



UNDERSTANDING AND DEVELOPING A MORPHOLOGIC OCCLUSION

Robert L. Schneider

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To Norman D. French

Master dental technician, husband, father, teacher, pillar of strength and my best friend. He gave so much and asked so little. May his enthusiasm for living be passed to everyone whose life he touched. Thanks Norm, we miss you.

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INTRODUCTION

This text will provide a description of tooth anatomy and contour, and illustrate proper embrasure form and contact position, which will serve as a reference in developing a morphologic tooth contour and occlusal scheme. Also included is a description of the basic determinants of occlusion and how they affect tooth morphology and occlusion. A step by step sequence for a wax build-up technique will be described with corresponding illustrations to facilitate mastering these concepts and techniques.

There are several wax build-up techniques used for teaching occlusal morphology and occlusion. These are primarily the work of H.L. Lundeen, E.V. Payne and P.K. Thomas. Lundeen and Payne advocated a technique for the development of a cusp marginal ridge occlusion, such as frequently found in nature. Thomas advocated the cusp fossa concept additive waxing technique. In theory this will direct forces of occlusion down the long axis of the tooth, and concentrate forces to specific convex points on the occlusal surface. The technique advocated in this text will be a modification of the P. K. Thomas technique that has been used by the author for many years.

This text is designed to be a teaching tool and reference for the student of dental morphology, elements of occlusion and additive waxing techniques. The ultimate goal of this text is to provide the dental technician and dental practitioner team a reference and means of mutual understanding and communication when developing a physiologic dental restoration for their patients.

Special thanks are in order for Dr. Tom Huff for his enthusiasm and help in developing this manual. Without his knowledge and input this would not have become a reality.

CHAPTER 1

FUNDAMENTALS OF OCCLUSION

The majority of humans exhibit a mutually protected occlusion. This means the posterior or multi-cusped teeth, protect the anterior teeth from excessive horizontal forces in the maximum intercuspation position. In the closure position the stamp cusps of the maxillary and mandibular teeth fit into definite fossae of opposing teeth without slide or horizontal interferences and direct their forces into the long axis of the teeth. Therefore, the forces on the anterior teeth are lighter or negligible compared to the posterior teeth.

Also, the anterior teeth protect the posterior teeth in eccentric movements. As soon as the posterior teeth disengage, the anterior teeth (primarily the cuspids) guide the movement so that all of the posterior teeth disclude; with the exception of the mandibular first premolar in protrusive. In an ideal physiologic occlusion the six maxillary anterior teeth engage the six mandibular and first premolars in protrusive movements. In a lateral movement the incisors and cuspids would stop the closure. All posterior teeth would immediately disengage. It is necessary to keep in mind that the pathways of the condyles in the glenoid fossa govern these movements.

If the teeth do not occlude in a cusp-fossa relationship at the instant of closure, and a "centric slide" or mesial deflection of the mandibular teeth occurs, the mandibular incisors can slide into the maxillary incisors and cause spreading of these teeth in many instances. Also significant wear patterns on the teeth may be noted which further the development of a pathologic occlusal patterns. This can be very destructive to the dentition, both anterior and posterior.

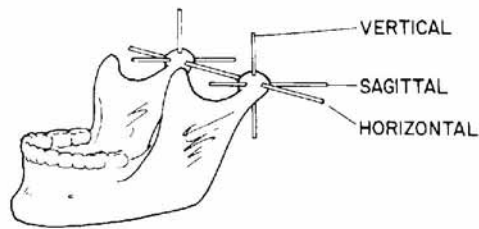
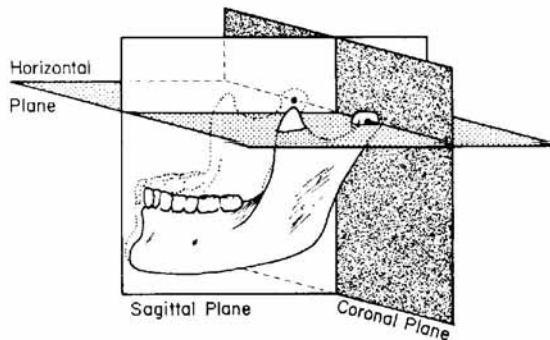
Most natural dentitions exhibit a cusp-marginal ridge relationship. The majority of prosthodontists follow the cusp-fossa concept when restoring a dentition. Each major cusp of every posterior tooth fits into a definite fossa on its opposing tooth. These cusps will seat in to their fossa without deflection or interferences with all cusps touching their vertical stops simultaneously.

The major cusps that fit into fossae are called "**functional**" cusps and are the principal milling or chewing cusps. The functional cusps of the maxillary teeth are the lingual cusps and the functional cusps of the mandibular teeth are the buccal cusps.

The buccal cusps of the maxillary teeth and the lingual cusps of the mandibular teeth are non-occluding, under normal circumstances, and are used to grasp and shear food. These cusps are called the "**non-functional**" cusps.

Leading out of the fossae are developmental and supplemental grooves. These are the pathways for the stamp cusps to move through. Each pathway is a gothic arch tracing determined by the movements of the mandible.

Also when evaluating mandibular movements it should be remembered in what planes the movements are described. For our purposes we will be concerned with the horizontal plane, vertical (coronal) plane and the sagittal planes.



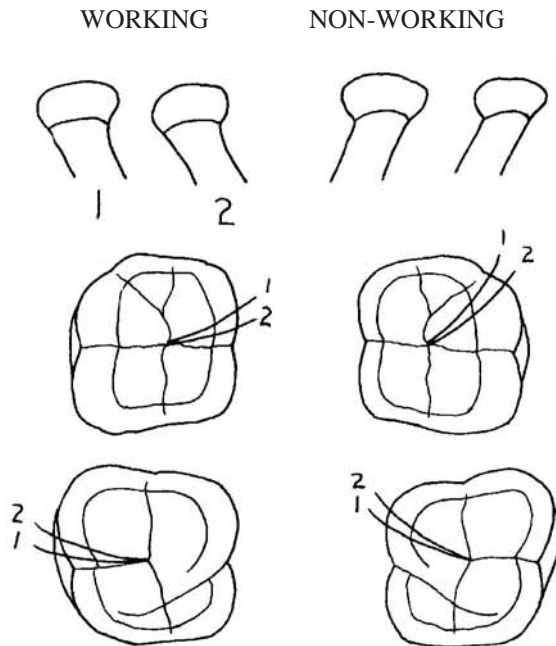
Elements of Occlusion

1. The closer the tooth to the mid-sagittal plane, the more acute the angle between the working and non-working grooves.
2. The greater the intercondylar distance, the more mesial the working and nonworking grooves of the maxillary teeth. the reverse is true of the mandibular teeth - more distal.
3. The lesser the intercondylar distance, the more distal the working and nonworking grooves on the maxillary teeth. the reverse is true of the mandibular teeth - more mesial.
4. The greater the intercondylar distance, the greater the lingual concavity of the maxillary anterior teeth.

5. The greater the side shift (bennett movement), the more distal the non-working grooves on the maxillary teeth. the reverse is true of the mandibular teeth - more mesial.
6. The greater the angle of the eminentia the deeper the fossa and higher the cusps **may** be.¹
7. The lesser the angle of the eminentia, the shorter the cusps and shallower the fossa **must** be.
8. The greater the vertical overlap of the anterior teeth, the longer the posterior cusps **may** be. the lesser the vertical overlap the shorter the cusps of the posterior teeth **must** be.
9. The greater the bennet shift the shorter the cusps **must** be. the lesser the side shift the longer the cusps **may** be.
10. The greater the bennet shift the greater the concavity is needed for the maxillary anterior teeth to permit disclusion.
11. The more nearly parallel the plane of occlusion is to the angle of the eminentia the shorter the cusps **must** be. the more the plane of occlusion diverges from the angle of the eminentia, the longer the cusps **may** be.

For example, the following diagram demonstrates the effect of intercondylar distance on the direction and placement of ridges and grooves.

¹ Exception - The greater the horizontal overlap of the maxillary anterior teeth, the shorter the cusps of the posterior teeth **must** be. The lesser the overjet the higher the cusps **may** be.



These rules and principles hold true when the mandible moves during function under the confines of the muscles, ligaments and glenoid fossa at the base of the skull. The fully adjustable articulator is designed in such a way to duplicate all of the pathways of movement in any given patient after a pantographic recording has been obtained starting with an accurate hinge axis location. This is because this position can be repeatedly relocated and is a reliable condylar position.

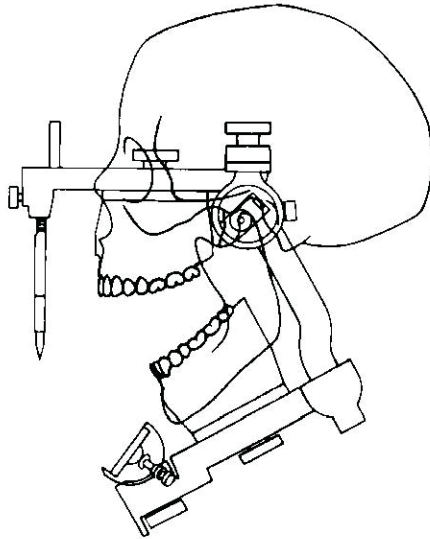
Functions of the Articulator

1. Simulates jaw movement.
2. Aids in diagnosis and treatment planning and patient presentation.
3. Facilitates accurate fabrication of occlusal surfaces of dental restorations.
4. Allows easier arrangement of teeth.

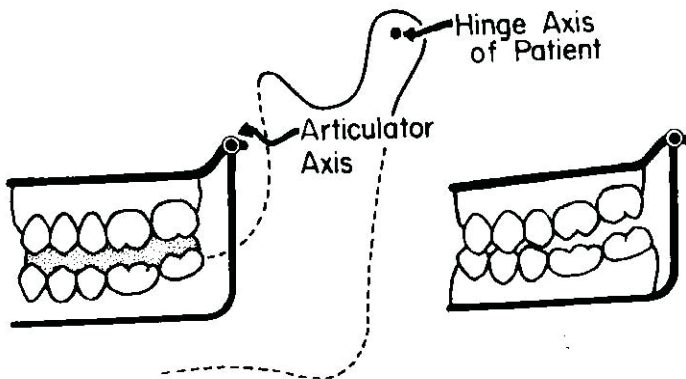
5. Accurately repeats jaw movements.
6. Maintains occlusal vertical dimension of casts.
7. Allows for alteration of the occlusal vertical dimension of casts.
8. When used with a face-bow, orients the maxillary cast in the same position to the condyles as in the patient's skull.

Advantages of an Articulator

1. Allows improved observation of the occlusion.
2. The patient's tongue, cheeks and saliva are eliminated.
3. Movement of the teeth is eliminated.
4. Can be adjustable to meet the patient's needs and duplicate the patient's anatomy.
5. Maintains a centric position.
6. Maintains a vertical dimension, regardless of wear of the casts.
7. Greatly improves communication with the laboratory technician.

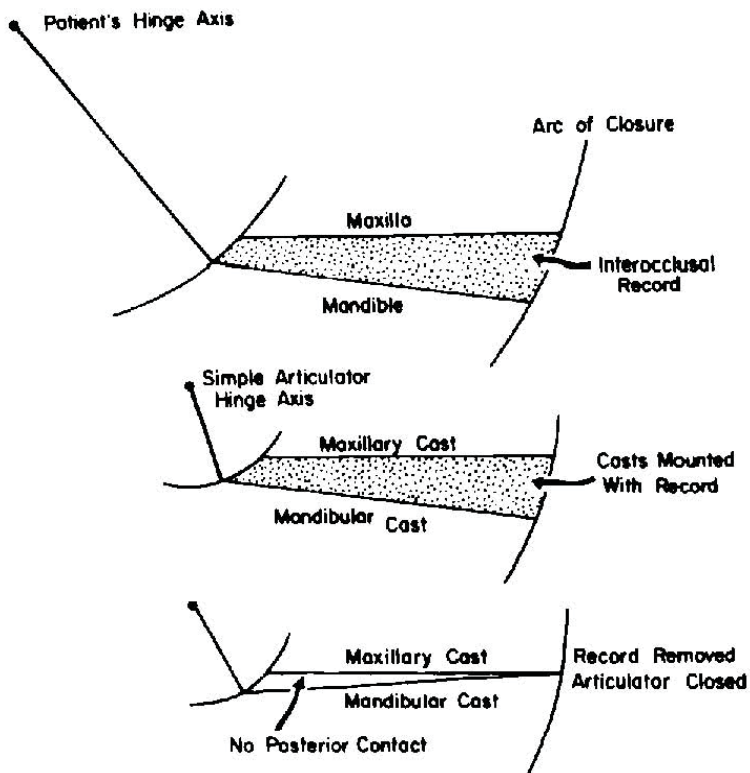


The articulator relates the patient's maxilla in the same relationship to the base of the skull and condyles. This allows the development of accurate occlusal anatomy in the same relationship that it is observed in the patient. Graphic from Teledyne-Hanau.

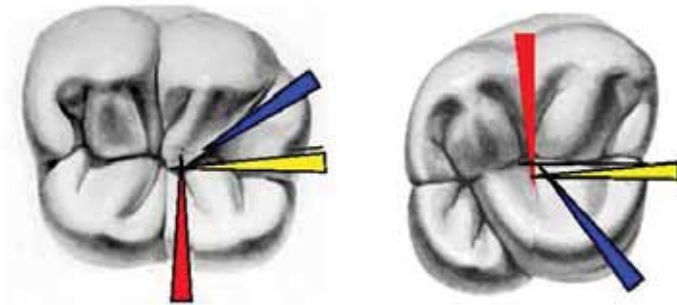


The use of simple articulators in larger more complex restorations may result in significant occlusal inaccuracies. This may require excessive chairside adjustment time or inaccurate compensation by the laboratory in

the fabrication of the restoration. Graphic from Teledyne-Hanau.



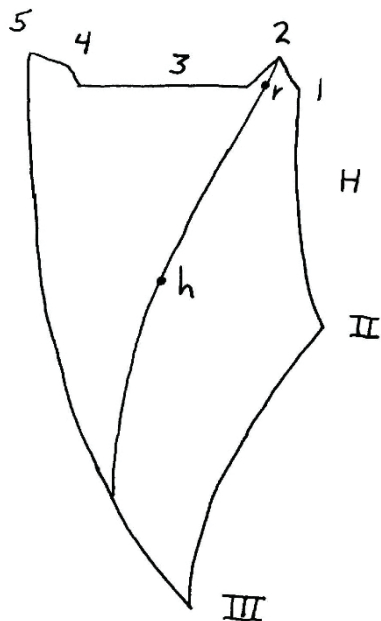
The comparison of the arc of closure with differences in articulator hinge axis location. Graphic from Teledyne-Hanau.



Gothic arch tracings on mandibular and maxillary right first molars representing the movement of the opposing working cusps. Non-working movement (**BLUE**), working movement (**RED**), and protrusive movement (**YELLOW**)

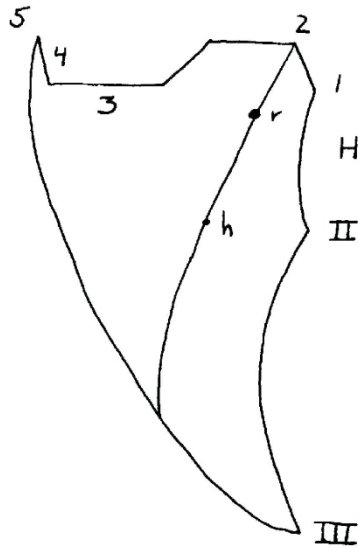
Posselt's envelope of motion in the sagittal plane

Class I Occlusion



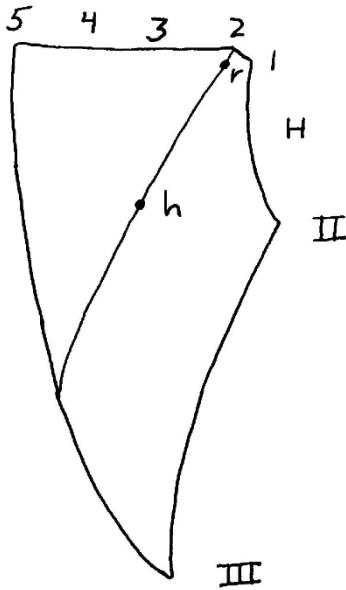
Posselt's envelope of motion in the sagittal plane

Class II Occlusion



Posselt's envelope of motion in the sagittal plane

Class III Occlusion



Key to Posselt's Illustrations

1 - 5 = Tooth guided movements

1 - 2 = Centric slide

2 = Maximum intercuspation

4 - 5 = Overlap of anterior teeth

5 = Maximum protrusive movement

H = Hinging

h = Habitual opening - not a border movement

r = rest position - for Class I (2 - 4 mm), Class II (4 - 6 mm), Class III (1 - 3 mm)

To help the reader better understand some basic fundamentals of occlusion and how mandibular border movements relate to dental anatomy several rules of clinical significance will be given as illustrations:

- The primary influence of the immediate side shift is on the width of the central developmental groove of the posterior teeth.
- The primary influence of the progressive side shift is on the buccolingual inclinations of the cusps of the posterior teeth. It also has an influence on the direction of the ridges and grooves of the posterior teeth.
- The protrusive condylar inclination has a primary influence on the mesial inclines of the mandibular cusp and the distal inclines of the maxillary cusps. This will also influence cusp height and cusp angle.
- The wider the intercondylar distance the more distal the working and non-working paths and grooves on the mandibular and maxillary posterior teeth.

