtained.

4th session

5. Installation of the ceramic crown

Technique: The crown fit session includes techniques for adjusting the ceramic (see Chapter 12) and the occlusion (see Chapter 13). The cementation technique should be performed following step 4 (page 382), using the professional's cement of choice (our team suggests the use of temporary cements as they have the benefit of reversibility, but the selection of the luting agent may vary according to each dentist's philosophy).

Objective: ceramic crown fit to provide adequate esthetics and function.

Rationale: Ceramic crowns feature superior esthetics and longevity, but leave little room for adjustments, so it should only be fitted after both patient and dentist are satisfied with the adaptation of all tissues to the temporary restoration.

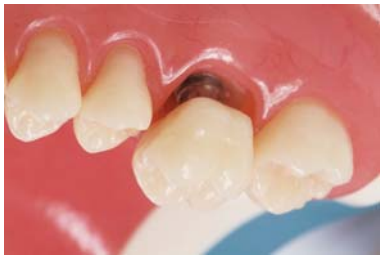


Figure 16.15: Crown try-in on the universal abutment for posterior cementation.

SCREWED-ON SINGLE-UNIT CROWNS IN THE POSTERIOR REGION OVER THE EXTERNAL HEXAGONAL CONNECTION IMPLANT

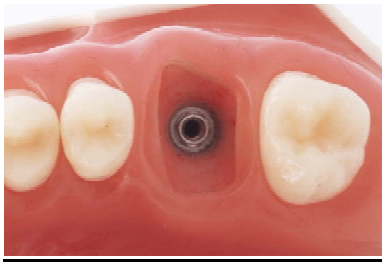


Figure 16.16: Target tooth: 26; Connection used: External Hexagon (Brånemark standard).

1st Session

1. Selection of the prosthetic component

Technique: Similar to cemented crowns in the posterior region. In the case of a screwed-on single-unit crown, the only component indicated for an external hex is a tapered abutment (for internal hex implants, the indication is also a tapered abutment and, for Morse taper implants, the indicated component is the Morse taper abutment).

Objective: To find the component that provides adequate mechanical properties for the final prosthesis.

Rationale: Tapered abutments can be used for single crowns thanks to their hexagon base, which acts to prevent the rotation of the cylinder (or crown)

around the component. In order to achieve this, anti-rotation cylinders must also be used.

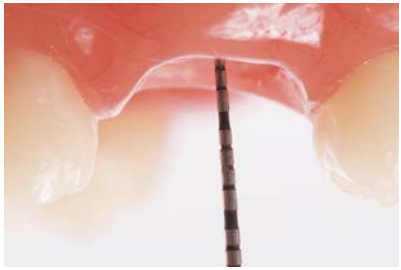


Figure 16.17: Measurement of the implant platform at the gingival margin with a periodontal probe.

2nd Session

2. Installation of the prosthetic component

Technique: The selected component (tapered abutment) must be fitted using a tapered screwdriver and the torque recommended by the manufacturer (20N.cm) measured by a torque wrench.

Objective: To install the component so that the risk of long-term loosening is minimized.


a


b


c

Figure 16.18 (a) Tapered screwdriver with adapter for manual use. (b) Installation of the tapered abutment. (c) 20N.cm torque.

3. Protection of the tapered abutment (with protective cap or temporary prosthesis)

Use of the protective cap

Technique: Components for screwed prostheses must be protected from any type of deformation that could impair the adaptation of the final crown. Adequate protection of such abutments can be achieved using protective caps (in a similar way to healing abutments) or a temporary crown made directly after the installation of the component. The temporary may be made using acrylic resin following the negative impression sculpting approach (see Chapter 9).

Objective: To protect the abutment against deformations that may impair the adaptation and long-term stability of the ceramic crown.

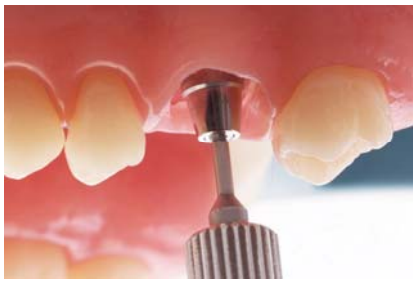


Figure 16.19: Installation of the protection cap with a hexagonal screwdriver and light finger torque.

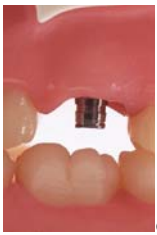
Making the temporary (direct approach)

Technique: A temporary anti-rotation screw-on abutment is required. This abutment cylinder should be placed in position to establish the height at which it should be sectioned to allow the crown to be made without interfering with esthetics and occlusion. After cutting the cylinder, it must be screwed on and the screw access orifice sealed prior to making the temporary, which in turn should be made according to the negative impression sculpting approach in acrylic resin (showed in Chapter 9). A torque of 10N.cm ought to be used at this stage and the access orifice sealed as described on page 388.

Objective: To protect the tapered abutment.


a


b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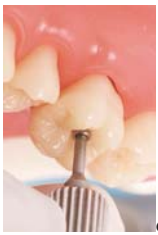
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Figure 16.20: (a) Temporary titanium abutment set with an antirotating base, crown retaining screw, and hexagonal key. (b) Temporary abutment in position with demarcated height for cutting. (c) Sectioned intermediate cylinder in position. (d) Installation of the screw-retained temporary crown.

3rd Session

4. Transfer impression

Technique:

• Installation of the pop-on transfer;

• Impression tray try-in and cutting (DHPro);

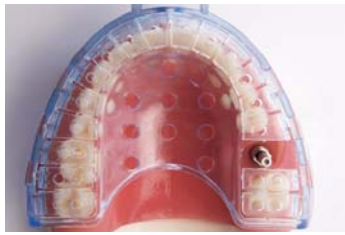
• Covering the cut-out area with micropore tape to prevent excessive loss of impression material;

• Transfer impression using heavy and light addition silicone (one stage technique).

Objective: To transfer the position of the implant in relation to the neighboring intraoral tissues.

Rationale: Due to the type of component used, the correct transfer of the tapered abutment's hexagon edges can only be achieved using the open tray technique and square transfers.


a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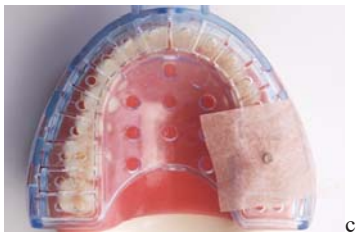
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d

Figure 16.21: (a) Square transfer installed on the taper abutment. (b-c) Impression tray try-in (see Chapter 6) and sealing of the cut-out area with micropore tape (d) Detail of the impression obtained and screwing of the analog to the transfer.

4th session

5. Installation of the ceramic crown

Technique: The crown fit process includes adjusting the ceramic (see Chapter 12) and the occlusion (see Chapter 13). Retention is obtained by torquing the screw, as recommended by the manufacturer (10N.cm) using a torque wrench. The orifice must be sealed as described on page 388 though, for the definitive crown, the sealing material may be composite resin.

Objective: Ceramic crown fit to provide adequate esthetics and function.

Rationale: The ceramic crown provides superior esthetics and longevity, though it leaves little room for adjustment and so it should only be fitted once the surrounding tissues are accommodated around the temporary crown.

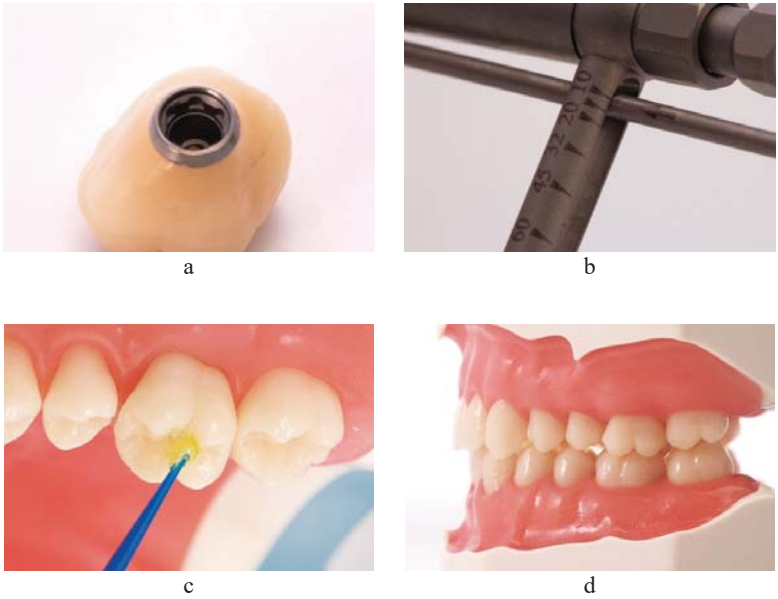

Figure 16.22: (a) Metal-ceramic crown with an anti-rotation base. (b) 10N.cm torque recommended by the manufacturer. (c) Bonding agent for final seal with composite resin. (d) Final appearance of the crown in position.

CHAPTER 17

IMPLANT-SUPPORTED FIXED PARTIAL DENTURES

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André Antonio Pelegrine
Marcelo Sperandio
Marcelo Lucchesi Teixeira
Peter Karyen Moy

INTRODUCTION

Due to the high success rates reported, dental implants are the best option for the rehabilitation of tooth losses, be they single, partial, or complete. In the case of multiple teeth replacements, the greatest challenge is to rehabilitate in terms of both function and esthetics.

In the rehabilitation of partially edentulous patients, the dentist must decide between screwed or cemented restorations. Both retention methods have advantages and limitations. The best feature of screwed restorations is their reversibility, which is a favorable option when associated with well positioned implants. Its main disadvantage is screw loosening, which is mainly due to a lack of passive seating in the metal framework. The advantages of cemented prostheses in comparison to screw-retained restorations have the higher likelihood of obtaining a passive seating for the metal framework, better load distribution, and esthetics, among others. The main disadvantages are related to the risk of cement residues and the difficulty of recovering the prosthetic work, which makes it less reversible than screw-retained restorations.

Whether in cemented or screwed-on prostheses, the installation of an intermediate device (abutment) is a key factor for success in all cases. The dentist must, therefore, observe the following parameters: free interocclusal space, single or multiple prosthesis (to evaluate the need for anti-rotational

platforms), quantity/quality of gingival tissue, and whether there is need for the angulation correction of the implant.

In this chapter, the clinical procedures for the preparation of fixed bridges over implants, both cemented and screwed-on, will be discussed.

Instruments and materials used in this Chapter

- Prosthetics kit
- Periodontal probe
- Intermediates (tapered mini abutments)
- Protection caps
- Mini-abutment transfers
- Intermediate analogs (tapered mini abutments)
- Marten hair paintbrushes # 0 and # 00
- Pattern Resin GC acrylic resin: powder + liquid
- 03 Dappen's dishes
- Spatulas # 72 and LeCron
- Radiography film
- Die pins
- Set of plastic stock impression trays (DHPro)
- Maxicut drills
- Impression material dispensing syringe
- Addition or condensation silicone
- Silicone for registration
- Carborundum discs
- High-speed handpiece + set of metal adjustment burs
- Motor + straight handpiece + contra-angle (or electric motor)
- EPPIC: DHPro Metal Finishing Kit
- EPPIC: DHPro Ceramic Finishing Kit
- Occlusion marking paper (suggestion: Accufilm II or Bausch double-sided and double-colored paper)
- Two Miller Tweezers
- Clinical kit containing probe, mirror, and clinical tweezers

FIXED PARTIAL DENTURES

Cemented Implant-supported Fixed Bridges

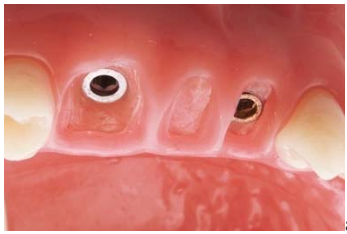
1st Session

1. Implant Transfer Impression (Installation of transfers)

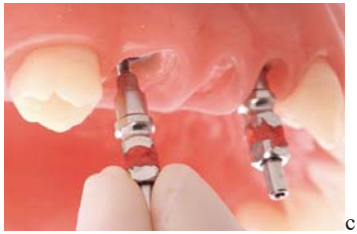
Technique: Remove of the healing abutments. Install the impression transfer (open tray) to each implant (take a periapical radiograph if External Hexagon or Internal Hexagon). Using the Nealon technique, apply acrylic resin (Pattern Resin GC) in the retentive area of the transfers.

Objective: To stabilize the transfer set and to establish a relationship with the adjacent tissues.

Rationale: Precision of the implant position.


a


b


c


d

Figure 17.1: (a) Occlusal view of the implants. (b) Transfer from the open tray implant platform. (c) Installation of the transfers. (d) Transfers installed.

2. Implant Transfer Impression (attaching the transfers)

Technique: Join the impression transfers with Pattern Resin GC using the Nealon technique.

Clinical Tip: Use a die pin, since its flat surface prevents rotation of the set.

Objective: To stabilize the transfer set and to establish the relationship with the adjacent tissues.

Rationale: Precision of implant position.

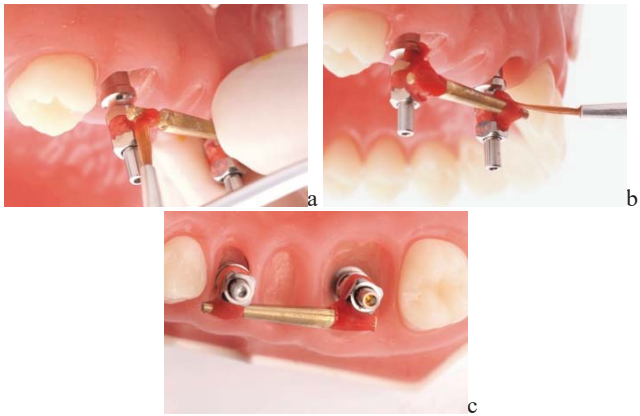


Figure 17.2: (a-b) Joining the transfer using a die pin. (c) Occlusal view of the transfer-die pin assembly.

3. Implant Transfer Impression

Technique: Select a plastic impression tray with a size compatible with the arch. Mark the areas of the transfer screws in the tray. Cut windows using a maxicut drill in the region relating to the screws of the transfers for access. Close the access windows to the transfers with Micropore tape. Take the impression using heavy and light silicone (one-stage technique). Cast the model using type IV plaster. Place the healing abutments back over the implants.

Objective: Customization of the stock tray and make a negative template to facilitate the confection of fixed bridges over the implants.

Rationale: Establish access to the transfer screws and produce a working model to make an implant-supported fixed bridge.

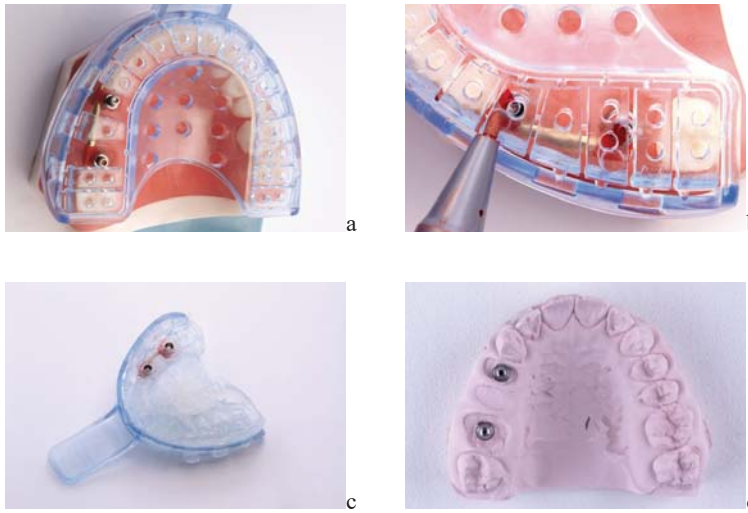


Figure 17.3: (a) Marking the area to be cut out. (b) Perforated impression tray. (c) Silicone impression. (d) Working model.

2nd Session

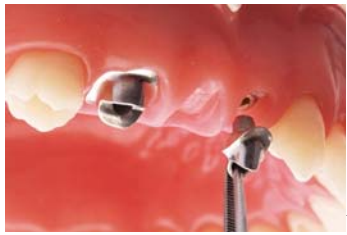
1. Installation of the abutments

Technique: Removal of the healing abutments. Install the custom abutments to the implant (a radiographic examination is recommended in the case of External Hex or Internal Hex). Use a specific screwdriver manually at first and then a torque wrench for the final torque.

Objective: To install and verify the adaptation of the abutment to the implant.

Rationale: Optimize the adaptation precision between the abutment and the implant.


a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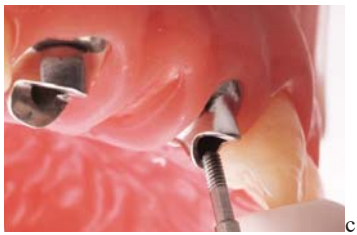

c


d

Figure 17.4: (a) Custom abutments. (b) Abutment installation. (c) Using the prosthetic screwdriver to fix the screw-retained abutment. (d) Abutment screw torque (20N.cm).

2. Abutment seal and temporization

Technique: Seal the inner aspect of the abutment cylinder with PTFE tape and then composite resin. Light cure.

Objective: To seal the region of screw passage.

Rationale: Prevent contamination and the flow of cement into the screw access orifice.

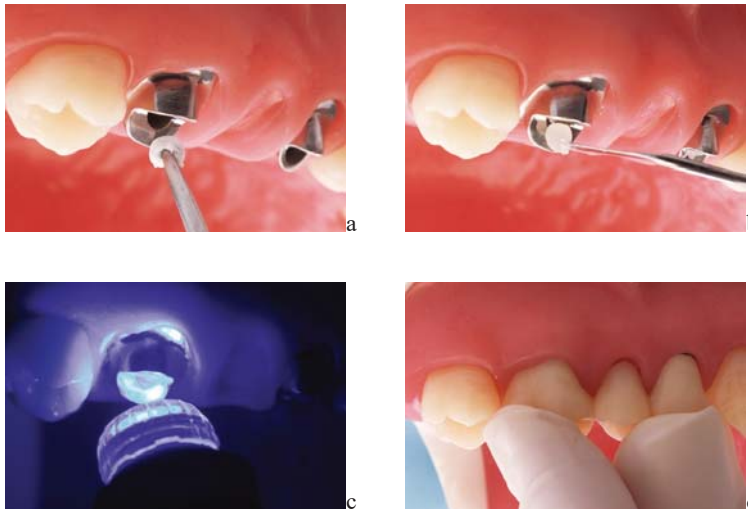


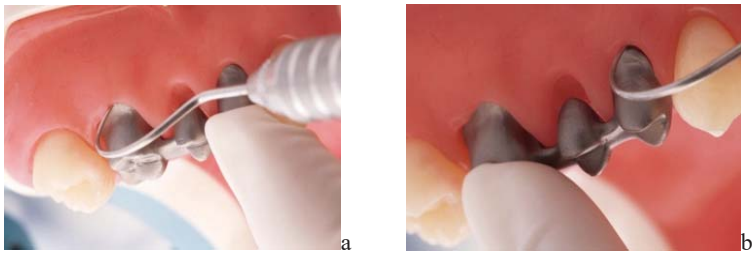
Figure 17.5: (a) PTFE tape being condensed into the screw access orifice. (b) Composite resin filling. (c) Light curing. (d) Temporary in position.

3. Proof of the metal framework

Technique: Temporary removal. Metal framework try-in. Adjusting the internal space (liquid carbon technique, shown in Chapter 11). Evaluate some types of cervical misalignment with the aid of a probe. Should there be maladaptation of the fixed bridge, it must be sectioned transversely from mesial to distal in the region of the pontic for welding.

Objective: To passively adjust the metal framework over the abutments.

Rationale: It is difficult to achieve absolute precision with single piece metal frameworks.



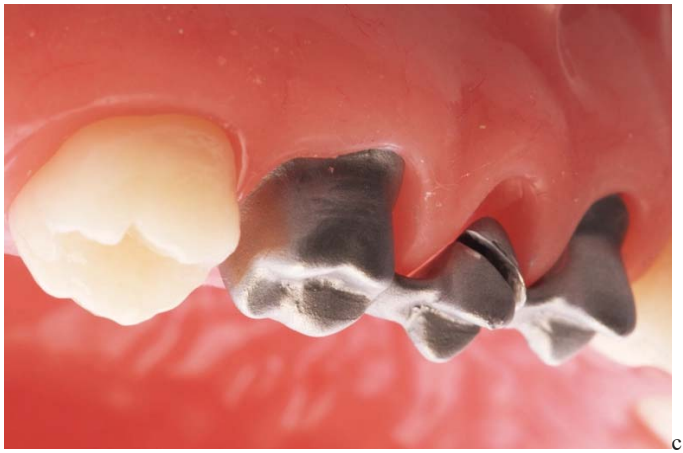

c

Figure 17.6: (a-b) Evaluation of cervical maladaptation. (c) Sectioning the framework for welding.