"It must be recognized that the person operating the instrument is more important than the instrument. If dentists understand their articulators and their deficiencies they can compensate for their inherent inadequacies..."

—Dr. Carl O. Boucher

"A good practitioner doesn't need a fully adjustable articulator... just a fully adjustable mind."

—Dr. Harold Shavell

CHAPTER 2

EMBRASURES, PROXIMAL CONTACTS, AND CUSP RELATIONSHIPS/ORIENTATION

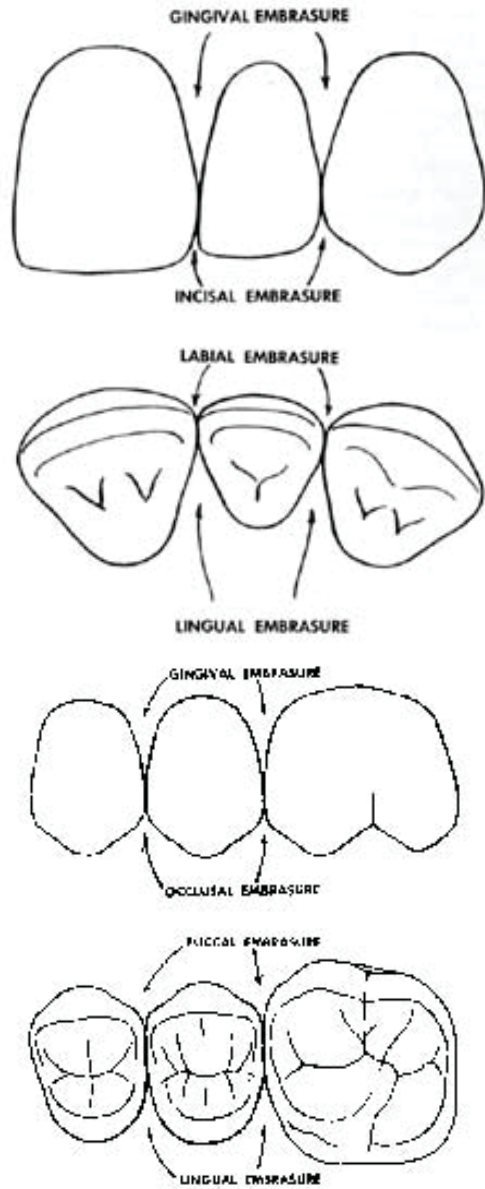
Embrasures

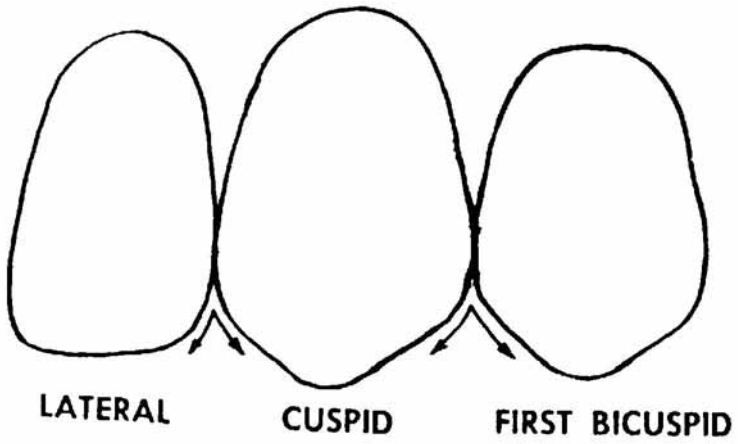
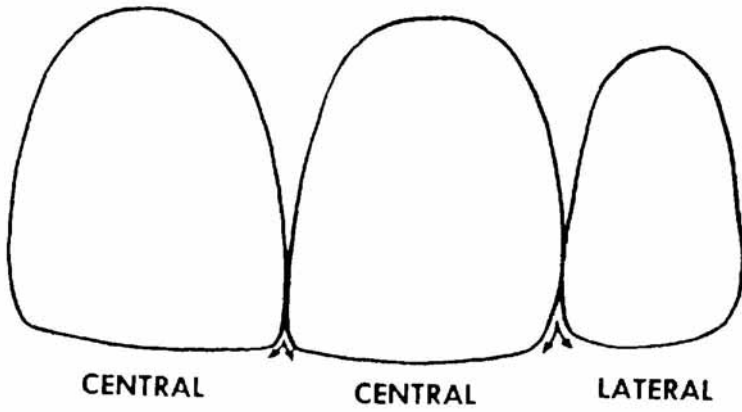
Embrasures form contours and proximal contacts. An attempt should be made to duplicate nature as closely as possible. Embrasures are found on the lingual, facial, occlusal or incisal and gingival surfaces of the teeth.

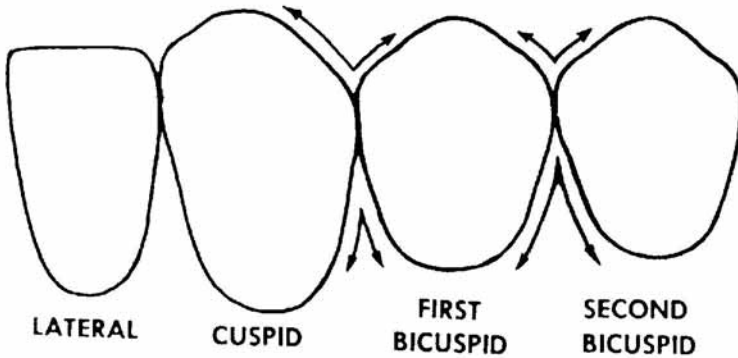
Embrasures that are too wide can create food traps and cause food impaction that can promote periodontal disease. Also in the anterior area this may contribute to less than optimal esthetic situation.

Embrasures that are over closed or squared off can create food traps gingival to the proximal contacts and prevent proper cleansing by the tongue and cheeks and the patient. This also will contribute to the development of periodontal problems around the affected teeth. The over contoured or bulky gingival embrasures can also impinge upon the soft tissues contributing to inflammation and periodontal disease. A physiologic contour is mandatory for optimal gingival health.

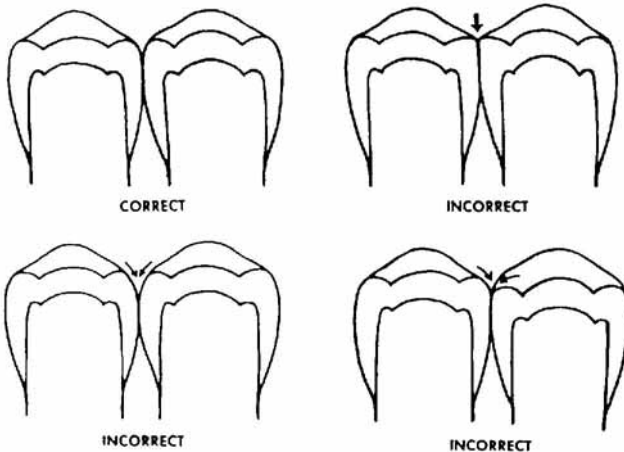
Most often in sets of like teeth (central incisors, premolars, etc.) the adjacent embrasures are mirror images of each other so that a symmetrical pattern is developed. Embrasures are very similar in transition teeth, distal of cuspid and mesial of first premolar or mesial of cuspid and distal of lateral incisor. All embrasures, lingual, facial, occlusal or incisal and gingival can generally be described in this manner.

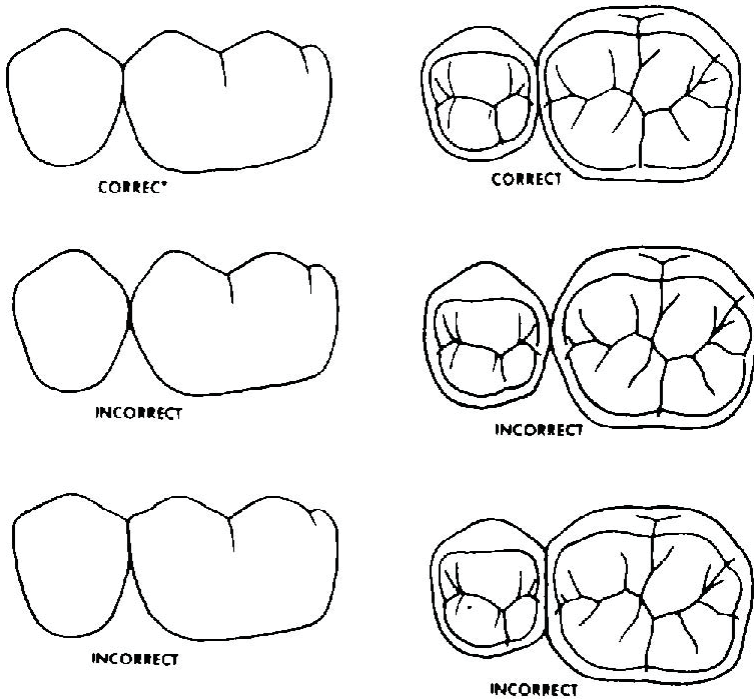






Occlusal embrasures are dependent on the placement and shape of the marginal ridges. There should be enough of an embrasure for dental floss to lie in but not disappear. Regular dental floss should "snap" and not shred when passed through the embrasure. It is also necessary to have enough room for food escape during mastication. Too wide an opening can create wedging and food impaction. The marginal ridges should be at equal heights on adjacent teeth and be slightly rounded. Uneven or marginal ridges that are too deep may result in chronic food impaction.

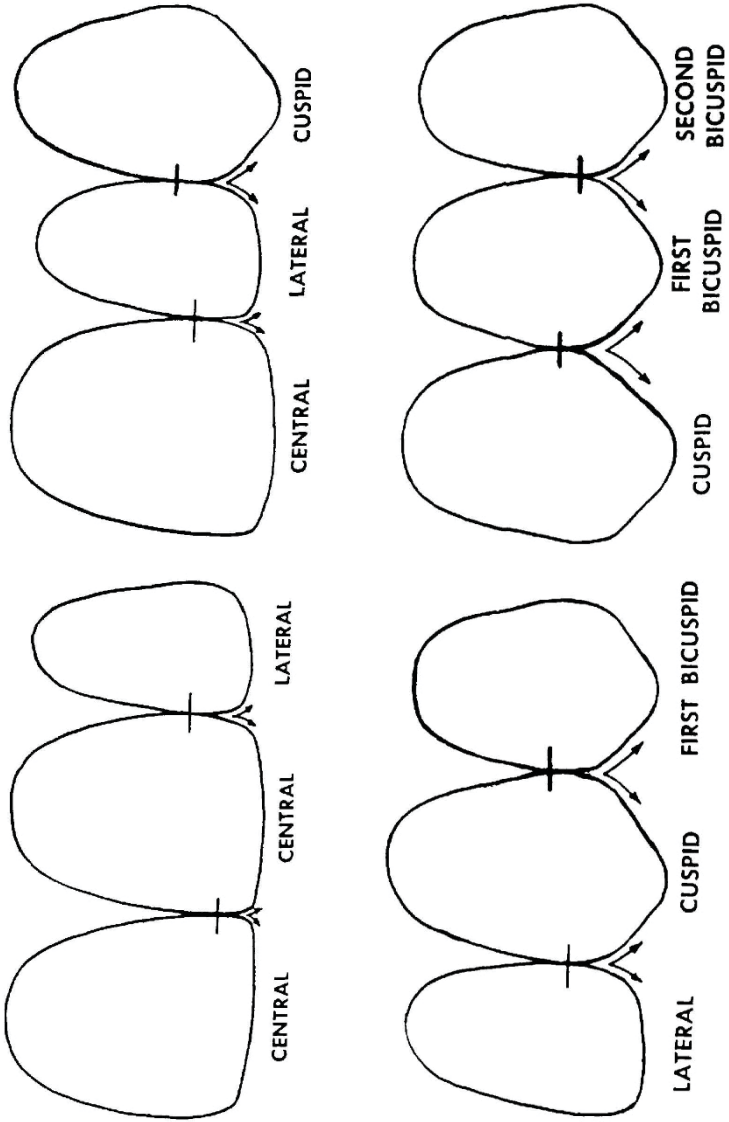


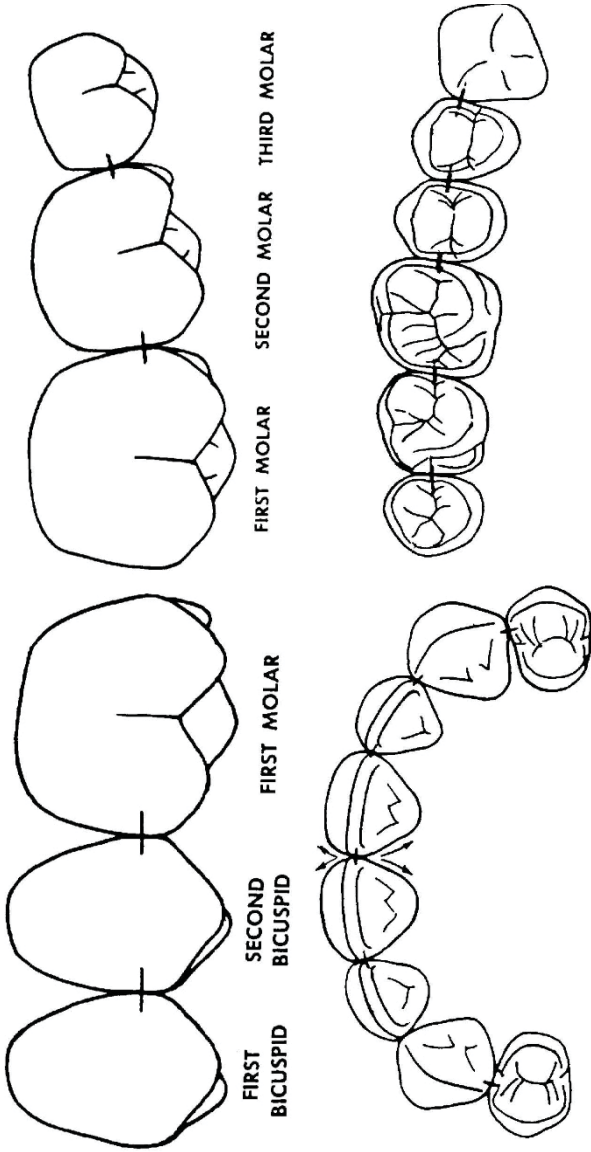


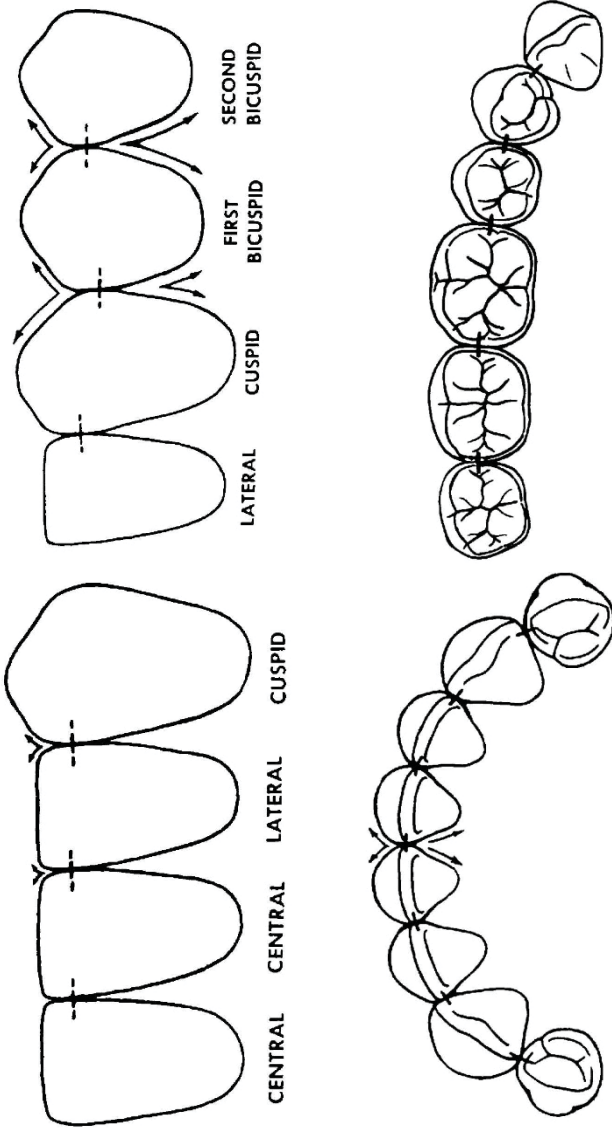
Proximal Contacts

A common misconception is that a proximal contact is a point. Remember that proximal contact areas are not points. The shape of the contact is dependent upon the age of the patient and the amount of wear on their teeth. Younger people have less wear on their teeth and have smaller proximal contact areas. As people age and their teeth wear the proximal contact areas become more broad and flat. The contact area is also dependent on other factors such as anatomy, shape, and position of the individual tooth and occasionally the periodontal condition of the teeth. The contact point will vary in its position on the tooth depending on the tooth's position in the arch. From the facial view the contact point is located gradually more gingival as the arch progresses distal. From the occlusal view the contact point will progress more lingual/palatal as the arch progresses distal. This is true for both the maxillary and mandibular arches.