4. Removal for welding (if applicable)

Technique: Stabilize the set. Attach the separated metal frameworks initially with pattern acrylic resin and subsequently with a die pin and pattern acrylic resin (page 288). Send for welding. Temporary recementation.

Clinical Tip: Use a die pin to prevent rotation of the set.

Objective: To passively adjust the metal framework over the abutments.

Rationale: It is difficult to achieve absolute precision with single piece metal frameworks.

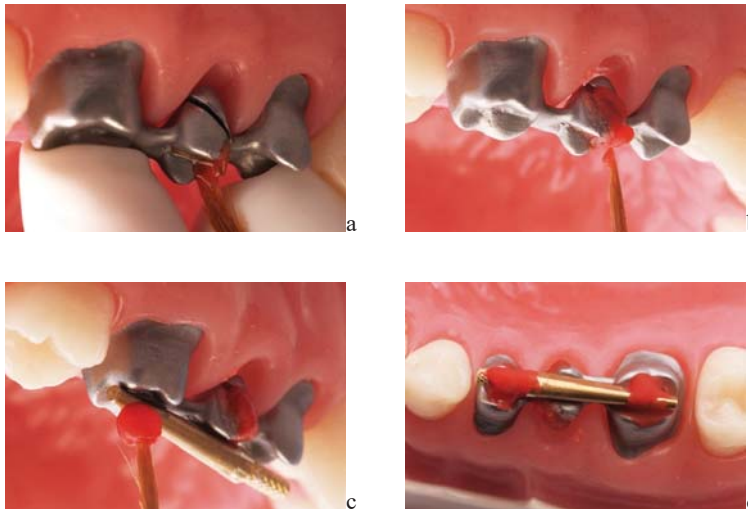


Figure 17.7: (a-b) Stabilization and joining the set with pattern acrylic resin. (c-d) Joining the infrastructure with the die pin and pattern acrylic resin.

3rd Session

1. Metal framework try-in after welding

Technique: Temporary removal. Install the metal framework over the abutments. Adjust the inner aspect of the prosthesis (showed in chapter 11). Check for cervical misalignment with the aid of a dental probe.

Objective: To passively adjust the metal framework over the abutments.

Rationale: Accurate adaptation of the metal framework.

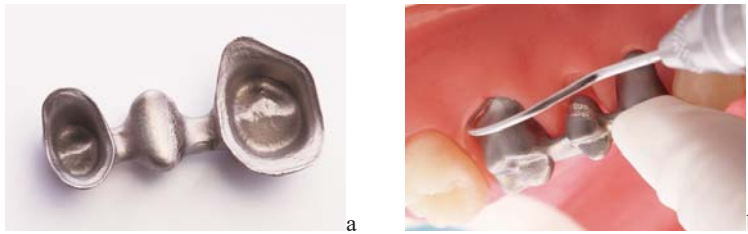


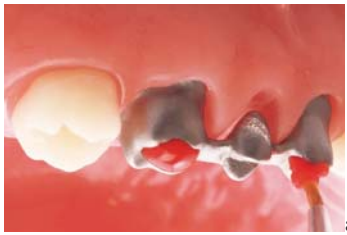
Figure 17.8: (a) Framework after welding. (b) Evaluation of cervical adaptation.

2. Occlusal Registration and Transfer Impression

Technique: Install the metal infrastructure. Adjust the interocclusal space if necessary. Record the interocclusal registration with pattern acrylic resin and take the transfer impression using heavy and light silicone (one-stage technique). Select the color for the ceramic work. Mount the models in a semi-adjustable articulator (SAA). Recement the temporary bridge.

Objective: Stabilize the metal framework over the abutments in relation to the opposing teeth.

Rationale: Transfer of the framework for the application of the ceramic cover.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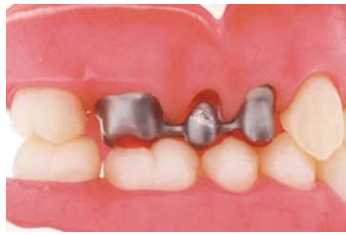
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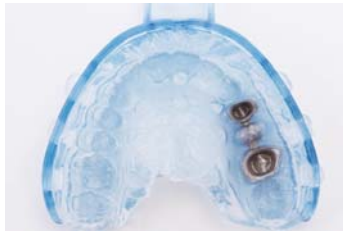
d

Figure 17.9: (a) Pattern acrylic resin being used for occlusal registration. (b) Maxillomandibular record. (c) Framework with inter-occlusal registration. (d) Transfer impression.

4th Session

1. Ceramic try-in and adjustment

Technique: Temporary removal. Place the metaloceramic fixed bridge over the implants. Check and adjust the internal and interproximal spaces. Use

carbon tape, liquid carbon, dental floss, and burs for the ceramic (see Chapter 12).

Clinical Tip: Use dental floss to check the interproximal contact point. If it breaks or shreds, the ceramic should be reduced and, if there is no contact point, ceramic needs to be added.

Objective: Ceramic try-in for esthetic and functional adjustments.

Rationale: To refine the important characteristics of metaloceramic restorations.

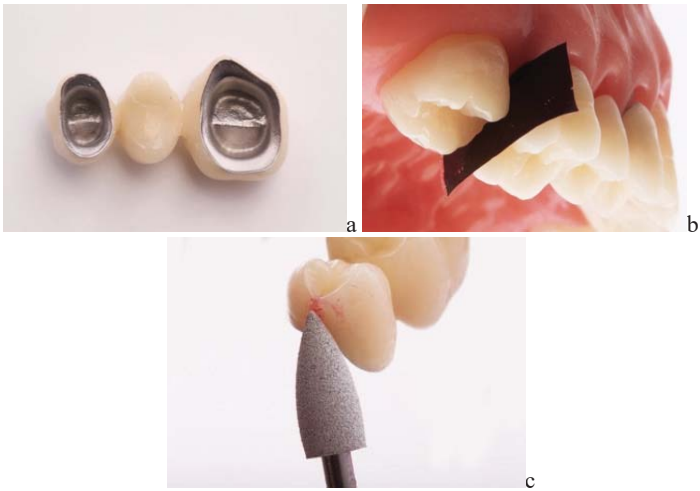

Figure 17.10: (a) Porcelain applied over the metal framework. (b) Identification of interproximal contacts. (c) Adjusting the interproximal contacts.

3. Testing and adjusting the ceramic (continued)

Technique: Check occlusal contacts. Observe buccal and lingual alignment. Verification of cervical margins. Refining and polishing. Send the appliance for glazing. Recement the temporary in place (see Chapters 12 and 13). If polishing the definitive fixed bridge can be done at chairside, then definitive cementation may take place at this stage.

Objective: To make final esthetic and functional adjustments to the ceramic.

Rationale: To refine the important characteristics of metaloceramic restorations.


a

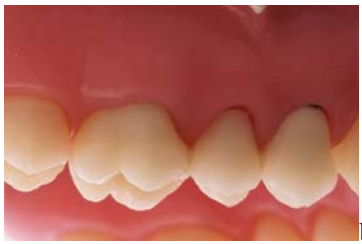
b

Figure 17.11: (a) Fixed bridge try-in. (b) Fixed bridge cemented into place.

SCREWED-ON IMPLANT-SUPPORTED FIXED BRIDGES

(Important: for internal hex connections it is mandatory to have a high level of parallelism between implants, to allow the confection of screwed-on bridges.)

1st Session

1. Selection of abutments

Technique: Removal of the healing abutments. Measure the depth of the implants in relation to the gingival tissues using a periodontal probe. Observe the implant platform and height in relation to the opposing teeth. Place the healing abutments back over the implants.

Objective: To establish the transmucosal height and diameter of the abutments in relation to the implant platform. Check for the need to apply angled or custom abutments.

Rationale: To program the exit of the screws of the definitive prosthesis in the central region of the occlusal face, allowing sufficient space for the restoration.

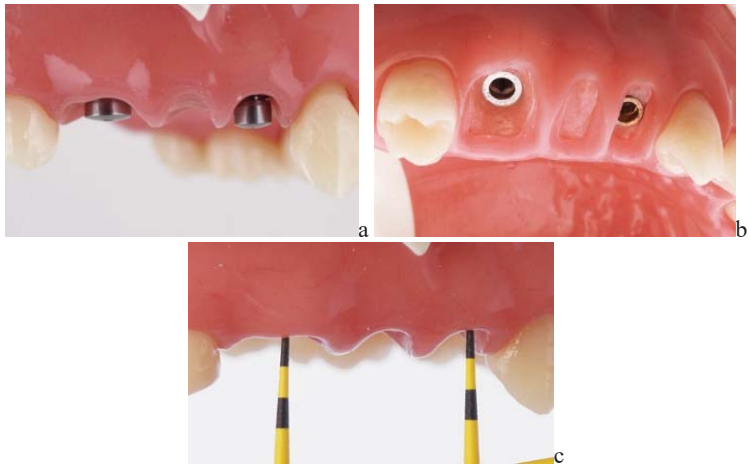

Figure 17.12: (a) Healing abutments in position. (b) Occlusal view of the implants. (c) Transmucosal height measurement using a periodontal probe.

2nd Session

1. Installation of the abutments

Technique: Removal of the healing abutments. Screw the abutment to the implant using the recommended screwdriver.

Clinical Tip: If the implant has an External Hex or Internal Hex interface, take a radiograph to ascertain adequate seating of the abutments.

Objective: To install and verify the adaptation between the abutment and the implant.

Rationale: It is important to ensure the precision of adaptation between the abutment and the implant.

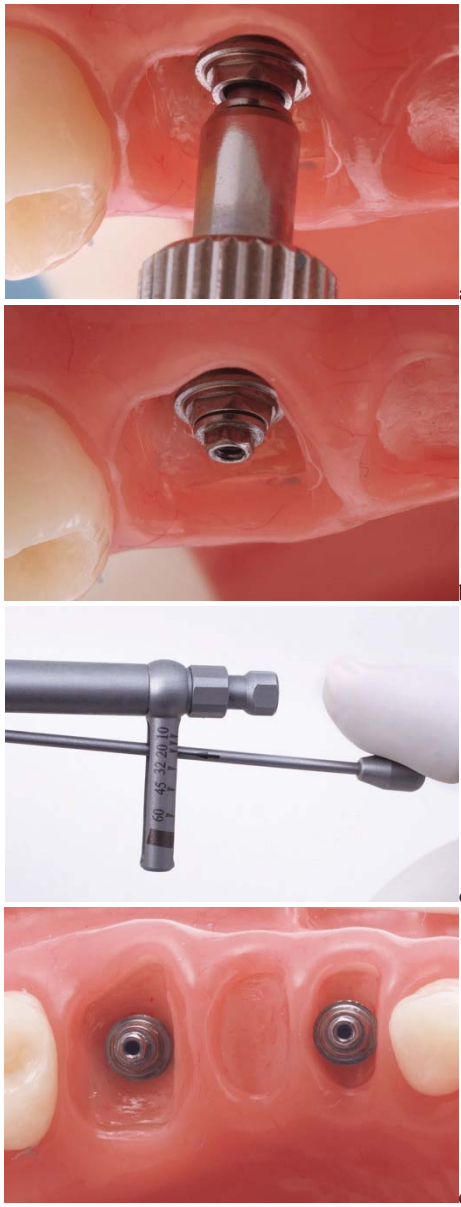

Figure 17.13: (a) Use of the recommended screwdriver. (b) Abutment in position. (c) Use of the prosthetic torque wrench (20N.cm). (d) Abutments installed.

2. Installing and joining the transfers

Technique: Install the impression transfer (open tray) to the abutment (take a radiograph if necessary). Apply pattern acrylic resin to the retentive area of the transfers using the Nealon technique. Join the transfers with pattern acrylic resin.

Objective: To stabilize the transfer set and relate it to the adjacent tissues.

Rationale: Ensure the accuracy of the position of the abutments.

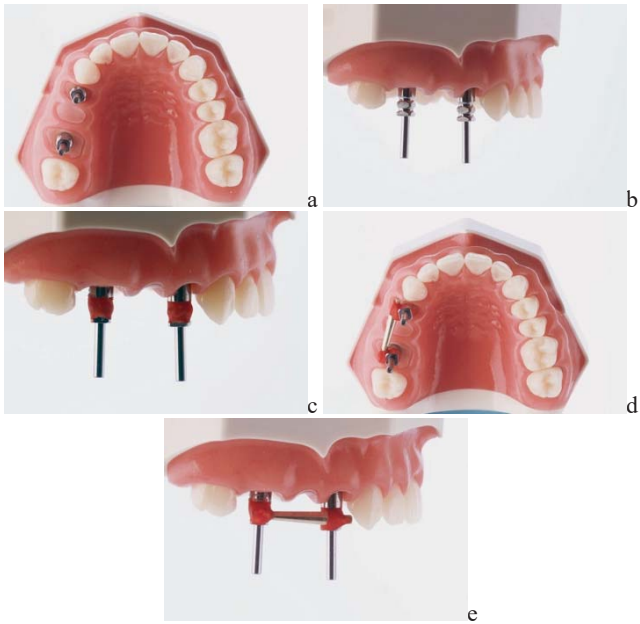

Figure 17.14: (a-b) Installed transfers (occlusal and frontal view). (c) Pattern resin GC in the retentive region of the transfers. (d-e) Joining the transfers with die pin and Nealon technique (frontal and occlusal view).

3. Tray adjustment

Technique: Select a plastic stock tray that is compatible with the size of the arch. Cut windows using a maxicut drill in the region to match the area of the transfer screws for access.

Objective: Customization of the stock impression tray.

Rationale: Provide the lab technician with important information regarding the dimensional conditions of the implants in relation to each other and to the remaining intraoral structures.

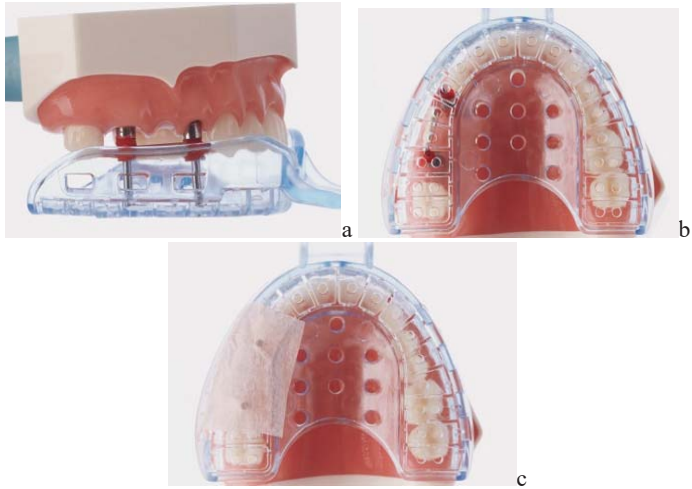

Figure 17.15: (a) Marking the area to be cut out. (b) Perforated tray. (c) Custom tray with micropore tape covering the cutout windows.

4. Transfer impression and obtaining the working cast

Technique: An impression of the transfer set is completed with the custom tray and impression silicone (putty and light) aided by an impression material dispensing syringe. Installation of the analogs in the impression. Fill the impression with type IV plaster. Register the occlusal records. Assemble the models on a Semi Adjustable Articulator. Replace the protective abutments.

Objective: To create a negative template to facilitate the subsequent procedures of the implant-supported fixed bridge.

Rationale: Provide the lab with the dimensional conditions of the implants between each other and the adjacent intraoral structures.

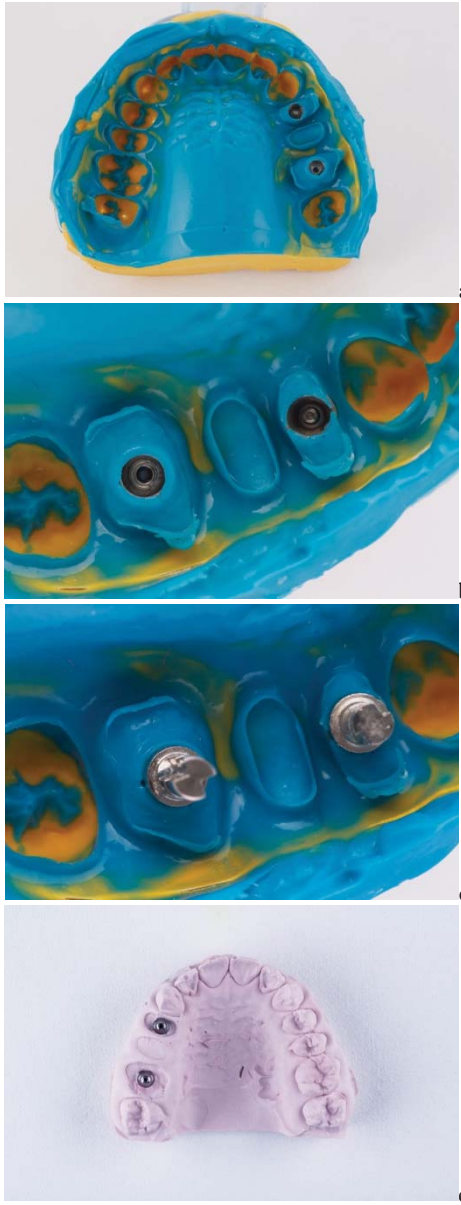

Figure 17.16: (a) Impression taken. (b) Detail of the transfers. (c) Tapered mini-abutment analogs adapted to the transfers. (d) Working model.

5. Installation of the Protective Abutment

Technique: To install a protective abutment aided by a screwdriver.

Objective: To protect the intermediate component.

Rationale: To prevent irreversible changes to the surface of the intermediates during the prosthetic steps.

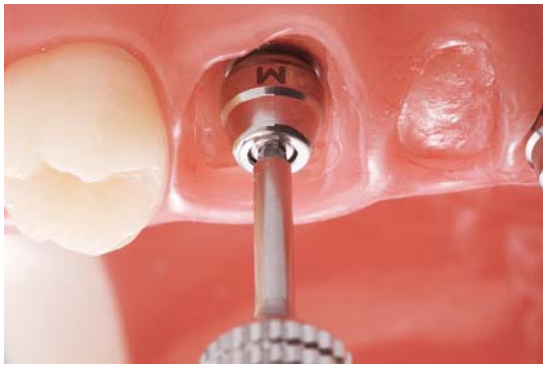

Figure 17.17: Using the recommended screwdriver to install the protective abutment.

3rd Session

1. Metal framework try-in

Technique: Remove the protective abutments. Install the metal framework over the abutments. Check for cervical maladaptation by applying finger pressure on one end of the fixed bridge and screwing the other, and vice versa. If any maladaptation is found, the framework must be sectioned for welding.

Objective: To passively adjust the metal framework over the abutments.

Rationale: It is difficult to achieve adequate precision from single piece metal frameworks.

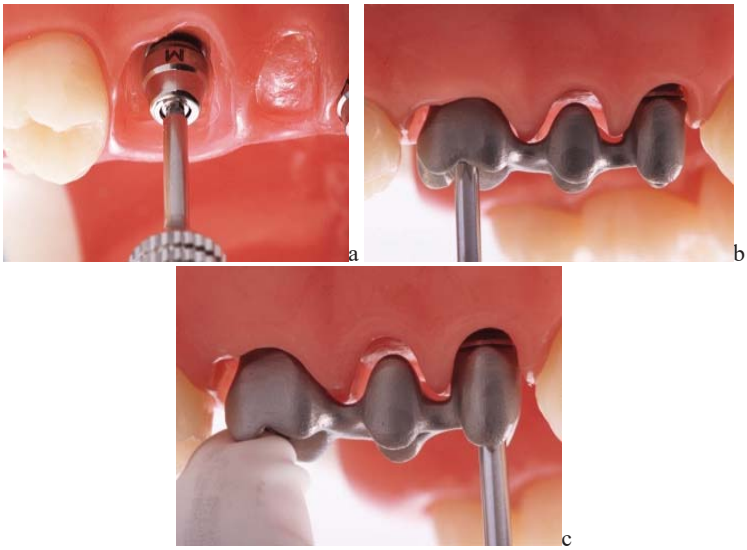

Figure 17.18: (a) Removal of the protective abutment. (b-c) Installation of the framework checking for maladaptation on both sides (one at a time).

2. Sectioning the framework for welding

Technique: The section for welding should be performed on the pontic from mesial to distal using a carborundum disc. The two ends of the metal framework should then be joined back together with pattern acrylic resin and a die pin (see Chapter 11). Replacement of the protective cylinders.