From a facial or lingual view, in an esthetic area or the maxillary arch, the proximal contact may depend on the contour and position of the periodontal tissues. If there has been a significant loss of hard and soft tissues in the interproximal it usually is desirable to lengthen a contact area from occlusal to gingival maintaining a proper embrasure form at the gingival. This will help to prevent "black triangle disease" which can result following periodontal surgery or as the result of chronic periodontal disease, when large amounts of interproximal tissues are lost. This proximal contact area modification aids in attaining optimal esthetics and allows the patient to perform hygiene procedures to maintain the health of the periodontium.

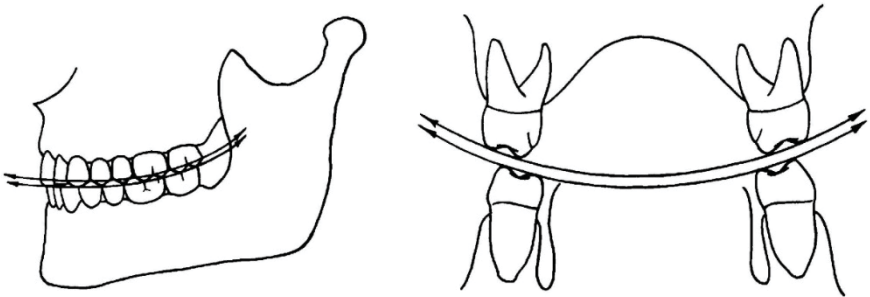




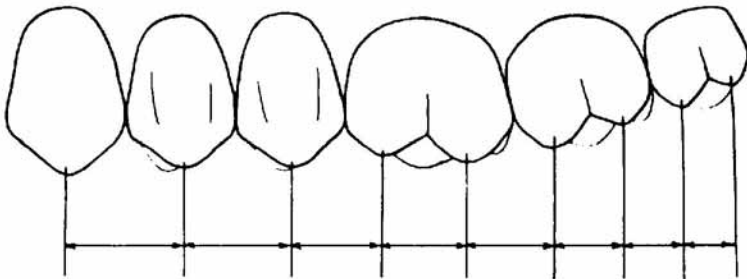


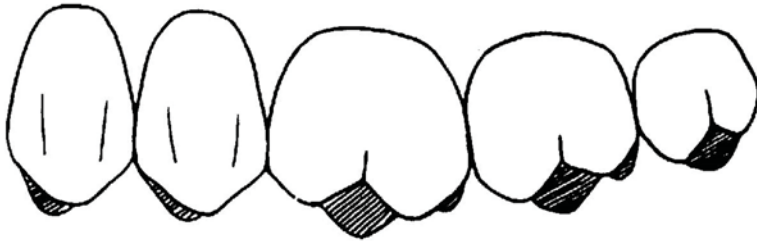
Cusp Relationships/Orientation

The cusp length and relationship can be determined following development of the anterior component of occlusion. When the cuspid guidance has been determined it is much easier to facilitate cusp placement and length. The cusps should be placed to develop an anterior-posterior curve (Spee) and also a medial-lateral curve (Wilson), as is seen in unrestored natural dentition. These curves can be visualized as a segment of a sphere with the center being located in the glabella.

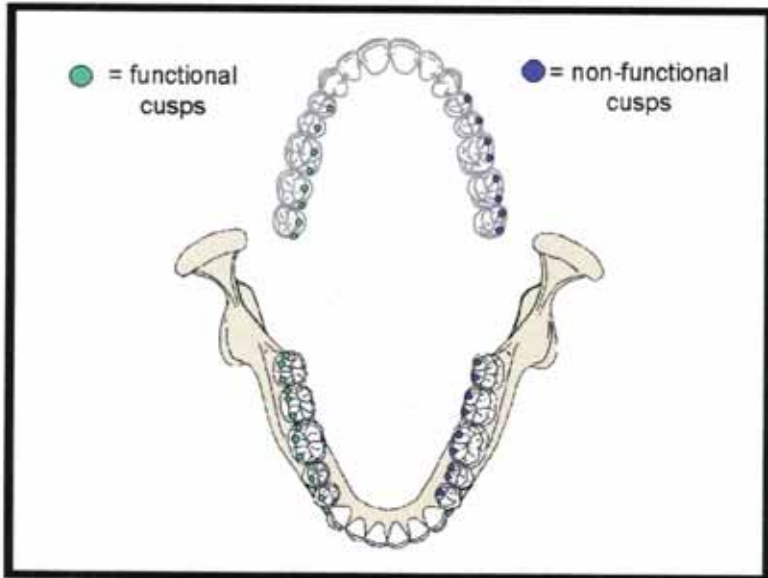


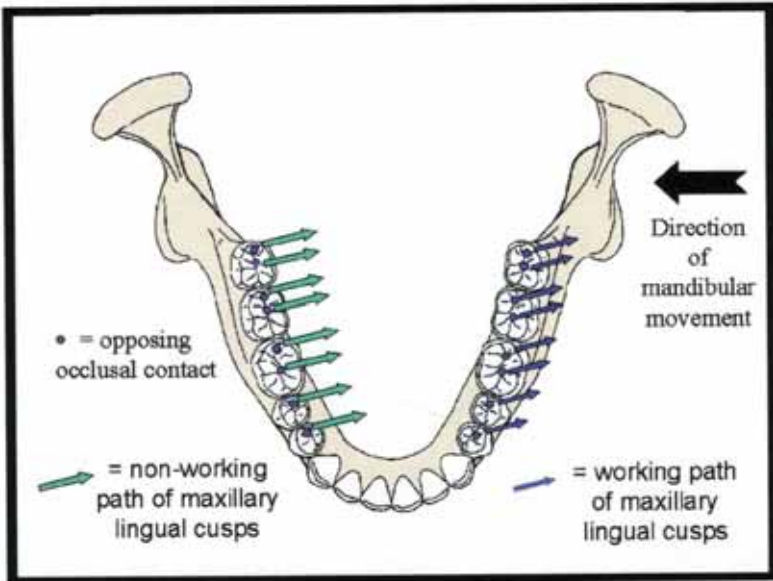
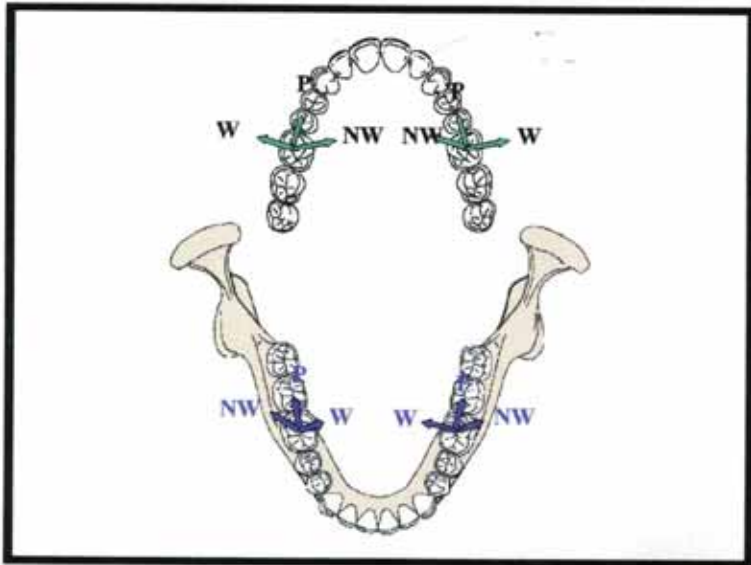
The cusp tips tend to become closer, mesio-distally, as the arch proceeds distally. Also note the lowest position in the maxillary arch in a horizontal/lateral plane is the mesial lingual cusp of the maxillary first molar. The next lowest position is the distal buccal cusp of the maxillary first molar.

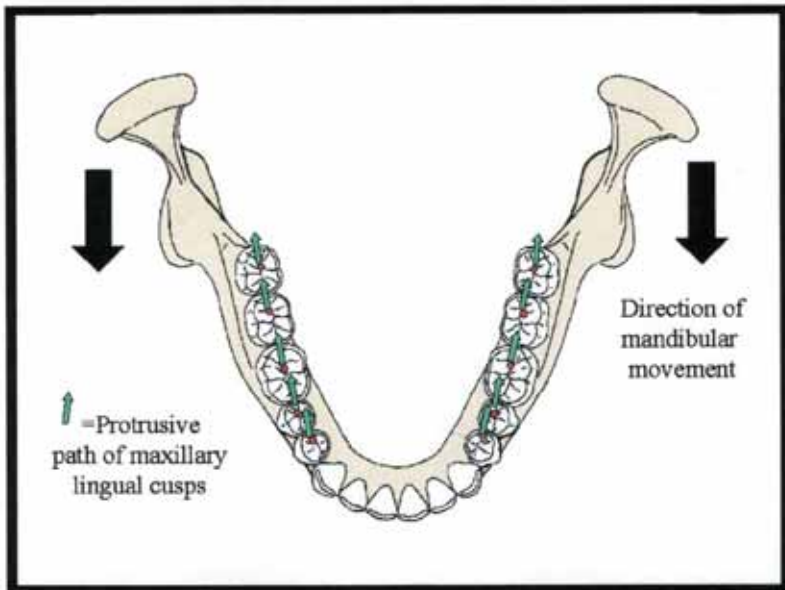
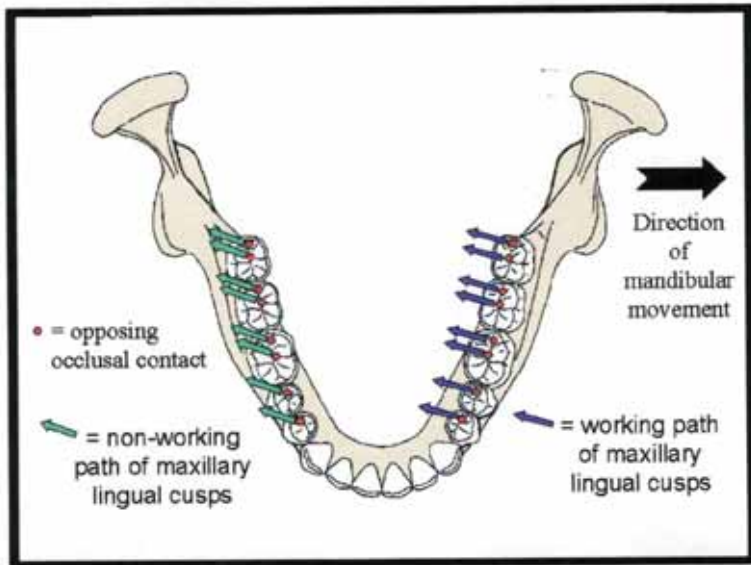


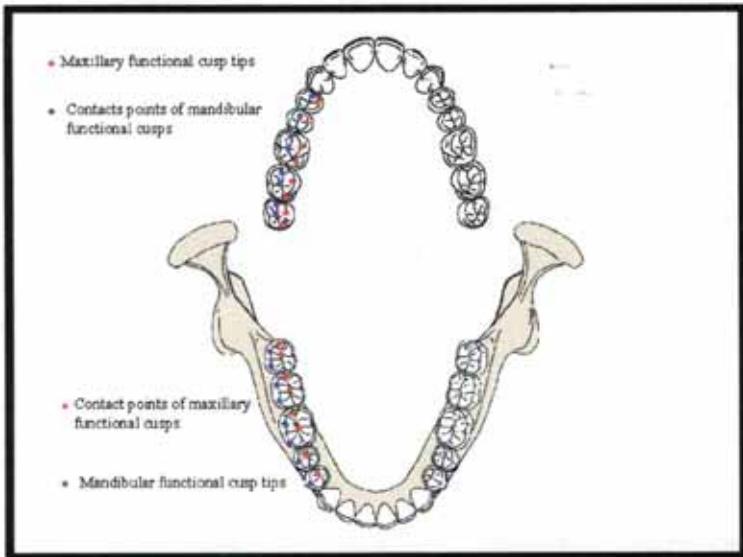


In lateral excursions, with cuspid guidance and disclusion, none of the posterior cusps should contact or interfere with this movement. Also, there should be a slightly increased distance between the cusps as the arch progresses distally. This will prevent formation of a group function type of occlusion when/if the canine cusp tip wears, thus decreasing the angle of the cuspid disclusion. With a moderate amount of wear in the cuspid cusp tips a cuspid-protected occlusion is maintained.









CHAPTER 3

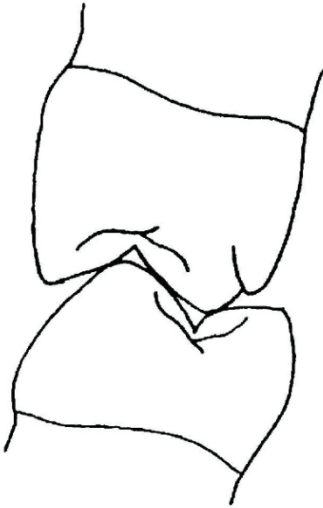
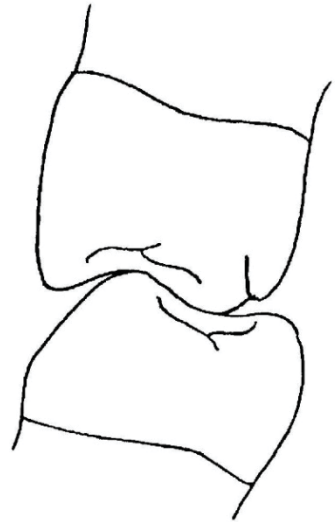
ADDITIVE WAX BUILD-UP TECHNIQUE

Introduction

The wax build-up technique is a series of orderly steps that consist of adding wax to the dies in a predetermined step-by-step procedure. This technique will form tooth morphology that is relative to the patient's determinants of occlusion. The use of colored waxes for different components of the occlusal surface will help you more easily visualize the process.

Wax patterns developed using this technique not only simulate natural tooth morphology, but apply the patient's determinants of occlusion to the meaning and purpose of ridge and groove direction, lingual contour of the maxillary anterior teeth, cusp height and placement, and fossa placement and depth. Placing the occlusal components in this manner will allow you to develop an optimal occlusal scheme for the patient.

The rationale for this philosophy is that convex surfaces allow a contact pattern with small area contacts that distribute forces over a wider area of the occlusal surface. This should minimize occlusal wear and occlusal stresses and trauma to the teeth and the investing tissues. Flat occlusal surfaces may not disclude as rapidly as convex surfaces and may result in excess occlusal wear and potential occlusal trauma, which result in reduced masticatory efficiency.

CONVEX SURFACES**FLAT SURFACES**

The technique that will be described is a modification of the P.K. Thomas technique to develop cusp fossa occlusal contacts.

Purpose of the Wax Build-up Technique

1. To position the cusp in a favorable position with the opposing tooth.
2. To eliminate lateral interference between cusps in working, non-working and protrusive mandibular movements.
3. To develop occlusal surfaces that look like natural teeth, with well-developed cusps, irregularly contoured ridges and grooves. The fused surfaces of the wax build-up technique will result in a more natural appearing tooth.
4. To allow pathways of movement or escape of cusps through developmental and supplemental grooves in an organized manner to harmonize with the natural condylar movements of the mandible.
5. To direct the forces of the cusps into and down the long axis of the tooth, placing it as near the center of the cusps as possible. This is where it can withstand occlusal forces most favorably.