Objective: Return the passivity and the adaptation of the metallic superstructure to the intermediate abutment.

Rationale: Passivity of the metallic superstructure over the intermediate abutments.

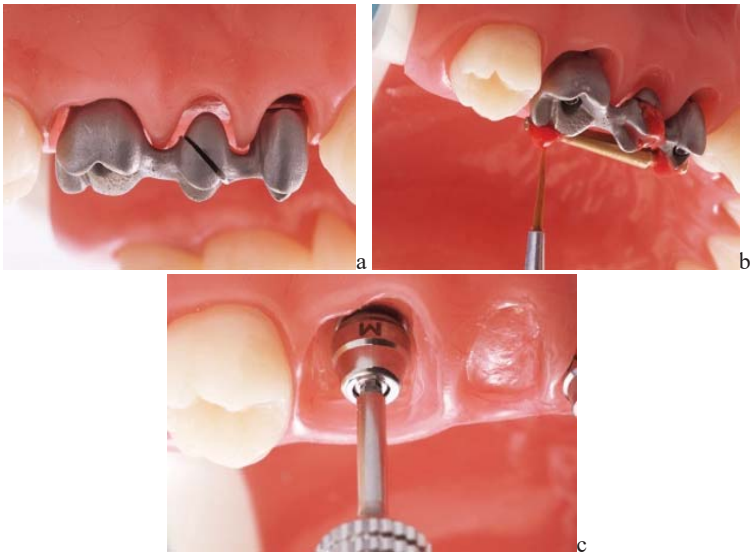

Figure 17.19: (a) Sectioning the framework for welding. (b) Joining the framework. (c) Placing the protective abutments.

4th Session

1. Metal framework try-in

Welded framework try-in

Technique: Removal of the protective abutments. Install the welded framework over the abutments. Check for cervical maladaptation (see Figures 17.8 A, B). Register the interocclusal relationship and take a new transfer impression. In order to achieve this, replace the abutment screws for the transfer screws (the long ones). Reassemble in the Semi Adjustable Articulator. Select the color. Place the protective abutments back over the implants.

Clinical Tip: Use the Sheffield approach (finger pressure of the framework against each abutment for evaluation).

Objective: To stabilize the metal framework against the abutments.

Rationale: Working towards a passive adaptation between the framework and the abutments.

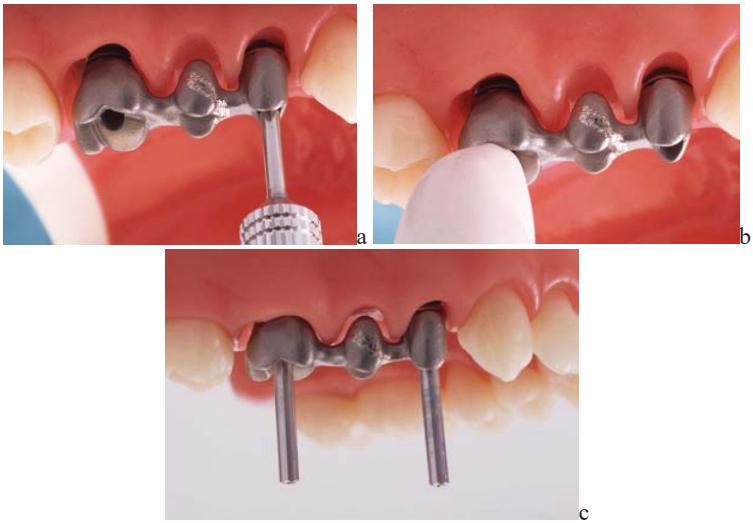

Figure 17.20: (a) Framework installation. (b) Sheffield's test. (c) Framework with screws transfers.

5th Session

1. Installation of the implant-supported bridge

Technique: Removal of the protective abutments. Install the screw-retained FB after ceramic and glaze testing (see Chapter 12). Use the specific screwdriver with manual torque at first and later apply a controlled torque using a torque wrench. Fill the screw access orifice of the abutment with PTFE tape and then seal it with composite resin.

Objective: To achieve an excellent relationship between the fixed bridge and the surrounding oral tissues.

Rationale: To promote optimal adaptation of the implant-supported FB to the abutments and adjacent tissues.

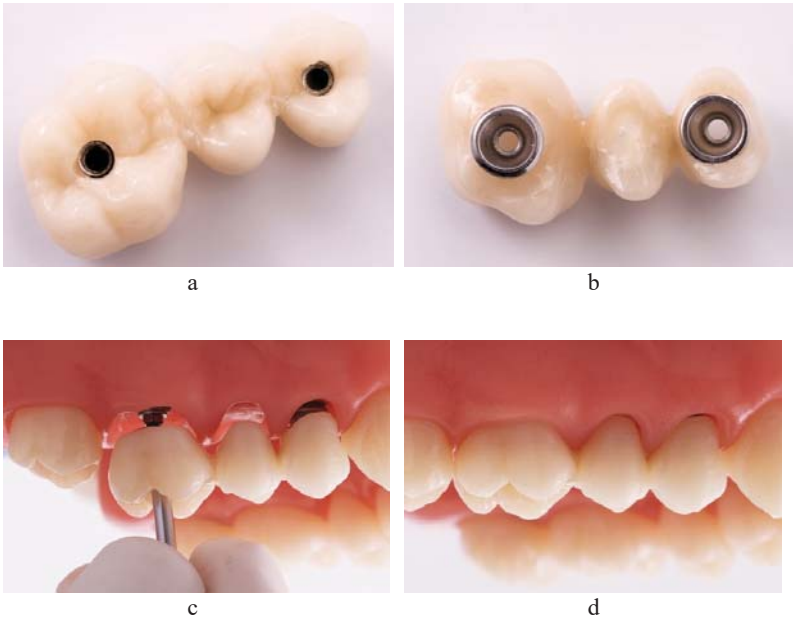

Figure 17.21: (a-b) Porcelain applied to the framework. (c) Manual torque. (d) Bridge fitted.

CHAPTER 18

COMPLETE DENTURES

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Marcelo Lucchesi Teixeira
Peter Karyen Moy

INTRODUCTION

The widespread use of fixed-complete dentures has led many professionals to revert to the concepts of complete dentures. In general, one of the most frequent errors found in daily clinical practice are protocols with an inadequate design, either for esthetic reasons or for occlusal/functional ones.

The present chapter aims to show that complete dentures, either implant-retained (overdentures) or implant-supported (fixed), achieve better results when made based on the principles of conventional complete dentures.

When an optimal complete denture is made in advance, the planning of implant placement and the selection of abutments becomes easier, which is in addition to the fact that such predictability facilitates implant positioning to optimize biomechanical performance and facilitate hygiene for the fixed prosthesis. The consequence is that such cases have a higher chance of uneventful long-term success.

Figure 18.1: Mannequin used for complete denture training.

EQUALIZED ANATOMICAL IMPRESSIONS

Technique: Impression compound impressions should be taken in order to push away the musculature and frenula, as well as any excess soft tissue. Subsequently, equalization of the first impression using a light body impression material should be taken to balance out the compression areas so that unwanted bone resorption is avoided.

Objective: To obtain casts with an optimized extension of the correct basal area, which is free from compression.

Rationale: If the basal area is overextended, the complete denture will have serious stability problems. On the other hand, stability and retention problems can occur from an underextended basal area, which may also lead to focal compression forces, thereby promoting painful compression sores, which in turn may accelerate bone resorption.

Materials Used for Equalized Anatomical Impressions

- Impression compound cakes
- Impression stock trays for edentulous arches
- Blade (knife)
- Mixing glass pad
- Spatula 36
- Mortar and spatula
- Cloth strainer
- Zinc-eugenol paste
- Stone

Figure 18.2: Impression compound cakes and stock trays for edentulous patients.

Selection of the trays

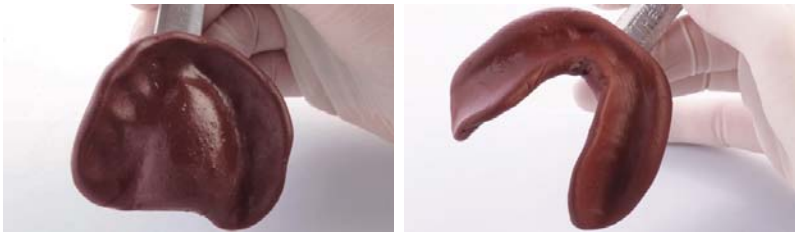
Technique: Check if the tray will encompass the area of the tuberosity (upper arch) and the retromolar pad (lower arch), allowing 2mm of space for the impression material along the buccal sulcus.

a b

Figure 18.3: (a) upper tray try-in; (b) lower tray try-in.

Placing the material in the impression tray

Technique: Plasticize the impression compound in a 65°C water bath and manipulate it until it becomes homogeneous. Because of low flow of this material, the accommodation of the impression compound into the tray should be done in a way to obtain a gross conformation of the alveolar ridge, thereby facilitating the impression.



a b

Figure 18.4: (a) accommodation of the impression compound into the upper tray; (b) accommodation of the impression compound into the lower tray.

Taking a Primary Impression

Technique: After placing the impression over the area, press it firmly against the alveolar ridge and surrounding tissues. Then pull the surrounding tissues, including the cheek and lips, away from and against the impression tray.

For the lower impression, the patient should be asked to touch the palate with the tip of their tongue, as well as to project it outwards and move it sideways.

a b

Figure 18.5: (a) Upper primary impression; (b) Lower primary impression.

Rating the impression compound impression

Technique: Factors to be evaluated:

- Arch imprinted within the center of the tray
- Matte and uniform surface

- Soft tissue spread
- Imprint of the buccal sulcus
- Copy of the tuberosity area (upper)
- Copy of the buccal arch in the shape of an *S* (lower)

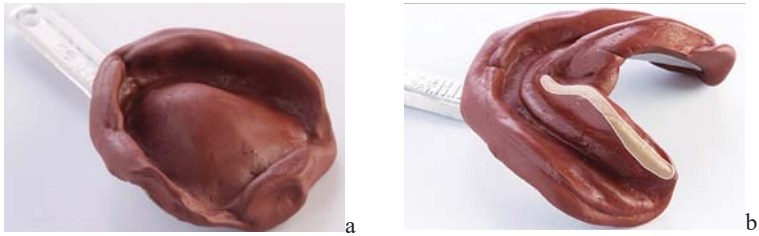


Figure 18.6: (a) Upper primary impression; (b) Lower primary impression.

Making relieving areas in the impression

Technique: Use a blade, a Stanley knife, or a sharp knife) to shave off some of the impression compound material to create some room in the main compression areas of the impression:

- Upper: crest of the alveolar ridge and anterior aspect of the ridge
- Inferior: crest of the alveolar ridge and region of the mylohyoid insertion

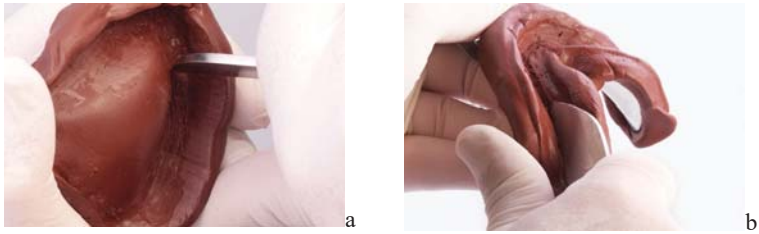


Figure 18.7: (a) Relieving the anterior region of the upper alveolar ridge. (b) Relieving the region of the mylohyoid line of the lower impression.

Equalization technique for the primary impression

Objective: Impression compound is an excellent material for spreading the soft tissues away but, due to its low flowability, it over compresses the alveolar ridge, which may lead to bone resorption after the denture is fitted.

The areas of uneven compression should, therefore, be relieved, thereby equalizing the impression with a medium flow impression material, such as zinc oxide eugenol (ZOE) impression paste, regular body silicone, or alginate.

Figure 18.8: Material used for equalization of the primary impression.

Equalizing impression with ZOE paste

Technique: Apply a thin layer of ZOE paste over the entire impression compound surface and insert the load tray into the patient's mouth, ensuring that it is positioned according to the ideal position, which has been predefined. A light pressure should be applied.

a b

Figure 18.9: (a) ZOE paste impression for equalization of the upper primary impression. (b) Impression with ZOE paste for equalization of the lower primary impression.

Evaluation of the primary equalized impression

Technique: The impression compound must be fully covered by the ZOE paste. An exposed impression compound means that elimination of the compressive areas was not achieved, in which case the ZOE paste should be removed, the compression areas relieved, and a new impression taken.

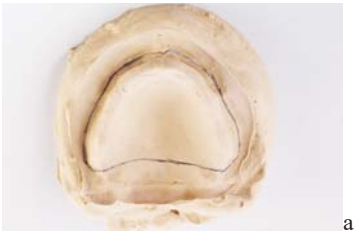

a


b

Figure 18.10: (a) Upper primary impression after equalization. (b) Lower primary impression after equalization.

Primary cast

Technique: Use dental stone (type III) to produce the primary cast. It is important to outline the limits of the soft tissue so that the edges of the casts can safely be trimmed to facilitate the manufacturing of custom trays.


a


b

Figure 18.11: (a) Upper primary cast. (b) Lower primary cast.

Secondary equalized impression

Technique: The secondary impression is completed from the patient's custom trays using the two-stage technique with Addition Silicone. First, a medium-flow silicone impression is taken; if there is any area of the tray exposed, it should be trimmed down. Subsequently, another impression is taken with light body (high flow) silicone to provide detail.

Objective: To produce an impression that maximizes basal contact area which is free from compression spots and shows a wealth of details, while respecting the musculature and soft tissues.

Rationale: Decreased basal contact area and insufficient copying of details may affect denture retention. Overextension of the impression can generate ulcers and also affect denture stability.

Materials used for secondary equalized impressions

- Handpiece and a motor (compressed air or electricity driven)
- EPPIC Acrylic Resin Kit (DHPro)
- Tray adhesive for PVS
- Medium viscosity A-silicone (Silagum mono or medium, DMG)
- High Viscosity A-silicone (Silagum light, DMG)
- Silicone Dispenser with respective mixing tips
- Spatula #36
- Stanley knife
- Clinical examination instruments (tweezers and dental mirror)
- Cotton buds
- Wax sticks
- Wax sheets
- Superglue
- Dental Stone (type III)

Figure 18.12: Silicone, mixing tips, and custom trays for secondary impressions.

Making the custom trays

Technique: Make the custom trays with acrylic resin by first adding powder to the cast, and then saturating it with the monomer liquid. It is important that the trays are made respecting the pliable area of the cast (Figures 18.11 A and B) and the edges are smooth.


a


b

Figure 18.13: (a) Upper custom tray with a handle in the anterior region. (b) Lower custom tray with a handle in the anterior region and two supporting platforms in the region of premolars.

Tray adjustment

Technique: The main key to good impressions is a well-adjusted custom tray. The tray should encompass the entire basal area without overextended areas (which must be assessed by the movement of the perioral musculature) or compression (assessed by the visualization of ischemic areas under the transparent tray).


a


b

Figure 18.14: (a) Upper custom tray try-in. (b) Custom lower tray try-in.

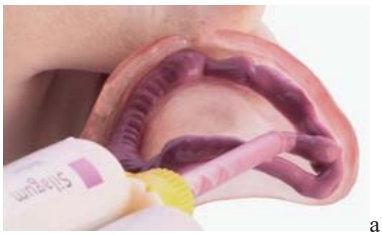
Application of the tray adhesive

Technique: Apply the tray adhesive (with cotton buds) to the entire inner aspect of the tray including about 5 mm of the outer edges. Wait at least 5 minutes to apply the impression material.

Figure 18.15: Adhesive used to bond the silicone to the custom trays.

Application of silicone to the custom trays

Technique: Apply the fluid silicone using the dispenser and spread it with spatula #36, which improves the flow direction of the material.


a


b


c


d

Figure 18.16: (a) Application of silicone in the upper tray; (b) Silicone spreading on upper tray with spatula #36; (c) Application of silicone to the lower tray; (d) Silicone spreading on the lower tray.

Secondary impression

Technique: Insert the tray into the patient's mouth and apply light pressure to settle it. When taking impression of the upper arch, ask the patient to open wide and then pout protruding their lips.

For the lower arch, ask the patient to open their mouth wide after the tray placement, place the tip of the tongue on the palate, move it to both sides, and then project it out.


a

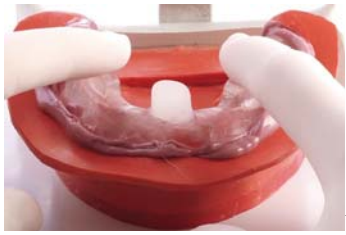

b

Figure 18.17: (a) Upper secondary impression. (b) Lower secondary impression.

Evaluation of the impression

Technique: Assessing the quality of the impression to ensure that the impression material is covering the entire tray. Exposed acrylic is evidence of areas of compression or overextension. In such cases, these areas should be adjusted.

After making adjustments, an impression adhesive should be applied over the adjusted area if necessary.


a

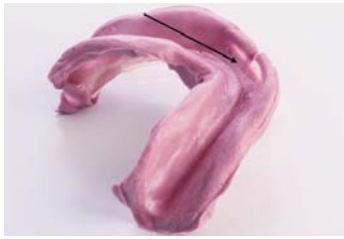

b

Figure 18.18: (a) Adequate upper impression. (b) Lower impression with a compression area (arrow) that must be worn down.

Equalization of the secondary impression

Technique: Similar to the first stage of the secondary impression: Apply the fluid silicone (light or X-light) with a dispenser and spread it using spatula #36.

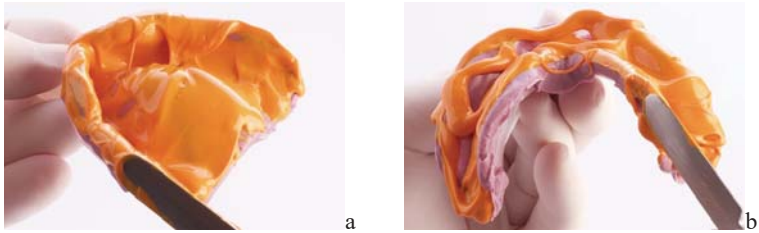


Figure 18.19: (a) Light silicone spreading to the upper impression using spatula #36; (b) Application of light silicone to the lower impression.

Final secondary impression

Technique: Similar to the first stage of secondary impression (page 429).

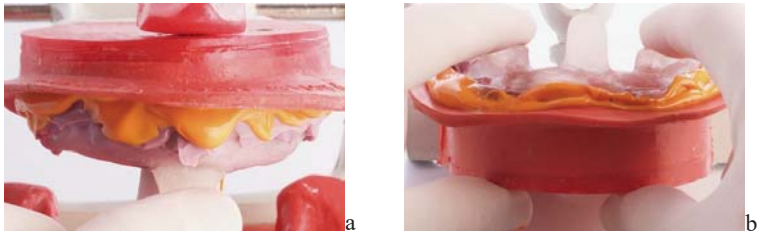
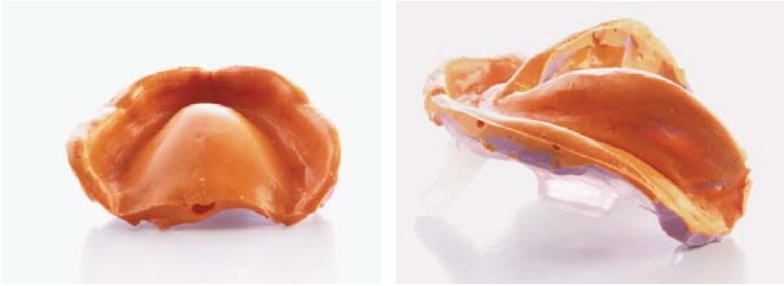


Figure 18.20: (a) Refinement of the upper secondary impression with light silicone. (b) Refinement of the lower secondary impression with light silicone.

Evaluation of the final secondary impression

Technique: The impression should be assessed in terms of material coverage over the entire tray, including the edges.

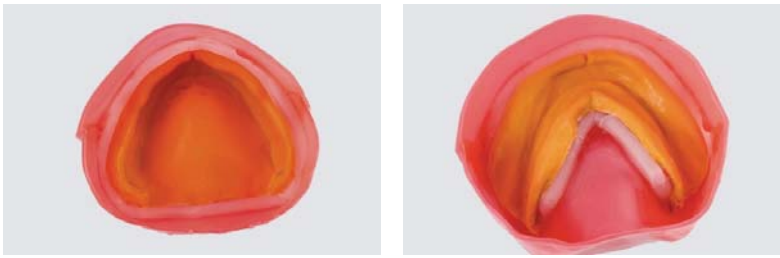


a b

Figure 18.21: (a) Adequate upper impression. (b) Adequate lower impression.