6. To develop contact areas, embrasure form and axial contours of the crowns of the teeth to prevent pathological (iatrogenic) processes to occur to the investing tissues of the dentition.

Armamentarium for Wax Build-up Technique

A wax build-up technique differs from the traditional wax carving procedures, therefore, different instrumentation is recommended to facilitate mastering the proposed procedure. The P. K. Thomas waxing instruments are suggested for the wax build-up procedure and will be used in the following description.

The PKT # 1 and 2 are curved and tapered and used to add molten wax in small increments and smoothing small areas. The # 3 is a pointed burnisher which should not have a sharp point but rather smooth and rounded on both the large and smaller ends. The # 3 is used to perfect and enhance the developmental and supplemental grooves, rather than carving in these grooves. The # 4 is a modified carver used to remove wax from the external surface during initial contouring and removing wax at the marginal areas, and can also be used to carry molten wax in larger increments than the # 1 and 2. The # 5 instrument is a carver used to remove excess wax from cusp ridges. The concave shape of this carver will maintain the convexity of the cusp ridges.

A powdered wax or zinc stearate powder is usually used for dusting the waxed surfaces to determine occlusal contacts and prevent wax from adhering to opposing surfaces during waxing. This allows the operator to observe desirable and undesirable eccentric contact points/areas. Powdered wax or zinc stearate is recommended, as it will not contaminate the wax pattern and burns out cleanly with no residue to affect the casting. A waxing brush is used to apply the white powder to the occlusal surface. A double-ended brush is recommended as the stiffer end can be used to remove excess pieces of loose wax and smooth surface of the wax and the softer end is used to dust the powder on the occlusal surface.

Multiple colors of inlay wax will also be used for teaching this technique and to help the clinician visualize the various components of the occlusal surface.

Oversize single posterior teeth and life size dental arches can also be used in demonstrating this technique of tooth development.

Basic Steps for Wax Build-up Procedures

1. Locate and place functional cusp cones (yellow wax)
2. Place triangular ridge and buccal/lingual cusp contours on functional cusp (red wax)
3. Locate and place non-functional cusp cones (yellow wax)
4. Place triangular ridge and buccal/lingual cusp contours on non-functional cusp (green wax)
5. Place mesial and distal cusp ridges on functional cusp (blue wax)
6. Place mesial and distal cusp ridges on non-functional cusp (blue wax)
7. Place mesial and distal marginal ridges (yellow wax)
8. Fill in and refine supplemental anatomy (green wax)

The above steps will be discussed in more detail in the following description of the technique and illustrations:

1. Locate and place functional cusp cones (yellow)

The cones should be waxed so they are symmetrical in shape and smooth. Normally they cannot be placed with one large drop of wax, but must be gradually built-up with successive layers. After the correct height and dimensions are obtained, using the PKT # 1 and 2, they can be smoothed and shaped with the PKT # 4.

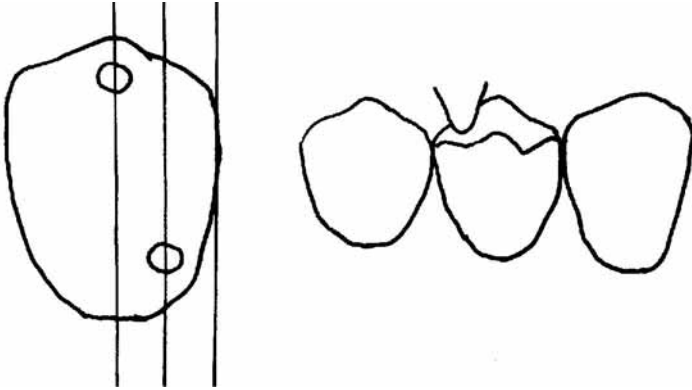
The articulator should move freely so lateral and protrusive movements can be addressed as the waxing procedure progresses.

The RULE OF THIRDS serves as a guide as to the tentative placement of cusps in a bucco-lingual relationship

A. Lingual (functional) cones of the maxillary teeth - Maintain a mental picture of the Curve of Spee and Curve of Wilson at this stage.

(1) The lingual cone of the maxillary first premolar is placed. It is more mesial than the buccal cusp and placed in the mesial one-fourth of the occlusal outline. It is placed to fit into the projected distal fossa of the

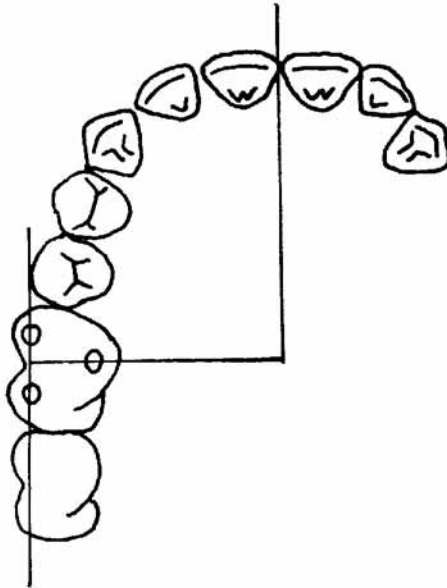
mandibular first premolar. The lingual cusp of the maxillary first premolar is slightly shorter or the same length as the buccal cusp.



(2) The second premolar is the same as the buccal cusp or slightly longer. The cusp is placed to fit into the projected distal fossa or just mesial of the distal marginal ridge of the mandibular second premolar.



(3) The mesial lingual cusp of the maxillary first molar is placed to fit just distal in the central fossa of the mandibular first molar, just distal of the buccal triangular ridge. The mesial lingual cusp of the maxillary first molar is longer than the buccal cusps. It is framed or centered by the two buccal cusps.



In a working movement this cusp will disclude between the lingual cusps of the mandibular first molar. In a non-working movement the mesial lingual cusp will pass in a distal direction between the disto-buccal cusp and the distal cusp following the disto-buccal groove. In a protrusive relationship it will travel distally in the central groove of the mandibular first molar.

(4) The distal lingual cusp is projected into the distal fossa of the mandibular first molar. The cusp will pass distal to the disto-lingual cusp of the mandibular first molar in a working movement and in a non-working movement it passes through the embrasure of the first and second mandibular molars.

(5) The rules for the maxillary second molar are essentially the same as that for the maxillary first molar.

B. Buccal (functional) cones of the mandibular teeth.

(1) The buccal cusps of the mandibular premolars are placed to fit into the proposed mesial fossae of the maxillary premolars just distal to the mesial marginal ridge. The length of the cones is adjusted to have overlap of cusps. Visualize the final length of the cusp fitting into the depth of the fossa of the maxillary premolars. The cusps are then checked in lateral movements

to see that they do not contact by at least 1 millimeter. In the non-working movement the mandibular buccal cusp moves mesial to the lingual cusps of the maxillary premolar. The mesial slope of the buccal cusp of the mandibular first premolar may contact the distal slope of the maxillary cuspid in the protrusive and latero-protrusive position in harmony with the anterior teeth.

(2) The mesial buccal cusp of the mandibular first molar should fit into the mesial fossa of the maxillary first molar just distal to the mesial marginal ridge. In a working movement this cusp moves mesial to the mesial buccal cusp of the maxillary first molar and in a non-working movement it works mesial to the mesial lingual cusp of the maxillary first premolar.

(3) The distal buccal cusp occludes into the central fossa of the maxillary first molar and works through the buccal groove in the working movement, directly between the mesial buccal and distal buccal cusps. In the non-working movement the distal buccal cusp of the mandibular first molar passes through a groove in the mesial lingual cusp of the maxillary first molar in a lingual direction (Stuart's Groove).

(4) The distal cusp of the mandibular molar will ride into the distal fossa of the maxillary first molar and work out of the distal buccal developmental groove distal to the distal buccal cusp.

(5) The rules for the mandibular second molar are the same as the mandibular first molar.

2. Place triangular ridge and buccal/lingual cusp contours on functional cusp (red)

The triangular ridges are irregular in shape and size. The ridge is narrower toward the cusp tip and varies in direction and width as it approaches the central developmental groove. The surface is also slightly irregular, however, mostly convex. The mid one-half to middle one-third is the primary contact area in maximum intercuspation, and is usually the widest mesial distal portion of the ridge. Larger cusps have larger triangular ridges. The shapes are slightly different according to their function.

3. Locate and place non-functional cusp cones (yellow)

A. Buccal (non-functional) cones of the maxillary teeth.

(1) Begin with the buccal cone of the maxillary first premolar and work distally. The maximum length of the cones is determined by the lateral-protrusive relationship. In a balanced occlusion the opposing cones would touch. In a mutually protected occlusion, the cones will miss by approximately 1 millimeter. The cones are placed in the proper mesio-distal relationship as determined by the following rules:

- a. The distances between the cones are progressively less from the cuspid to the third molar.
- b. The cones of the maxillary premolars should pass distal to the mandibular buccal cones without touching by about 1 millimeter.
- c. The buccal cusps of the maxillary molars should pass through embrasures following the same rule of clearance of at least 1 millimeter.
- d. The Curve of Spee and Curve of Wilson should always be kept in mind as these cones are placed.
- e. The length of the buccal cones must be long enough to provide overlap of the tips of the mandibular buccal cusps.
- f. The distal buccal cusp of the maxillary first molar will usually be longer than the other cusps due to the allowance for more clearance by the smaller distal cusp of the mandibular first molar.

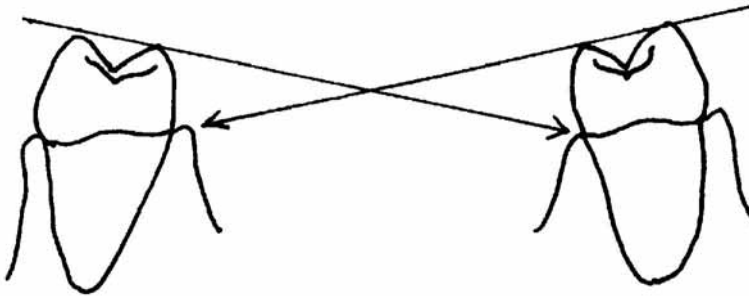
B. Lingual (non-functional) cones of the mandibular teeth.

(1) The mandibular first premolar lingual cone is a very small cusp and is placed well centered in a mesio-distal direction. It is long enough to provide a distal fossa and triangular ridge. In the working position, it will pass mesial to the lingual cusp of the maxillary first premolar.

(2) The mandibular second premolar may have one or two lingual cusps. This will be dependent on the shape of the linguo-axial surface. If the lingual surface is more square and the lingual embrasure adjacent to the molar is well filled, it would have two cusps, a mesial and distal. If the lingual cusp is more rounded it will have one lingual cusp. The mandibular second premolar lingual cusps are longer than the first premolars but shorter than

the mandibular molars. The lingual cusp of the maxillary second premolar passes between the two lingual cusps, or over them, in the working movement.

(3) The lingual cones of the mandibular molars are placed in a vertical position over the lingual axial surface. Occlusally these cones are lined up with the lingual surface. The height is determined by an imaginary plane through the tips of the mandibular buccal cusp tips and the lingual cusp tips that should fall approximately at the gingival crest on the opposite side of the arch.



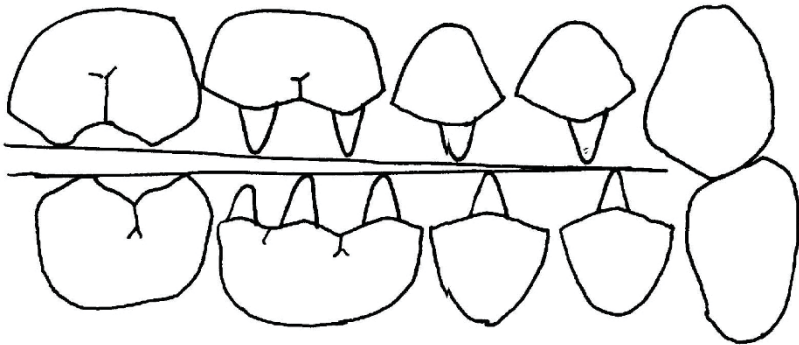
The cones are placed so they will not interfere with working movements and should be evaluated in all possible movements. They should be placed to form natural occlusal surfaces without distorting cusps.

(4) Placement of **all** of the cones, at this point, should be checked for:

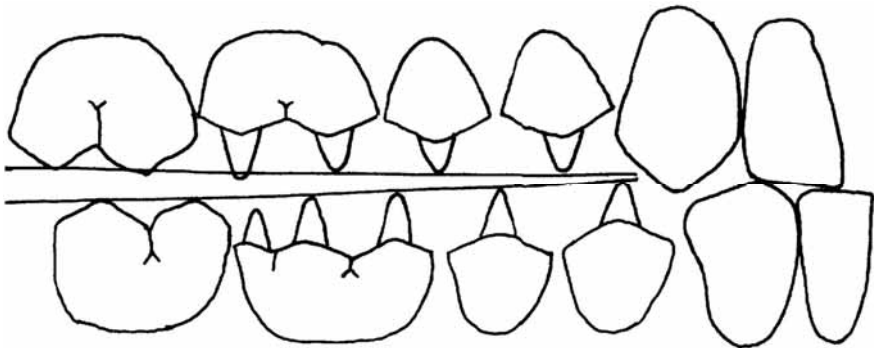
- a. Alignment
- b. Curvature - Anterior-posterior and medio-lateral.
- c. Positioned for natural appearance of anatomy.
- d. Clearance by no less than 1 millimeter in working movements.
- e. Position of all stamp cusps in relation to the projected fossae.
- f. Check mesial lingual cone of maxillary molars for framing in buccal cusps.
- g. Check lingual cusps of maxillary premolars for mesial orientation in comparison to the buccal cusp.

- h. Check spacing of maxillary buccal cones so that space between them is gradually diminishing as the arch goes toward the third molar.

Position of the buccal cones in working movement. Note gradual separation as the arch moves toward the distal.

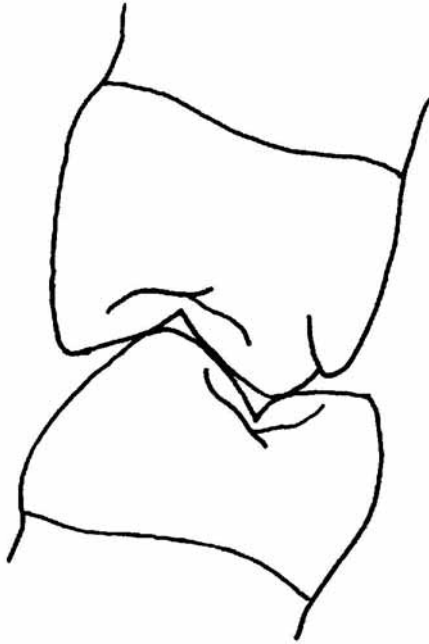


Position of the buccal cones in protrusive position. Note the gradual separation as the arch progresses distal.



4. Place triangular ridge and buccal/lingual cusp contours on non-functional cusp (green)

The description of the non-functional cusp triangular ridges is the same as for the functional cusp. When completed the functional and non-functional cusp triangular ridges and cusp ridges should contact in three points, a tripod effect, to provide stabilized occlusal contacts as illustrated.



5. Place mesial and distal cusp ridges on functional cusp (blue)

6. Place mesial and distal cusp ridges on non-functional cusp (blue)

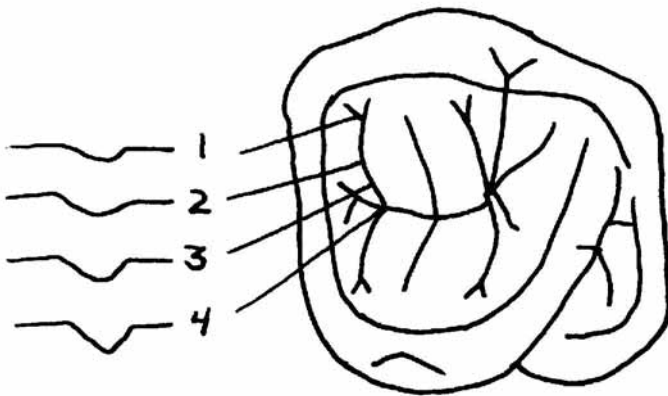
When completed the cusp ridges on the functional cusps and non-functional cusps will be approximately parallel when placed end to end, although increasing in amount of separation as the arch progresses distal. For example, in a right working movement the maxillary first premolar mesial buccal cusp ridge is approximately parallel to the mandibular first premolar distal buccal cusp ridge. A similar situation exists for the buccal or lingual cusps, depending on the direction of movement.