Boxing the impression

Technique: Surround the impression using beading wax and superglue 3 mm below the edges of the impression material to create a dam for the stone. The dam should be made using baseplate wax sheets, which should be halved (lengthways). For the lower impression, the space occupied by the tongue in the mouth should also be boxed in. Boxing the impression aims to safeguard its edges.



a b

Figure 18.22: (a) Upper impression casing. (b) Lower impression casing.

Making the working casts

Impression casting should be done with dental stone type III, following the manufacturer's recommendation.

Figure 18.23: Upper working cast.

Preparation of the base of the registration rims

Technique: Make special trays using self-polymerizing acrylic resin (AAR) following the sprinkle-on acrylic technique (spread the powder over the surface of the cast then apply the liquid monomer). It is important that they are properly limited to the pliable area with a thickness of 1.5 mm.

Figure 18.24: Upper resin baseplate.

Adjustment of the lower registration rim

Materials needed to make the registration wax rims:

- Working casts with their respective acrylic bases
- Marking pencil
- Dry Tip Compass
- Flexible ruler
- Wax #7
- Flame lamp
- Spatula #7
- Spatula #36
- LeCron-type spatula
- Blowtorch
- Curve of Spee forming plate
- Solid Vaseline

Lower occlusal plane (rim wax)

Technique: The lower rim wax should be completed first because bone resorption occurs at the expense of the two bone plates simultaneously, which allows the lower occlusal plane to be made according to the muscular neutral zone.

Objective: To establish the lower occlusal plane guide in the zone of muscular neutrality leaving it at the height of the moist line of the lower lip and ending flush with the retromolar pad.

Rationale: The area of muscular neutrality is the region where the artificial teeth should be positioned to ensure the maximum stability of the lower denture.

Outlining the anatomical landmarks

The reference lines

Technique: We must initially outline the retromolar pad, the external oblique line, and the mylohyoid line. With a dry point compass, the distance between the marked external oblique line and mylohyoid line can be gauged and a new line should be drawn in the middle between them (CL).

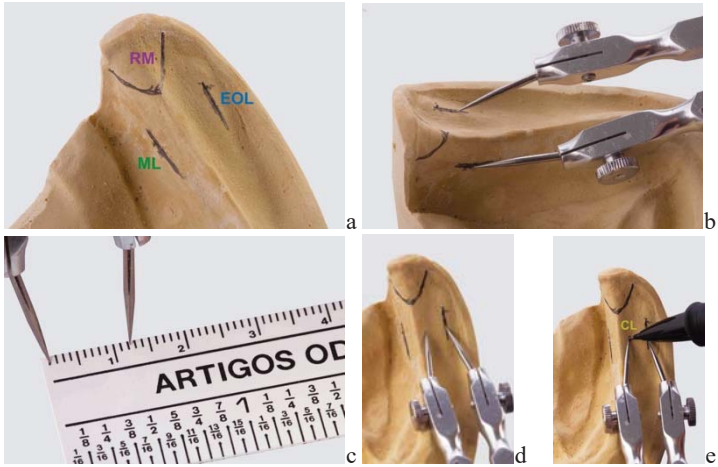


Figure 18.25: (a) Demarcation of the retromolar pad (RM) the mylohyoid line (ML), and the external oblique line (EOL). (b-c) Measurement of the distance between the outer external oblique and mylohyoid lines. (d-e) Marking a new line in the middle of the lines initially marked (CL).

Outlining the reference lines

Technique: Using a flexible ruler, the posterior reference lines between CL and the crest of the residual alveolar ridge are determined. At the anterior region, a line is drawn at the largest portion of the residual ridge. Such demarcations are done in the outer area of the cast to guide the confection of the lower orientation plane in the zone of muscular neutrality.

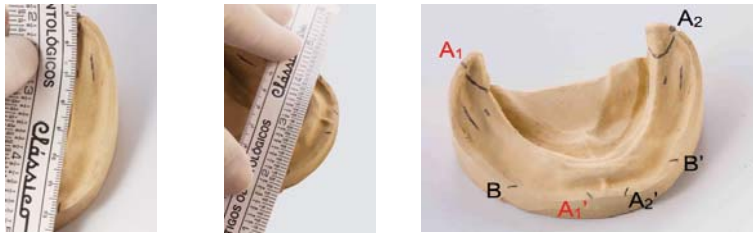
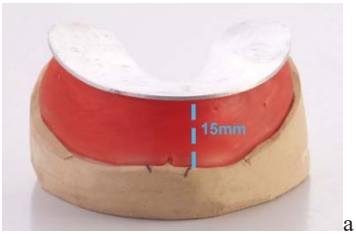


Figure 18.26: (a) Demarcation of the posterior reference line between CL and the crest of the alveolar ridge. (b) Demarcation of the anterior reference line. (c) Cast with the demarcation of the reference lines. (A, A') posteriors lines. (B, B') anterior lines.

Lower wax rim

Technique: Place the wax rim onto the acrylic baseplate at a height of 15 mm in the anterior region ending at zero with the retromolar pad. The conformation can be done using the curve of Spee forming plate. According to the pre-demarcated points in the cast, draw the lines on the occlusal surface of the rim, leaving the plane 1cm thick and 5mm on either side of the line in the posterior region, 7mm buccally, and 3mm lingually in the anterior region.



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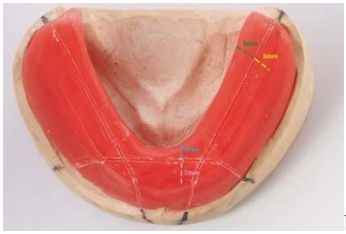

b

Figure 18.27: (a) Curve of Spee forming plate on the lower rim wax. (b) Lower rim wax with demarcated reference lines.

Technique: Using the curve of Spee plate, adjust the orientation plane leaving it at the height of the moist line of the lower lip (the line between the labial mucosa and the vermillion) and always end at zero with the retromolar pad.

Figure 18.28: Adjusted wax rim.

Upper wax rim

Technique: The height of the wax rim should be calculated according to the rest vertical dimension (RVD). Subsequently, 2mm is reduced from the rim arriving at the patient's occlusion vertical dimension (OVD).

Objective: Establish the upper orientation plane directly in the patient's mouth by recording the vertical dimension of occlusion and centric relationship.

Rationale: The rims must be carefully made, as they will guide the assembly of the teeth.

Materials used to manufacture the upper rim wax

- Upper acrylic baseplate
- Lower rim wax rim correctly adjusted
- Baseplate wax #7
- Flame lamp
- Spatula #7
- Spatula #36
- LeCron-type spatula
- Blowtorch
- Solid Vaseline
- Willis bite gauge

Rest Vertical Dimension (RVD) record

Technique: Using the physiological muscle relaxation technique, register the RVD at physiologic position and then the orientation plane is made directly in the patient's mouth with the wax rim softened to facilitate the record when the patient bites down.

Figure 18.29: Upper rim wax according to the rest vertical dimension (RVD).

Modified Paterson Wear

Technique: Warming up the two rims: the patient is asked to rub the two rims, reducing the vertical dimension by 2mm, which is equivalent to the freeway space. With this procedure, the wax rims will be customized to the patient's articular fossa.

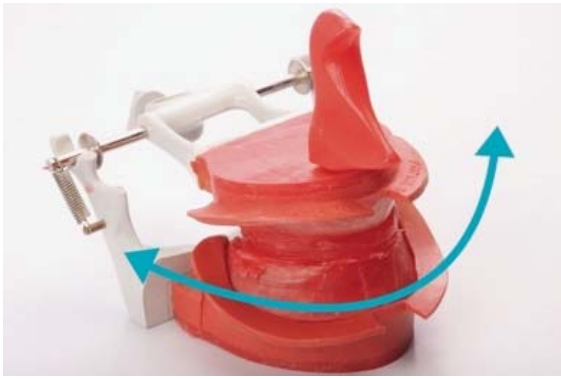


Figure 18.30: Modified Paterson wear.

Obtaining the occlusion vertical dimension (OVD)

Technique: The OVD is obtained after reducing 2mm for the freeway space of speech.

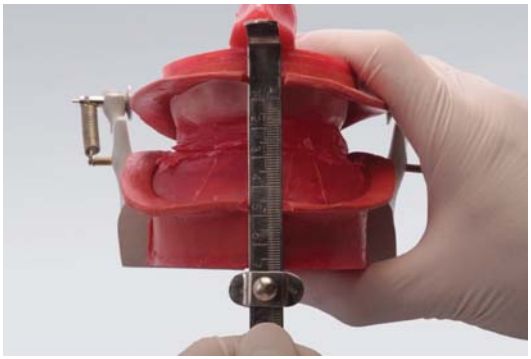


Figure 18.31: Upper and lower orientation planes (rims) recording the OVD.

Esthetic evaluation of the rims

Technique: Evaluate the wax rims *in situ* checking the OVD and CR.

Figure 18.32: Wax rims try-in.

Assembly of the Upper Cast in an SAA

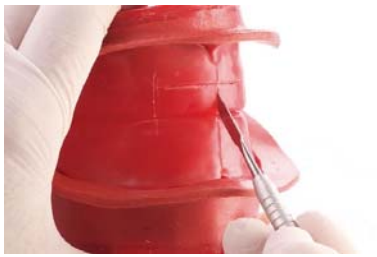
Technique: With mounting stone or die stone type IV secure upper cast in the articulator using the Camper plane platform (see the sequence in Chapter 6).

Figure 18.33: Assembling the upper rim using the Camper Plane plate.

Reference Lines

Technique: After assembling the upper cast, the orientation plane is returned to the patient's mouth to demarcate the reference lines and lock the planes together. Draw the midline according to the patient's facial features, high smile line (Forced Smile), and canine-to-canine line leaving the patient's lips closed by marking the end of the labial commissure.

a



b

Figure 18.34: (a) Reference lines for teeth selection and assembly: midline (ML), high smile line (SL), and canine-to-canine line (CCL); (b) Draw the midline in the lower plane so as not to lose the references during the assembly of the teeth.

Locking the Rims Together

Technique: Lock the wax rims together using clamps to prevent movement that could compromise the records taken. Remove the entire assembly from the patient's mouth.

a

b

Figure 18.35: (a) Locking the orientation planes together. (b) Orientation planes are recorded in the position determined by the professional.

Assembly of the Lower Cast in a Semi Adjustable Articulator (SAA)

Technique: The SAA is turned upside down and the lower cast is fixed to the articulator using some plaster, making sure that the incisal guide pin is touching the plate (see the sequence in Chapter 6).

Figure 18.36: Transport from the lower cast to the articulator.

Teeth Try-In

Technique: The function and esthetics must be checked, since this assembly will be cloned for the preparation of the multipurpose surgical guide for positioning the implants. Check the esthetics, speech, anterior, and lateral guidance. Check the assembly of teeth in the anterior region making sure they do not touch.

Objective: To ensure the esthetics, speech, and function of the prosthesis.

Rationale: The surgical guide is made based on the approved position of the teeth.

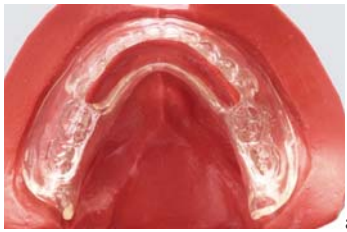

a


b

Figure 18.37: (a) Assembly of the teeth from the laboratory. (b) Try-in in the mouth.

Surgical Guide Evaluation

Technique: Once the position of the teeth is approved by both the patient and the dentist, the prosthesis is then cloned (in this case, the lower denture). The surgical guide is evaluated with regards to the occlusion and adaptation of the alveolar ridge. The guide is extremely useful to determine the position of the implants to be placed and used for impressions, as well as for occlusal registration.


a


b

Figure 18.38: (a) Test of the surgical guide over the alveolar ridge. (b) Surgical guide in position testing the occlusion.

Implant Placement

Technique: The implants must be installed aided by the surgical guide in Chapter 1. The selection of tapered mini abutments is based on the estimated final gingival margin (in the case of immediate loading) or real (when the selection is made late in the process).


a

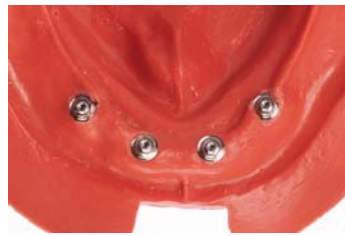

b

Figure 18.39: (a) Implants in place. (b) Tapered mini abutments installed.

Transfer Impression

Transfer Union

Technique: The procedure for impressions of multiple implants for screwed prosthesis was described in Chapter 17. In the case of complete dentures, the surgical guide also acts as an impression tray. The transfers should be joined to provide dimensional accuracy and stability among the implants. For this, dental floss, die pins, or resin segments may be used as the means for attaching the transfers. Acrylic resin is used to join such devices

following the Nealon technique (page 229). Make sure that the joining devices do not interfere with the surgical guide.

Objective: To transfer the position of the implants accurately.

Rationale: Passive insertion of the metal bar is fundamental for the longevity of both prosthesis and implants. Inaccurate impressions lead to maladjustment and non-passive frameworks.

Materials Used for the Transfer Impression

- Multifunctional guide
- Prosthetic kit for the implant
- Transfers for tapered mini abutment for open tray
- Self-polymerizing acrylic resin (Pattern GC) or similar
- Paintbrush size 0
- Tray adhesive for PVS
- Monophase A-silicone (Silagum) or Polyether (Impregum)
- Silicone for Occlusal registration (O'Bite)


a

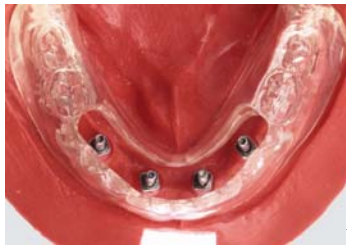
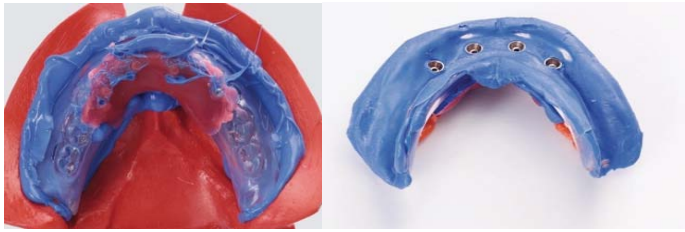

b

Figure 18.40: (a) Transfers joined using acrylic resin. (b) Verification of the absence of the interference of the transfers in the multifunctional guide.

Preparation of the Guide and Silicone Application

Technique: The occlusal opening of the guide must be sealed, which may be achieved using micropore-type tape (page 412)(or baseplate wax #7. The tray adhesive must be applied to the inner portion of the multifunctional guide (page 428). The impression must be made according to the one-step technique using monocomponent A, silicone, or regular polyether. To facilitate impression removal, the transfer screws should break through the sealing material of the surgical guide.



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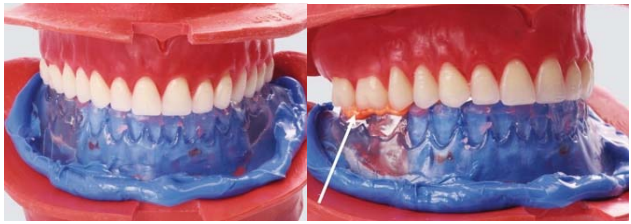

d e

Figure 18.41: (a) Lower transfer impression. Note that the transfer screws are exposed to facilitate removal of the impression. (b) Lower transfer impression outcome. (c) The open tray transfer screw of the tapered mini abutment must be replaced by the tapered cylinder screw so that there is no occlusal interference. (d) Occlusal relationship of the multifunctional guide in relation to the opposing teeth. (e) Intermaxillary record using silicone for registration (arrow), with the patient in occlusion.

Intermaxillary Record

Technique: In order to test the occlusion between the surgical guide and the opposing arch, the transfer screws are removed and replaced with the screws of the tapered mini-abutments cylinders because they will certainly interfere in this process. The guide should then be checked to ensure its correct occlusal relation with the opposing teeth and also with the OVD.

The registration is made using specific silicone for occlusal registration (O'Bite) and a silicone dispenser. The material is dispensed onto the surgical guide and the patient is asked to bite down (see Figure 18.41 e).

Superstructure Try-In

Technique: The impression must reflect the correct positioning of the transfers and ideally, but not necessarily, have the entire surface of the guide covered by the impression material. The impression must be sent to the laboratory to make the cast, which will be assembled in an articulator and a silicone template will be made over the guide to direct the construction of the metal bar (framework) that will support the denture.

Materials Used for Bar Try-In

- Prosthetic kit for the implant
- Acrylic resin (Pattern GC)
- Paintbrush size 0
- Occlusal registration silicone (O'Bite)
- Dental probe
- Radiographic films

Bar Try-In for Adaptation and Passive Insertion

Technique: The passive insertion and removal of the bar in relation to the implants must be checked. There are three approaches to test passivity:

1. Intimate contact of the cylinders with the platform of the tapered mini abutments: This should be evaluated both visually and using a probe (page 286). Periapical radiographs may also be useful for this step.

2. Single Screw Test: Only install one screw in one of the implants at the ends and visually check by palpation if the bar remains seated on the other abutments, especially the one at the opposite end.

3. Smoothness when installing all screws: Evidence of resistance when tightening the screws indicates possible tensions between the screw and the abutment, which may compromise the concept of passive insertion.

In the case of non-passivity, the bar must be sectioned and welded together (page 289).

a b

Figure 18.42: (a) Metal bar in the cast in relation to the upper arch. (b) Metal bar try-in.

Teeth try-in over the Bar

Technique: Esthetics and function must be checked, and the pattern of assembly should be compatible with that from the previous step.

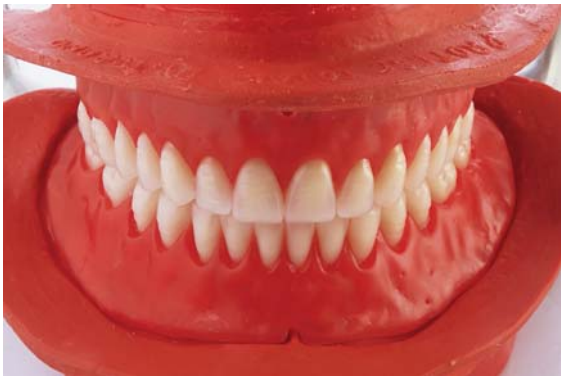

Figure 18.43: Teeth try-in.

Denture Installation

Materials Used to Install the denture

- Final complete denture
- Thin and medium marking paper
- Miller tweezers
- EPPIC Acrylic Resin Kit (DHPro)
- Motor, handpiece, and contra-angle
- Implant prosthetic kit

Denture Installation

Technique: The installation is completed by screwing the denture (bearing the concept of passive insertion in mind, page 446). The occlusal adjustment is completed with the aid of a leaf-gauge (Chapter 6) and medium thickness marking paper (100µm blue). Occlusal refinement is achieved using fine two-color marking paper (Chapter 13). The screw access orifice should be sealed with PTFE tape and the occlusal access closed with composite resin (page 388).

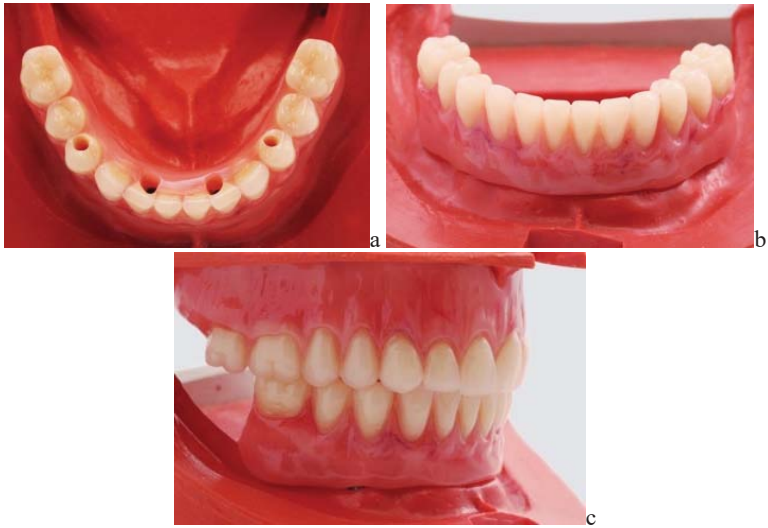

Figure 18.44: (a) Occlusal view of the denture. (b) Buccal view of the denture. (c) Occlusal relationship of the lower denture with the opposing arch.