7. Place mesial and distal marginal ridges (yellow)

8. Fill in and refine supplemental anatomy (green)

A. Qualities of a groove:

- (1) A groove always varies in width from origin to termination.
- (2) A groove always varies in depth from origin to termination.
- (3) A groove curves throughout its course from origin to termination.



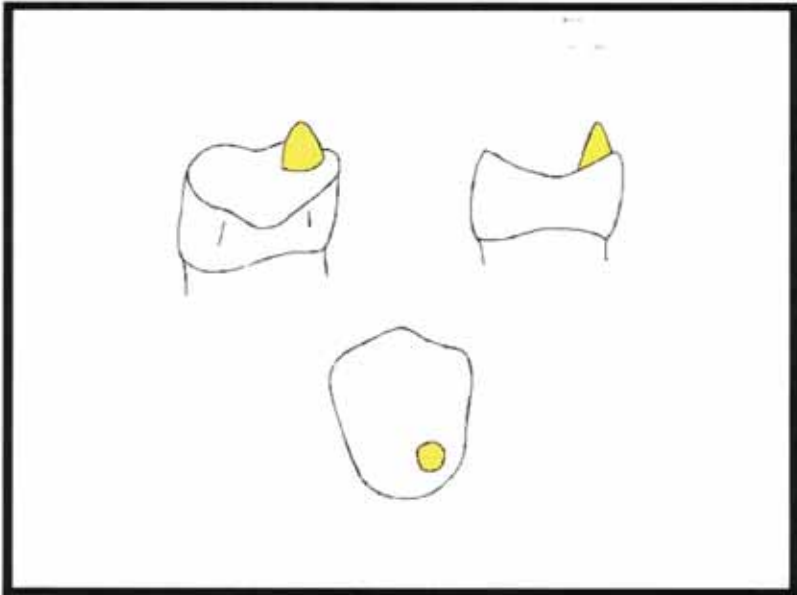
The most common difficulty in learning this technique is using too much wax to start forming the occlusal surfaces and build-up to the final contours. Also the working positions and gradual separation of the buccal (maxillary and mandibular) cusp tips as they progress distal requires attention to detail and practice.

Triangular ridges are placed second because of protrusive movements and because they provide for the primary shearing of food in the mastication process. Marginal ridges are subservient to the cusps that fit in the fossa and must not contact them in any excursive mandibular movement.

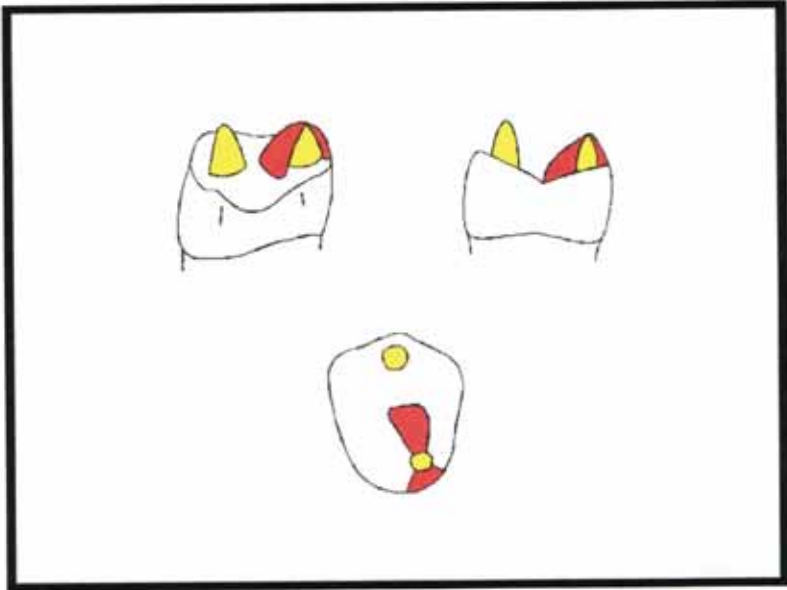
The following diagrams will illustrate the wax build-up technique as previously described for a maxillary first premolar. It very desirable that each and every student becomes a master of this technique, which is possible with meticulous attention to detail and practice, practice and more practice.

1. Functional cusp cone (yellow)
2. Functional cusp triangular ridge and lingual contour (red)
3. Non-functional cusp cone (yellow)
4. Non-functional cusp triangular ridge and buccal contour (green)
5. Mesial and distal cusp ridges on functional cusp (blue)
6. Mesial and distal cusp ridges on non-functional cusp (blue)
7. Mesial and distal marginal ridges (yellow)
8. Fill in and refinement of supplemental anatomy (green)

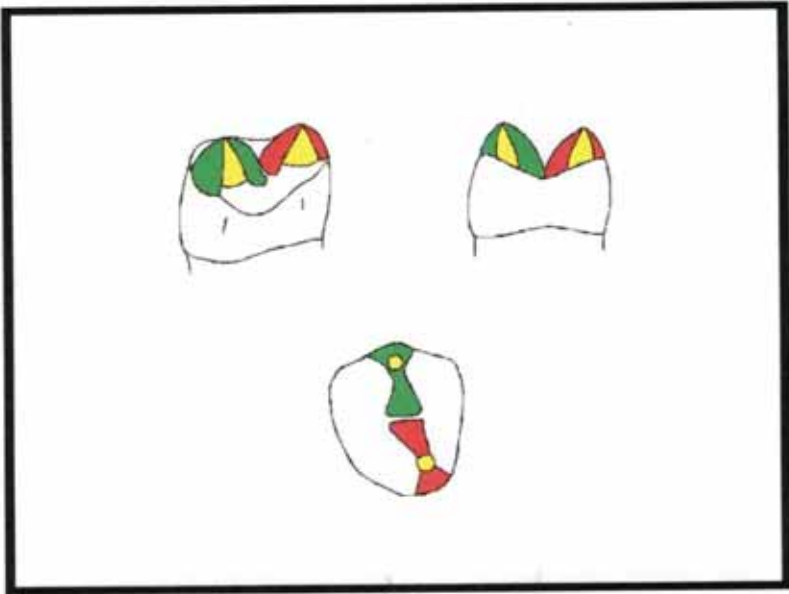
Step 1



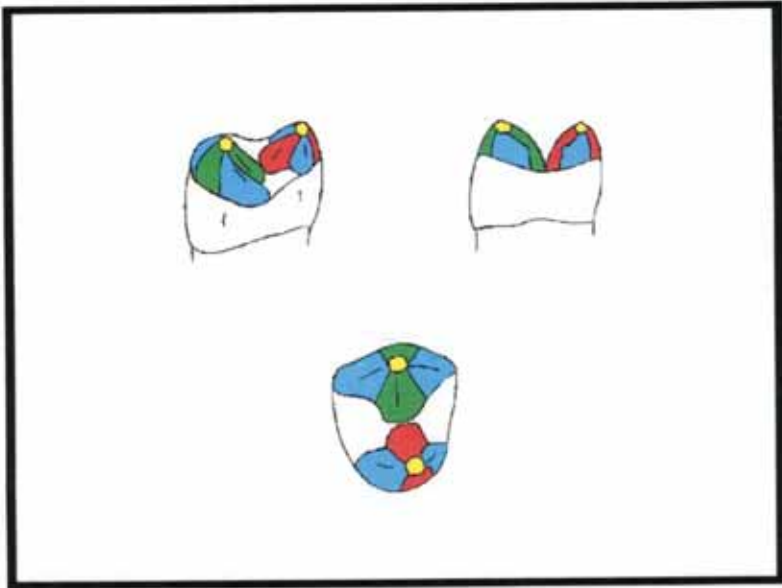
Steps 2 and 3



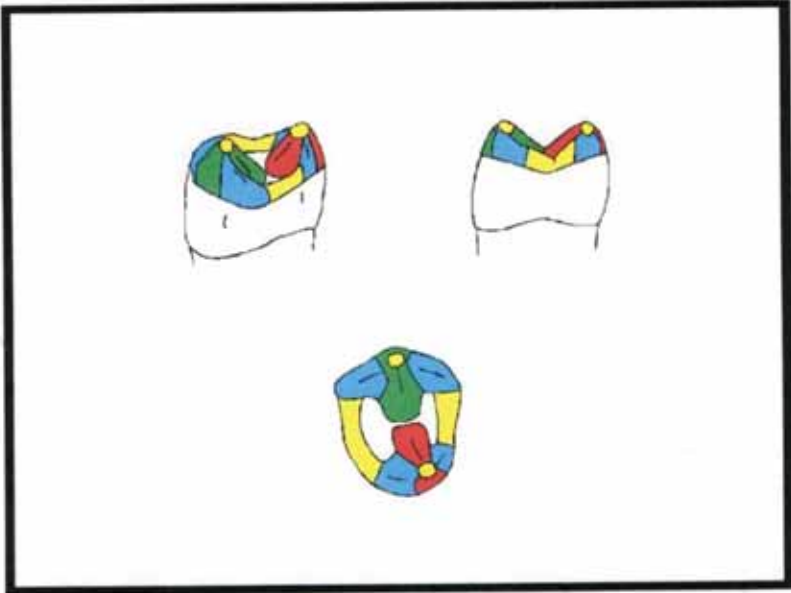
Step 4



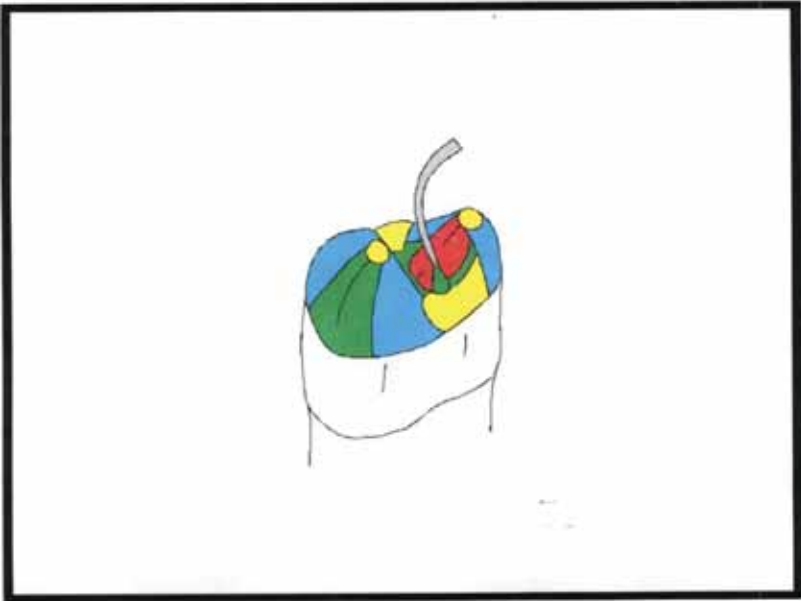
Steps 5 and 6



Step 7



Step 8



Examples of finished wax-ups using this technique are presented below. Some have utilized different color schemes, however they are utilizing the same technique and steps. An extremely functional and correct anatomic relationship is developed when utilizing this additive wax technique.



CHAPTER 4

DEVELOPING INTEROCCLUSAL CONTACTS USING THE WAX BUILD-UP TECHNIQUE

This section will describe the interocclusal contacts that can be developed utilizing the wax build-up technique. The information contained in this section describes the situation in a Class I occlusion with a cusp/fossa relationship. When the basic concepts of the contacts in a Class I situation are understood they can be applied, usually with modifications, to the various other classes of occlusion as well.

Anterior Tooth Occlusion

It is believed the preservation and integrity of the posterior teeth are interdependent on the function of the anterior teeth, the opposite is also true. Listed below are several observations that should be kept in mind when waxing the occlusal surfaces of the posterior teeth or the lingual surfaces of the maxillary anterior teeth.

- In maximum intercuspation the anterior teeth should not occlude. The cuspids should be in closer position to contact than the other anterior teeth.
- The mandibular anterior incisal edges should touch or engage the lingual inclines of the maxillary anterior teeth almost immediately upon any mandibular movement away from maximum intercuspation.
- The engagement of the anterior teeth dictates sliding contacts with pathways, which are a result of the condylar determinants.
- The lingual concavity of the maxillary anterior teeth should resemble or reflect the anatomic configuration of the condylar eminence. (It is thought the ideal anterior disclusive angle is 5° greater {steeper} than the condylar disclusive angle.

In developing this occlusal concept it is mandatory that the anterior disclusion must be developed in harmony with the condylar movement before we attempt to develop the posterior occlusion. When the molars and premolars are in maximum intercuspation, protect the incisors and cuspids. In protrusive excursive movements the incisors protect the cuspids, premolars and molars. In lateral excursive movements the cuspids protect the incisors, molars and premolars.

Posterior Tooth Interocclusal Contacts

A primary purpose of interocclusal contacts is to stop the closure of the mandible and to equalize the occlusal forces to prevent buccal/lingual, and mesial/distal movement of the posterior teeth. It is extremely important that these contacts be located on the correct anatomic elevations to minimize displacement or wear of the teeth. The occlusal contacts ideally should be points not areas as described and illustrated in a previous section. Several observations should be kept in mind when waxing the posterior occlusal scheme and are listed below.

- Posterior contacts are those contacts between opposing premolars and molars.
- They should occur simultaneously, whether they are those forces that stop the closure of the mandible or those that equalize the forces exerted during contacting surfaces of the opposing teeth.
- The exerted forces must be equal and opposite to each other in order not to damage the oral masticatory system.
- The contact between the teeth should be points not broad or wide areas.
- The contact between the teeth should only occur when the mandible is in maximum intercuspation with the maxilla.
- The contacts should only be found on the elevations of the teeth (triangular ridges, supplemental ridges, marginal ridges, and central ridges) but never on the cusp tips.

There are two main groups of interocclusal contacts:

- Closure Stoppers
- Equalizers

The following is a description of these two terms for the benefit of the reader who is unfamiliar with them.

I. Closure Stoppers

Purpose

1. To stop the hinge closure of the mandible as it centrally relates to the maxilla.
2. To assist in providing stabilization in a mesial/distal direction.

Location

1. Distal inclines of the maxillary posterior teeth.
2. Mesial inclines of the mandibular posterior teeth.
3. Primarily on the marginal ridge contours, but also can be on triangular, supplemental, or central ridges.
4. Must be placed closer to the crest or summit of elevations, otherwise protrusive excursive movements may interfere or abrade them.

II. Equalizers

Purpose

1. To offset or equalize the forces exerted by the closure stoppers, improving mesial/distal stability of the teeth.
2. To assure mesial/distal stability of the teeth.

Location

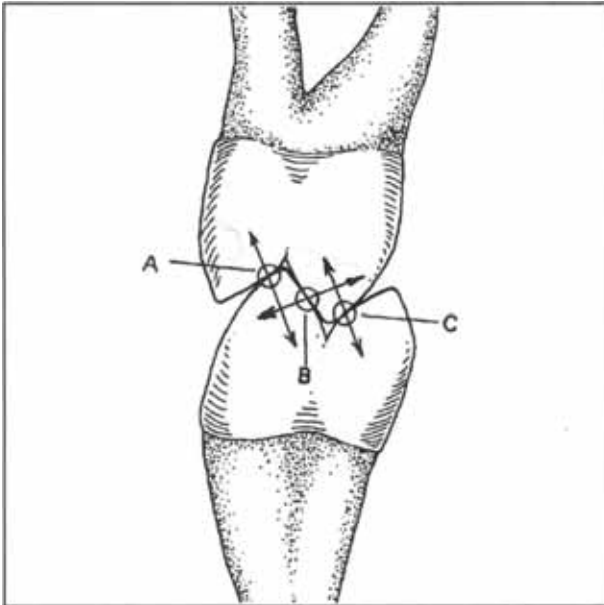
1. Mesial inclines of maxillary posterior teeth.
2. Distal inclines of mandibular posterior teeth.

3. Primarily on triangular, supplemental, and central ridges, rarely on marginal ridges
4. They should be more on the slope or summit of elevations, but can be on the crest or summit

CLOSURE STOPPERS and EQUILIZERS provide anterior posterior or mesial/distal stability for the dentition. A, B, and C contacts provide buccal/lingual stability and will be presented below.

Types of Interocclusal Contacts (A, B, and C)

All interocclusal contacts can be classified as A, B, or C contacts with the exception of those closure stoppers and equalizers found on the transverse marginal ridges. The illustration below shows the relative position of these contacts and their parallelogram effect of neutralizing contacting forces.



A Contacts

The A contacts occur when the non-functional cusps of the maxillary teeth occlude with the functional cusps of the mandibular teeth.

Maxillary location:

1. They should be on the triangular ridges of the buccal cusps, and occasionally they can be placed on the supplemental ridges.
2. They should be near the central developmental groove.
3. If they are equalizers, they should be on the mesial slope or subsummit.
4. If they are closure stoppers, they must be on the distal aspect of the summit of the triangular or supplemental ridges. If they are placed too far down the distal slope, protrusive excursions can abrade them and create deflective occlusal contacts.

Mandibular location:

1. They should be placed on the buccal surface of the mandibular functional cusps (mesial and distal slopes of the central ridges).
 2. If they are equalizers, they should be placed on the distal slope or subsummit.
 3. If they are closure stoppers, they must be on the mesial aspect of the summit of the central ridge. If they are placed too far down the mesial slope, protrusive excursions can abrade them and create deflective occlusal contacts.
- Maxillary premolars have two A contacts, one is an equalizer and one is a closure stopper
 - Mandibular premolars have one A contact, and it is an equalizer
 - Maxillary molars have four A contacts: two equalizers and two closure stoppers
 - Mandibular molars have four A contacts: two equalizers and two closure stoppers

C Contacts

The C contacts occur when the functional cusps of the maxillary teeth occlude with the non-functional cusps of the mandibular teeth. They are a mirror image of the A contacts.

Maxillary location:

1. They should be placed on the lingual surface of the maxillary functional cusps, on the mesial and distal slopes of the central ridges.
2. If they are equalizers, they should be on the mesial slope or subsummit.
3. If they are closure stoppers, they should be on the distal aspect of the summit of the central ridge.

Mandibular location:

1. Placement should be on the triangular ridges of the mandibular lingual cusps, occasionally on the supplemental ridges.
 2. They should be near the central developmental groove.
 3. If they are equalizers, they should be on the distal slope or subsummit.
 4. If they are closure stoppers, they should be on the mesial aspect of the summit of the triangular or supplemental ridges.
- Maxillary premolars have two C contacts, one is an equalizer and one is a closure stopper.
 - Mandibular premolars have one C contact, and it is an equalizer.
 - Maxillary molars have three C contacts: two equalizers and one closure stopper.
 - Mandibular molars have three C contacts: two equalizers and one closure stopper.

B Contacts

A and C contacts exert forces on the teeth that can result in buccal movement of the maxillary teeth and lingual movement of the mandibular teeth. To equalize the distribution of occlusal forces to the teeth the B contact must be present. The B contact is the most difficult contact to maintain, however it must be present or a malocclusion may develop. A and B contacts are equalizers. Occasionally a B contact is placed on the oblique ridge of the maxillary molar when it occludes with the distal stamp cusp of the mandibular molar, in this instance a B contact could be a closure stopper. Otherwise, in a routine Class I occlusion, all B contacts are equalizers.

The B contacts occur when the functional cusps of the maxillary teeth occlude with the functional cusps of the mandibular teeth

Maxillary location:

1. They should be on the triangular ridges of the maxillary functional cusps with one exception. The exception is the B contact on Stuart's supplemental groove on the maxillary molars.
2. They are placed half the distance between the cusp tip and the central developmental groove.
3. They are placed slightly on the mesial slope but can be on the summit of the triangular ridge.

Mandibular location:

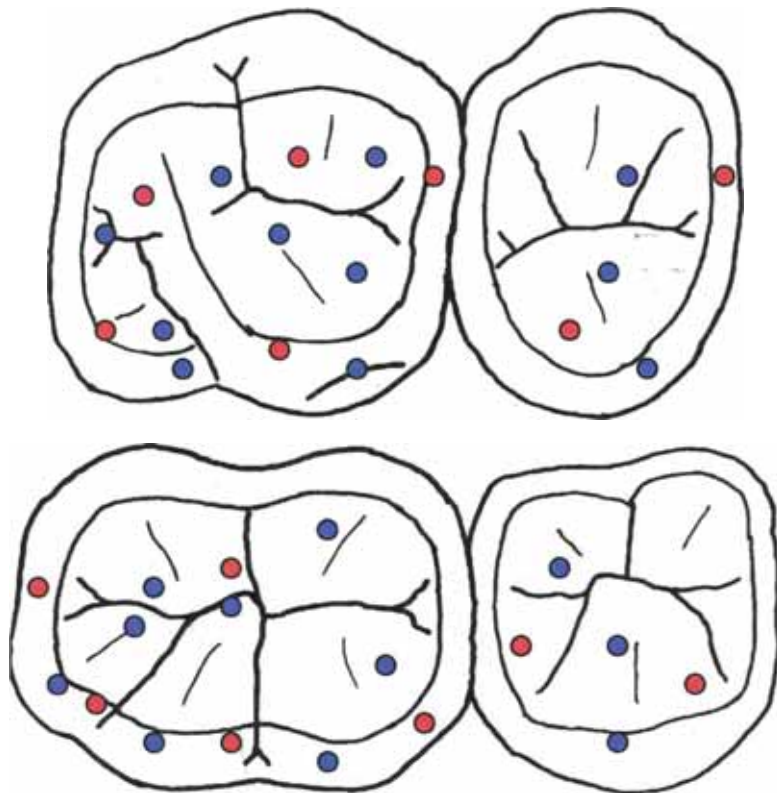
1. They should be placed on the triangular ridges half the distance between the cusp tip and the central developmental groove.
 2. They should be slightly on the distal slope but can be on the summit of the triangular ridge.
- Maxillary premolars have one B contact
 - Mandibular premolars have one B contact
 - Maxillary molars have three B contacts
 - Mandibular molars have three B contacts

The illustration below shows the position of the equalizers and closure stopper contact points in the maxillary and mandibular second premolar and first molars.

= Equalizer



= Closure Stopper



CHAPTER 5

DENTAL ANATOMY/INDIVIDUAL TOOTH DESCRIPTIONS

(illustrations from Linek Tooth Carving Manual)

The Maxillary Central Incisor

I. The tooth in general

The two maxillary central incisors approximate each other and may be located at the most anterior part of the maxillary arch on either side of the median line. They usually erupt at the age of seven to eight years.

II. The crown in general

A. Type - simple

B. Number of lobes of development - Four: three labial lobes and the cingulum or fourth lobe.

C. Shape - The crown is wedge-shaped, presenting four axial surfaces and an incisal edge.

D. Relationship to the long axis of the tooth - the incisal edge is located slightly to the labial of the mesio-distal plane passing through the long axis. The greater bulk of the crown is distal to the labio-lingual plane.

III. The root in general

A. Number - one

B. Shape - Conical, in the apical third, tapering gradually from the middle third to the apex.

IV. Axial surfaces of the crown

A. Labial surface

1. Shape - The outline of the labial surface appears as a modified square or rectangle. Individual types may be square, tapering or ovoid form, but are usually modified by a combination of these types. The contour of the surface is also variable in extreme types as flattened, convex or concave.
2. Mesial margin - This margin is usually straight, but converges slightly to meet the cervical margin.
3. Distal margin - The distal margin is more convex than the mesial margin, and rounds out slightly to the distal forming a more convex contact area.
4. Incisal margin - A slightly acute angle is formed at its junction with the mesial margin. At the junction of the distal margin and the incisal margin a slightly rounded angle, the disto-incisal angle, is formed.
5. Cervical margin - The cervical line is convex toward the root, and forms an arc of a quarter circle.
6. Developmental seams - The two labial developmental seams sometimes form very slight longitudinal depressions, noticeable only in the incisal half of the surface. They mark the junction of the three labial lobes.
7. Ridges - Sometimes a labio-cervical ridge is presented along the crest of the height of contour.
8. Height of contour - The labial surface is flattened in the incisal two-thirds and is convex in the cervical third. The height of contour is located within the cervical one-third and forms an imaginary arc paralleling the curvature of the cervical margin.

B. Lingual surface

1. Shape - The lingual surface is similar in outline to the labial surface, but is narrower in its cervical portion.
2. Mesial margin - The junction of the lingual and mesial surfaces forms the crest of the mesial marginal ridge.

3. Distal margin - The junction of the lingual and distal surfaces forms the crest of the distal marginal ridge. The distal margin is more convex and shorter than the mesial margin.

4. Incisal margin - The incisal margin is parallel with the incisal margin of the labial surface. The thickness of the incisal edge is variable. In worn incisal edges a distinct surface is presented.

5. Cervical margin - The cervical line of the lingual surface forms an arc of a smaller circle than does the cervical margin of the labial surface.

6. Developmental seams - Two lingual developmental seams sometimes form slight longitudinal depressions within the fossa.

7. Ridges - Three ridges are found on the lingual surface:

- (a) The mesial marginal ridge is formed by a roll of enamel at the junction of the mesial and lingual surfaces.
- (b) The distal marginal ridge is slightly wider and slightly shorter than the mesial marginal ridge.
- (c) The linguo-cervical ridge or cingulum is formed by an elevation of enamel, shaped like a segment of a sphere. Its incisal slope merges gradually into the lingual fossa.

8. Height of contour - The line representing the height of contour is located about two millimeters above the arc of the cervical line.

9. Fossa - A depression or hollow, called the lingual fossa, is presented on the lingual surface. It is bounded by the mesial and distal marginal ridges and the cingulum. The fossa configuration is variable in form.

C. Mesial surface

1. Shape - The shape of the mesial surface is somewhat triangular with the base toward the root.

2. Lingual margin - The outline of the lingual margin is concave in the incisal two-thirds, and convex in the cervical one-third.

3. Labial margin - Flattened in the incisal two-thirds, and convex in the cervical third.

4. Incisal margin - The incisal boundary of the mesial surface presents an angle that is formed by the merging of the labial and lingual margins.
 5. Cervical margin - The cervical line presents a curvature forming a V-shaped arc with the apex toward the incisal.
 6. Position of the contact area - The proximal contact area is located near the incisal angle.
 7. Cervical area - The area adjacent to the junction is flattened, the enamel and cementum being almost continuous.
 8. Height of contour - A V-shaped outline may be traced with its peak at the contact point.
- D. Distal surface - The distal surface is similar in shape to the mesial surface but differs in form as follows:
1. It is smaller in area and more convex.
 2. The distal contact area is more rounded.
 3. The cervical curvature forms an arc of lesser curvature.
 4. The cervical area may present a slight concavity.

V. Incisal edge

The incisal edge presents an elongated, slightly rounded surface extending from the mesial angle to the distal angle. The thickness varies between individuals depending on the type of tooth and on the amount of wear. The average thickness is about two millimeters. In worn teeth, a distinct surface is presented, which usually slopes to the lingual. In recently erupted teeth the three mamelons are visible on the incisal edge.

VI. Root

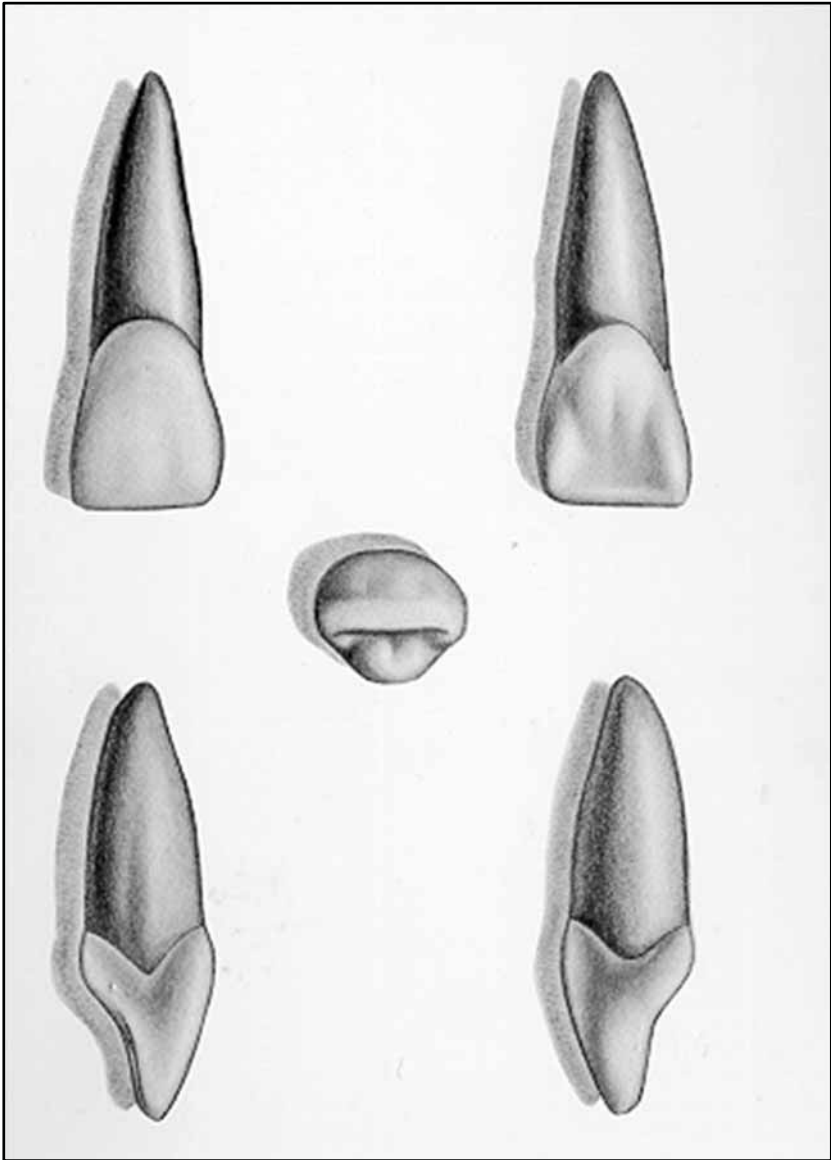
The root tapers gradually in its apical third. A cross section at the apex would present an outline of triangular form broader in the labial portion and presenting a slightly acute angle at the junction of the labial and mesial surfaces. The labial form of the root is flattened. The mesial and distal surfaces converge toward the lingual.

VII. How to distinguish a right or left maxillary central incisor

- A. Observe the slightly acute mesial incisal angle and the slightly rounded distal incisal angle.
- B. Observe the greater convexity of the distal surface.
- C. The distal marginal ridge is usually slightly wider than the mesial marginal ridge.

VIII. Applied anatomy

- A. The linguo-cervical ridge may be important in its function of deflecting food over the crest of the gingiva on the lingual.
- B. Caries occurring on the mesial and distal surfaces usually involves the contact point areas.
- C. Due to its location, the maxillary central incisor is often subject to fracture of the angles from trauma, etc.
- D. Frequently it is thought the form and color of the crown is usually in harmony with the individual's facial contour and complexion.
- E. The junction of the marginal ridges and cingulum area may result in an underdeveloped pit that is susceptible to caries.



The Mandibular Central Incisor

I. The tooth in general

The two mandibular central incisors approximate each other and are located on either side of the median line. They are the smallest of the permanent teeth in size, and are more constant in their anatomical forms. The mandibular centrals erupt between the ages of six and seven years.

II. The crown in general

A. Type - simple

B. Number of lobes of development - Four: three labial lobes and the cingulum or fourth lobe.

C. Shape - The crown is wedge-shaped, presenting four axial surfaces and an incisal edge. The mesio-distal and labio-lingual measurements are about five-eighths as great as the measurements of the maxillary central. The neck appears relatively more constricted than the neck of the maxillary central.

D. Relationship to the long axis of the tooth - The incisal edge is located slightly to the lingual of a mesio-distal plane passing through the long axis. The labio-lingual plane divides the crown and root into equal portions. The incisal edge is placed at right angles to the long axis as viewed from the labial aspect.

III. The root in general

A. Number - one, sometimes presenting a divided root canal.

B. Shape - The root is flattened mesio-distally, and is sometimes wider labio-lingually at its mid-section than the labio-lingual width of the crown. From a mesial or distal aspect, the labial outline of the tooth may present two distinct arcs, one arc forming the outline of the crown, the other or larger arc forming the outline of the root.

IV. Axial surfaces of the crown

A. Labial surface

1. Shape - The outline of the labial surface appears trapezoidal in shape, with the longer sides denoting the mesial and distal margins. The labial surface is smoothly convex in the cervical one-third and flattened in the incisal two-thirds.
2. Mesial margin - The mesial margin converges toward the cervix. The mesio-incisal angle is acute.
3. Distal margin - The distal margin converges toward the cervix. The distal-incisal angle is equally acute as the mesial-incisal edge.
4. Incisal margin - The incisal margin is straight and is placed at right angles to the long axis. In length it is about one-third greater than the cervical margin.
5. Cervical margin - The cervical line forms an arc of a small half-circle
6. Developmental seams - The two labial developmental seams are indistinct as observed on the adult tooth. On the newly erupted tooth, three rounded elevations may be noted on the incisal edge. These elevations or mamelons are rapidly worn away by the maxillary central during its incising function.
7. Ridges - No ridges are found on the labial surface.
8. Height of contour - The greatest convexity of the labial surface is located near the cervical margin, in a slight incisal direction.

B. Lingual surface

1. Shape - The outline is similar in shape to the labial surface, but is slightly smaller in area.
2. Mesial margin - The crest of the mesial marginal ridge form the mesial margin.
3. Distal margin - The crest of the distal marginal ridge form the distal margin.

4. Incisal margin - The margin is straight and placed at right angles to the long axis.
5. Cervical margin - the cervical line forms an arc of a smaller circle than does the cervical margin of the labial surface.
6. Developmental seams - The developmental seams are indistinct and usually lacking in appearance.
7. Ridges - The mesial marginal and distal marginal ridges are not pronounced and are only slightly rounded. The cingulum is small in area and forms the cervical one-third of the lingual surface. The mesial marginal ridge is usually slightly thicker than the distal marginal ridge.
8. Height of contour - The greatest convexity of the lingual surface is located slightly more incisal to the cervical margin.
9. Fossa - The lingual fossa is flattened and indistinct.

C. Mesial surface

1. Shape - The mesial surface is triangular in outline with a short base in relation to its sides.
2. Lingual margin - The incisal three-fourths of the lingual margin assume a slightly concave outline, while the cervical one-fourth is convex.
3. Labial margin - The incisal two-thirds of the labial margin are straight and incline slightly toward the lingual. The cervical one-third is convex.
4. Incisal margin - An acute angle is formed by the convergence of the labial and lingual margins at the incisal edge.
5. Cervical margin - The curvature of the cervical line forms a deep V-shaped arc with its apex toward the incisal.
6. Position of the contact area - The contact area is located slightly below the incisal margin.
7. Cervical area - A flattened appearance is evident in the cervical area and the crown and is *continuous*, with little or no overhang of enamel present.
8. Height of contour - The height of contour is almost identical with the shape of the mesio-labial and mesio-lingual line angles.

D. Distal surface

The distal surface of the mandibular central incisor appears almost identical in size and shape when compared with the mesial surface. Slight differences may be noted in that the contact area of the distal surface is slightly more convex, and a slight concavity may sometimes be observed in the cervical area.

V. Incisal edge

The incisal edge is usually straight from mesial to distal. Its parallel and right angle relationships to the mesio-distal and labio-lingual planes may be observed by viewing the crown from an incisal aspect. In thickness, the incisal edge varies with wear. When excess wear has occurred, the surface presented slopes slightly apical on the labial surface.

VI. Root

The labial and lingual surfaces of the root are decidedly convex and are much smaller in area than the mesial and distal surfaces. A characteristic linear depression may be observed on the mesial and distal surfaces of the root. A cross section at mid-root shows an elongated oval outline, pinched inward toward its center (slight figure-eight form). The apex of the root may have a slight distal inclination.

VII. How to distinguish a right or left mandibular central incisor

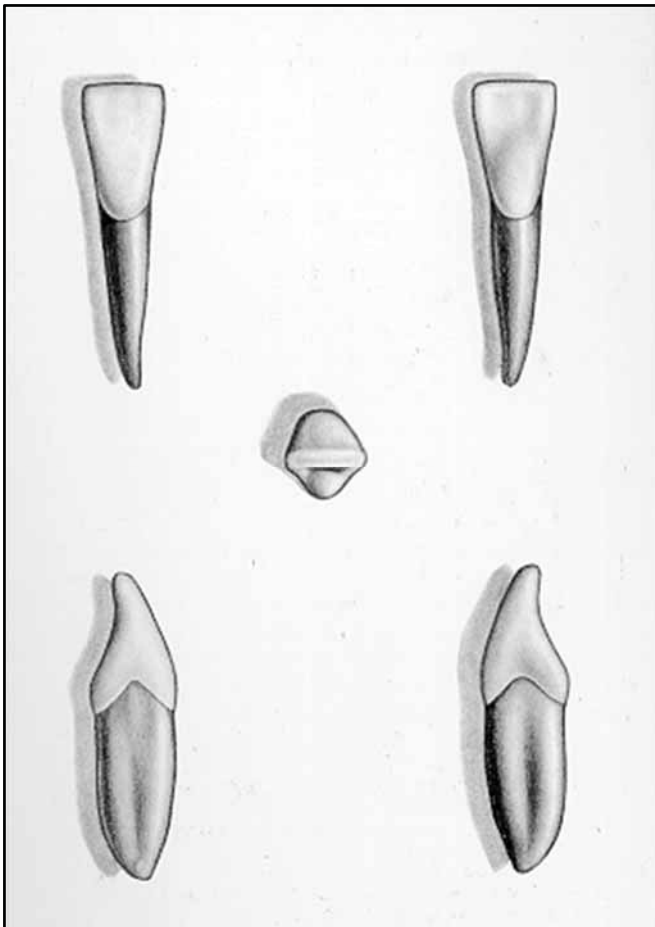
It is often very difficult to differentiate the right and left mandibular central incisors.

- A. The distal marginal ridge generally presents a slight concavity at its junction with the cingulum
- B. The cingulum sometimes appears to be slightly to the distal of the labio-lingual plane.

VII. Applied anatomy

- A. The incisal edge is generally abraded or worn in the adult and a thin line of dentin is usually observed between the labial and lingual plates of enamel.

- B. The mandibular centrals are less susceptible to caries than most other teeth, but are more subject to irregular alignment and periodontal disease.
- C. Calcareous deposits appear with more frequency in the cervical regions of the lingual surfaces of the mandibular incisors than in any other region of the arch.
- D. The mandibular central incisor is the only tooth of the thirty-two permanent teeth, occluding with only one opposing tooth, with the only exception being the maxillary third molar.



The Maxillary Lateral Incisor

I. The tooth in general

The maxillary lateral incisor is smaller in size than the maxillary central incisor, but presents the same general appearance and is usually harmonious in form with the central incisor. The maxillary lateral incisor is located distal to the central incisor and mesial to the cuspids. It erupts at the age of eight to nine years.

II. The crown in general

A. Type - simple

B. Number of lobes of development - Four: three labial lobes and the cingulum or fourth lobe.

C. Shape - The crown is wedge-shaped but presents with a greater general convexity than the maxillary central incisor.

D. Relationship to the long axis of the tooth - The incisal edge is located approximately on the mesio-distal plane, which passes through the long axis. In relation to the labio-lingual plane the greater half of the crown appears on the distal.

III. The root in general

A. Number - one

B. Shape - The root of the maxillary lateral incisor is smaller than the root of the maxillary central incisor, but presents a greater relative length in comparison to its crown. It is also relatively thicker through the neck.

IV. Axial surfaces of the crown

A. Labial surface

1. Shape - The outline of the labial surface is generally similar to the outline of the labial surface of the maxillary central, but its facial form presents a greater general convexity.

2. Mesial margin - The mesial margin converges slightly toward the apex and sometimes forms a slightly acute angle with the incisal margin. This

angle is generally more acute in comparison with the same angle of the maxillary central incisor.

3. Distal margin - The distal margin is always more convex than the mesial margin and sometimes a pear shaped outline may be observed.

4. Incisal margin - The incisal margin corresponds in outline with the incisal margin of the labial surface.

5. Cervical margin - The cervical margin is slightly less in length than the cervical margin of the labial surface and presents the same general outline.

6. Developmental seams - The developmental seams are sometimes more distinct than observed on the maxillary central incisor.

7. Ridges - The marginal ridges of the lingual surface are relatively broader mesio-distally in comparison to the marginal ridge of the maxillary central incisor and join with the cingulum at a more acute angle. The distal marginal ridge is broader and shorter than the mesial marginal ridge. The cingulum is less prominent than the cingulum of the maxillary central incisor.

8. Height of contour - The greatest convexity of the lingual surface is nearer the cervical margin than that of the maxillary central incisor.

9. Fossa - The lingual fossa is often small and irregular in shape. Frequently a pit fault is observed at the junction of the marginal ridges and cingulum.

D. Mesial surface

1. Shape - The mesial surface is triangular in form, the apex of the triangle forming the incisal edge. The surface is relatively narrower than the mesial surface of the maxillary central incisor.

2. Lingual margin - The lingual margin is not as concave in its incisal two-thirds as is the same margin of the maxillary central incisor.

3. Labial margin - The labial margin presents a greater general convexity in comparison to the corresponding labial margin of the maxillary central incisor.

4. Incisal margin - The incisal margin presents an acute angle that is more acute than the corresponding angle of the maxillary central incisor.

5. Cervical margin and curvature - The V-shaped outline of the cervical margin is relatively more acute than the corresponding cervical margin of the maxillary central incisor.

6. Position of the contact area - The contact area is located near the incisal angle.

7. Cervical area - A flattened cervical area is presented. Sometimes a distinct concavity is presented.

8. Height of contour - The crest of the height of contour is near the incisal edge.

D. Distal surface

1. The distal surface is smaller in area and more convex in all directions than the mesial surface.

2. The lingual margin of the distal surface is not as concave as the lingual margin of the mesial surface.

3. The labial margin is indefinite in its location at the rounded junction of the labial and distal surfaces.

4. The incisal margin of the distal surface merges into the rounded disto-incisal angle.

5. The curvature of the cervical margin presents a more rounded arc in comparison to the mesial surface.

6. The contact area located at the greatest convexity of the distal surface varies in location but is always placed nearer the cervical margin than is the mesial contact area in its cervical relation.

7. The cervical area is generally flattened but appears as a concavity from a labial aspect.

8. The height of contour is nearer the cervical than is the height of contour of the mesial surface.

V. Incisal edge

When viewing the maxillary lateral incisor from an incisal aspect, the convexity of the labial surface, the broad marginal ridges of the lingual surface, and the somewhat indefinite junction of the incisal edge and the distal surface may be noted.

VI. Root

The root tapers gradually from mid-root toward the apex. It is flattened on its mesial and distal surfaces and differs from the foot of the maxillary central incisor in that the triangular outline is not as prevalent. The apical third of the root usually inclines slightly toward the distal and is subject to greater variation in curvature than the maxillary central. A cross-section taken at the neck of the maxillary lateral usually shows a form that is ovoid in outline.

VII. How to distinguish a right or left maxillary lateral incisor

The rounded disto-incisal angle is a distinguishing feature of this tooth. The shortened and broader distal marginal ridge is usually a constant factor.

VIII. Applied anatomy

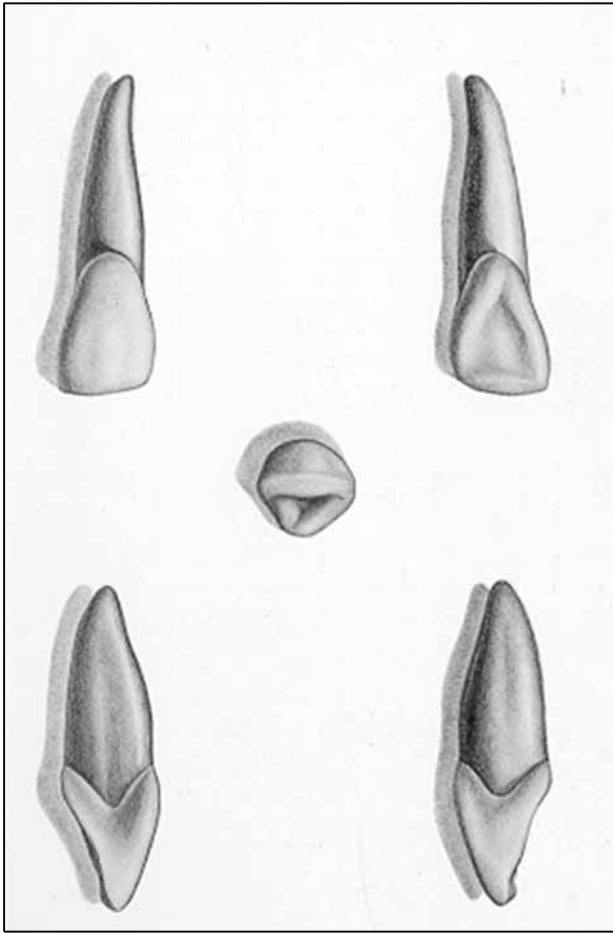
A. The maxillary lateral incisor sometimes presents a malformed crown commonly called a "peg lateral". Occasionally the maxillary lateral incisor is congenitally missing.

B. Caries often occurs on the mesial and distal surfaces, usually involving the contact areas.

C. Frequently a carious pit is found at the junction of the marginal ridges and the cingulum.

D. A fissured seam is sometimes observed as crossing the linguo-cervical ridge and its distal half and extending on the surface of the root.

E. A pronounced concavity is occasionally presented in the cervical area of the mesial surface that is often mistaken for caries.



The Mandibular Lateral Incisor

I. The tooth in general

The mandibular lateral incisor is located distally to the mandibular central incisor and mesial to the mandibular cuspid. Its general appearance and anatomic markings are similar to those of the mandibular central. The detailed anatomy is stated below as differences in comparison with the mandibular central incisor. The mandibular lateral incisor erupts between the ages of seven and eight years.

II. The crown in general

The crown is larger than the crown of the mandibular central and presents a *peculiar twist of its incisal portion*, characteristic of the tooth.

III. The root in general

The root is relatively longer than the root of the mandibular central incisor and is not as wide in its labio-lingual extent.

IV. Axial surfaces of the crown

A. Labial surface

1. The incisal edge sloped downward to the distal, while the incisal edge of the mandibular central incisor is straight.
2. The distal incisal angle is more obtuse and round, as compared with the mandibular central incisor.
3. The distal half of the crown presents with the greatest bulk.

B. Lingual surface

1. The lingual fossa is more defined than the lingual fossa of the mandibular central incisor.
2. The cingulum appears to be located more to the distal than the cingulum of the mandibular central incisor.

C. Mesial surface

1. The mesial contact point of the lateral is in line with a mesio-distal plane passing through the long axis of the tooth, while the mesial contact point of the mandibular central incisor is located slightly to the lingual of this plane.

D. Distal surface

1. The distal surface of the mandibular lateral incisor is less in area than its mesial surface and is more convex in appearance.
2. The cervical area presents a flattened appearance.

V. Incisal edge

The incisal portion of the crown of the mandibular lateral incisor appears twisted in a disto-lingual direction, although the incisal edge is straight from mesial to distal.

VI. Root

- A. The linear depression of the distal surface of the root is more pronounced than that of the mesial surface.
- B. On the mesial surface of the root the depression is not as pronounced as that found on the root of the mandibular central incisor.
- C. The apex of the root may have a slight distal inclination.

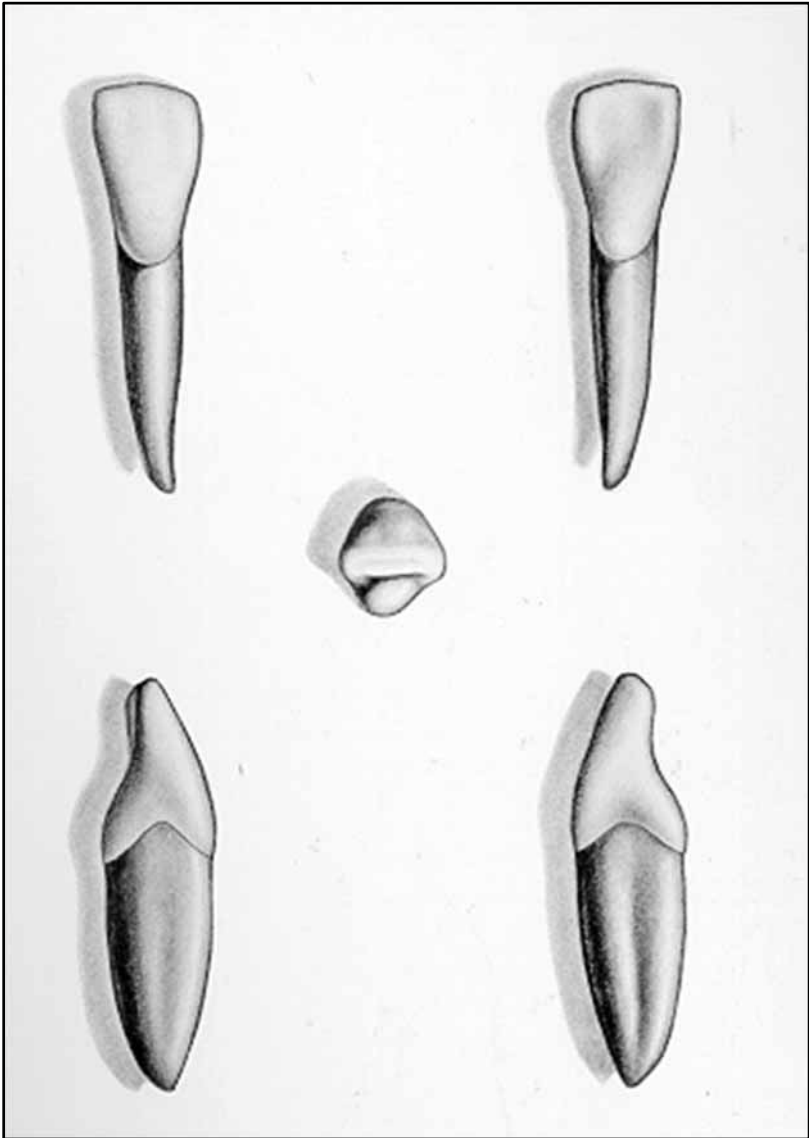
VII. How to distinguish a right or left mandibular lateral incisor

- A. The twist of the incisal portion of the crown is evidenced by a disto-lingual direction.
- B. The depression on the distal surface of the root is more pronounced.
- C. The distal surface of the crown appears to overhang the root.
- D. The root apex inclines to the distal.

VIII. Applied anatomy

The mandibular lateral incisor is also similar in many respects to the maxillary lateral incisor, but may be distinguished by the following characteristics:

- A. The lingual fossa of the mandibular lateral incisor is flatter in appearance.
- B. The marginal ridges of the maxillary lateral incisors are more pronounced than the marginal ridges of the mandibular lateral incisor.
- C. The cingulum is more constricted mesio-distally on the mandibular lateral incisor than the mandibular central incisor.



The Maxillary Cuspid

I. The tooth in general

The maxillary cuspid is the third tooth from the median line, and approximates the maxillary lateral incisors and the maxillary first premolar. It has the longest overall measurement of any tooth in the arch. Although described as an anterior tooth, the cuspid is generally considered as forming the angle of the arch, or the junction of the anterior and posterior teeth. It erupts between the ages of eleven and twelve years and because of its late eruption it is sometimes called the "cornerstone" tooth of the maxillary arch. The cuspid is also called the "canine" because of its prominence in dogs. It is also referred to as the "eye tooth" probably because the root apex is in such close proximity to the floor of the orbit of the eyeball.

II. The crown in general

A. Type - intermediate, because of the presentation of a modified cusp and two additional ridges.

B. Number of lobes of development - Four: three labial lobes and a prominent cingulum, or fourth lobe are presented.

C. Shape - The cuspid differs from the central and lateral incisors in that the incisal edge is made up of two slopes. Two axial ridges are also evidenced, one on the labial surface, and the other on the lingual surface. These ridges produce the thicker and more angular appearance of the crown.

D. Relationship to the long axis of the tooth - The tip of the cusp is located on the mesio-distal plane as observed from a mesial or distal view. From a labial view the bulk of the crown is located distally to the labio-lingual plane bisecting the tooth.

III. The root in general

A. Number - one

B. Shape - The root tapers gradually from mid-root to the apex and is flattened on its proximal surfaces. In length the root is about twice the length of the crown

IV. Axial surfaces of the crown

A. Labial surface

1. Shape - The labial outline is somewhat ovoid in appearance and presents a greater convexity in facial contour than either the maxillary central or lateral, due to the presence of a labial ridge.
2. Distal margin - The mesial margin begins at the base of the mesial slope of the cusp and converges toward the cervix.
3. Distal margin - The distal margin starts at the base of the distal slope of the cusp and converges toward the cervix. It is shorter and more convex than the mesial margin.
4. Incisal margin - The incisal margin is made up of two slopes; a mesial slope and a distal slope. They meet at the tip of the cusp to form an angle of about 90° in the newly erupted tooth. The distal slope is the longer of the two and forms a convex angle at its junction with the distal margin.
5. Cervical margin - An elliptical arc is formed by the cervical line.
6. Developmental seams - The two labial developmental seams are more prominent than observed on the maxillary central or lateral incisors.
7. Ridges - A prominent labial axial ridge extends from the tip of the cusp toward the cervical third. Frequently a labio-cervical ridge is presented.
8. Height of contour - The line forms an arc following the curvature of the cervical margin. The greatest convexity of the labial surface is located at about the junction of the cervical and middle third.

B. Lingual surface

1. Shape - The lingual surface of the maxillary cuspid is smaller in outline to the labial surface, but is slightly less in area. This is due to the convergence of the mesial and distal surfaces toward the lingual.
2. Mesial margin - The mesial margin is coincident with the crest of the mesial marginal ridge.
3. Distal margin - The distal margin is coincident with the crest of the distal marginal ridge. This margin is shorter and more convex than the mesial margin.

4. Incisal margin - Two slopes form the incisal margin of the lingual surface.
5. Cervical margin - The cervical margin forms an arc of a smaller circle than the arc of the cervical margin of the labial surface.
6. Developmental seams - The two lingual developmental seams are observed on either side of the lingual ridge.
7. Ridges - Four ridges are presented on the lingual surface of the maxillary cuspid:
 - (a) The lingual ridge runs from the tip of the cusp and joins with the cingulum. In its mid-third it is slightly concave and often lacking in elevation.
 - (b) The lingo-cervical ridge or cingulum is prominent and is a characteristic of the maxillary cuspid.
 - (c) The mesial marginal ridge is observed as a thickened roll of enamel
 - (d) The distal marginal ridge is shorter than the than the mesial marginal ridge.
8. Height of contour - The greatest convexity of the lingual surface is nearer the incisal than that found on the maxillary central or lateral incisor.
9. Fossa - The lingual surface presents a divided fossa, separated by the lingual ridge. This ridge is more prominent at the tip of the cusp and at the cingulum

C. Mesial surface

1. Shape - The mesial surface is wedge shaped and should be differentiated from the silhouette outline of the mesial aspect of the tooth.
2. Lingual margin - The lingual margin is convex in the cervical one-third, and straight in the incisal two-thirds.
3. Labial margin - The labial margin is slightly convex.
4. Incisal margin - The apex of the triangular-shaped mesial surface enters into the formation of the mesio-incisal angle, a joining of three margins, the labial, the lingual, and the mesial slope of the incisal edge.

5. Cervical margin - The curvature of the cervical line forms a concave arc towards the root.

6. Position of the contact area - The location of the contact area corresponds with the mesio-distal plane passing through the long axis. It is located at the junction of the middle and incisal one-third, and about midway between the labial and lingual margins.

7. Cervical area - The cervical area is slightly concave as observed from a labial point.

8. Height of contour - The arc denoting the height of contour passes through the contact point.

B. Distal surface

1. The distal surface is slightly less in area but more convex than the mesial surface.

2. The disto-incisal angle appears to overhang the cervical area of the distal surface.

3. The contact point is more to the cervical and to the lingual than the mesial surface.

4. The cervical curvature of the distal surface is not as pronounced as that of the mesial surface.

Va. Incisal edge

The distal slope of the incisal edge is longer than the mesial slope and has a slight lingual inclination. The incisal edge is thickened in comparison with the maxillary central or lateral incisor. Facets of wear are always evidenced on the lingual aspect of the incisal edge when the tooth is in functional occlusion.

Vb. Formation of the cusp

The cusp is described as being somewhat pyramidal in form, having four ridges and four inclined planes. The cuspid presents a modified cusp. The ridges of the cusp are made up of the mesial and distal slopes of the incisal edge and axial ridges of the labial and lingual surfaces.

VI. Root

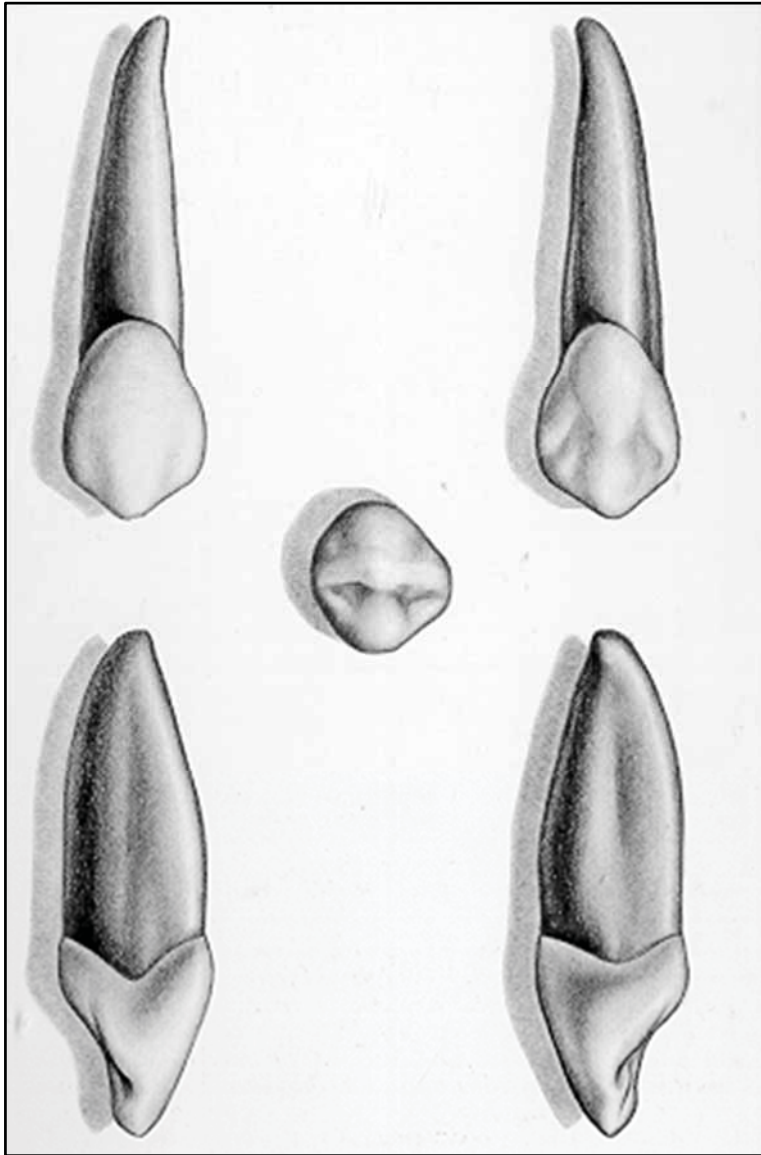
- A. The root of the cuspid is always considered as contributing to a difficult extraction. It is flattened mesio-distally and is convex on both labial and lingual aspects.
- B. A cross-section at the cervix presents an ovoid outline with the lingual portion describing an arc of a smaller circle than the labial portion.
- C. The apical one-third frequently has a distal inclination
- D. Both the mesial and distal surfaces have convexities, with the mesial being the most prominent.

VII. How to distinguish a right or left maxillary cuspid

The distal surface may be determined by the greater convexity of the disto-incisal angle, and the distal inclination of the root apex.

VIII. Applied anatomy

- A. The cuspid serves as an important abutment in prosthodontics due to its firm anchorage in the alveolar process.
- B. Impacted cuspids are not uncommon and should be detected as early as possible for corrective treatment by surgery and orthodontics.
- C. A poorly aligned cuspid should not be extracted as a measure of improving the esthetics of malocclusion.
- D. Extreme care should be exercised when moving the cuspids into congenitally missing maxillary lateral incisor positions. This is a compromise in esthetics and function.



The Mandibular Cuspid

I. The tooth in general

The mandibular cuspid is the third tooth from the median line. Similar to the maxillary cuspid, it is long and firmly anchored in the alveolar process. The anatomical markings are similar in name and location to those of the maxillary cuspid. It erupts between the ages of ten to eleven and sometimes as early as the ninth year.

II. The crown in general

A. Type - intermediate between the simple and complex; the anatomical markings being less prominent than those of the maxillary cuspid.

B. Number of lobes of development - Four: same as the maxillary cuspid but the fourth lobe or cingulum is not as prominent as that found on the maxillary cuspid.

C. Shape - The crown is wedge-shaped, but presents a more slender appearance than the crown of the maxillary cuspid.

D. Relationship to the long axis of the tooth -

1. The tip of the cusp is located slightly lingually to the mesial-distal plane.

2. The bulk of the tooth is labial to this plane.

3. In relation to the labial-lingual plane the bulk of the tooth is observed to be distal to the plane.

III. The root in general

A. Number - One, occasionally bifurcated.

B. Shape - The root is flattened mesio-distally. Its labial outline is continuous with the labial outline of the crown, the two forming a continuous arc from the apex to the incisal edge.

IV. Axial surfaces of the crown

A. Labial surface

1. Shape - the outline of the labial surface is somewhat ovoid, appearing more slender than the maxillary cuspid.
2. Mesial margin - The mesial margin is almost parallel to the long axis and is continuous with the mesial margin of the root.
3. Distal margin - The distal margin is shorter than the mesial margin, and is also more convex, especially in the incisal two-thirds of its length. The cervical one-third of the distal margin is continuous with the root outline.
4. Incisal margin - The incisal margin is made up of two slopes, the mesial slope forms one-third of its length, while the distal slope forms the remaining two-thirds. The distal slope presents a greater inclination in a cervical direction.
5. Cervical margin - The cervical margin forms an arc of a smaller circle than the cervical margin of the maxillary cuspid.
6. Developmental seams - The two labial developmental grooves are not as well defined as those of the maxillary cuspid.
7. Ridges - The labial ridge runs from the tip of the cusp in a parallel direction with the long axis. It is located mesially to the labio-lingual plane and marks the junction of the mesial third and the middle and distal thirds of the crown.
8. Height of contour - The arc begins at the mesial contact point, dips down to near the cervical margin, then curves upward to the distal contact point. Several transverse depressions are sometimes found in the cervical third of the labial surface.

B. Lingual surface

This surface is similar in outline to the labial surface. It may be compared with the lingual surface of the maxillary cuspid. The distinguishing features of the mandibular cuspid are:

1. The absence of the lingual axial ridge.
2. The lingual fossa is flattened or slightly concave.

3. The marginal ridges are narrow.
4. The cingulum is not as prominent as the cingulum of the maxillary cuspid.
5. The height of contour is located nearer the cervical margin.

C. Mesial surface

1. Shape - The mesial surface is triangular in outline.
2. Lingual margin - Lingual margin is relatively flat in shape.
3. Labial margin - Flattened in the incisal two-thirds, and slightly convex in the cervical third.
4. Incisal margin - The incisal margin forms an acute angle, typical of wedge-shaped teeth.
5. Cervical margin - The cervical area is flattened, with the crown and root being continuous in form.
6. Position of the contact area - The proximal contact is located in the incisal third and toward the mesial.
7. Cervical area - Presents a fine line distinguishable only in the color junction between the enamel and the cementum.

D. Distal surface

The distal surface of the mandibular cuspid is much smaller in area and is much more convex than the mesial surface.

1. Labial margin - Appears straight and in some instances slightly concave toward the labial.
2. Lingual margin - Is shorter than the lingual margin of the mesial surface.
3. Cervical margin - Less pronounced than the curvature of the cervical margin of the mesial surface.
4. Position of the contact area - In relation to the mesial contact point the distal contact point is more to the cervical and more to the lingual.
5. Cervical area - A marked concavity giving the appearance of an overhanging disto-incisal angle.

Va. Incisal edge

The distal slope of the incisal edge is longer than the mesial slope with slight distal inclination. The incisal edge is located slightly to the lingual of a mesio-distal plane passing through the long axis of the tooth. The incisal edge is thickened compared to the mandibular central or lateral incisor.

Vb. Formation of the cusp

The cusp is slightly pyramidal in form, having four ridges and four inclined planes. The cuspid presents with a modified cusp. The tip of the cusp marks the junction of the mesial one-third and middle one-third of the crown. The cusp is not as prominent as that of the maxillary cuspid.

VI. Root

A. The mesial surface of the root of the mandibular cuspid is flattened, and presents a curved labial outline continuous with the crown.

B. The lingual outline is straight, running almost parallel to the long axis of the tooth.

C. The distal surface of the root presents a linear depression.

D. The labial surface of the root is convex from mesial to distal, and is much less in area than the mesial and distal surfaces.

E. The root is slightly curved toward the distal in its apical third.

VII. How to distinguish a right or left mandibular cuspid

A. The mesial surface may be determined by its flattened appearance.

B. The labial surface is easily determined by the characteristic arc formed by the characteristic arc formed by the outline of the crown and the root.

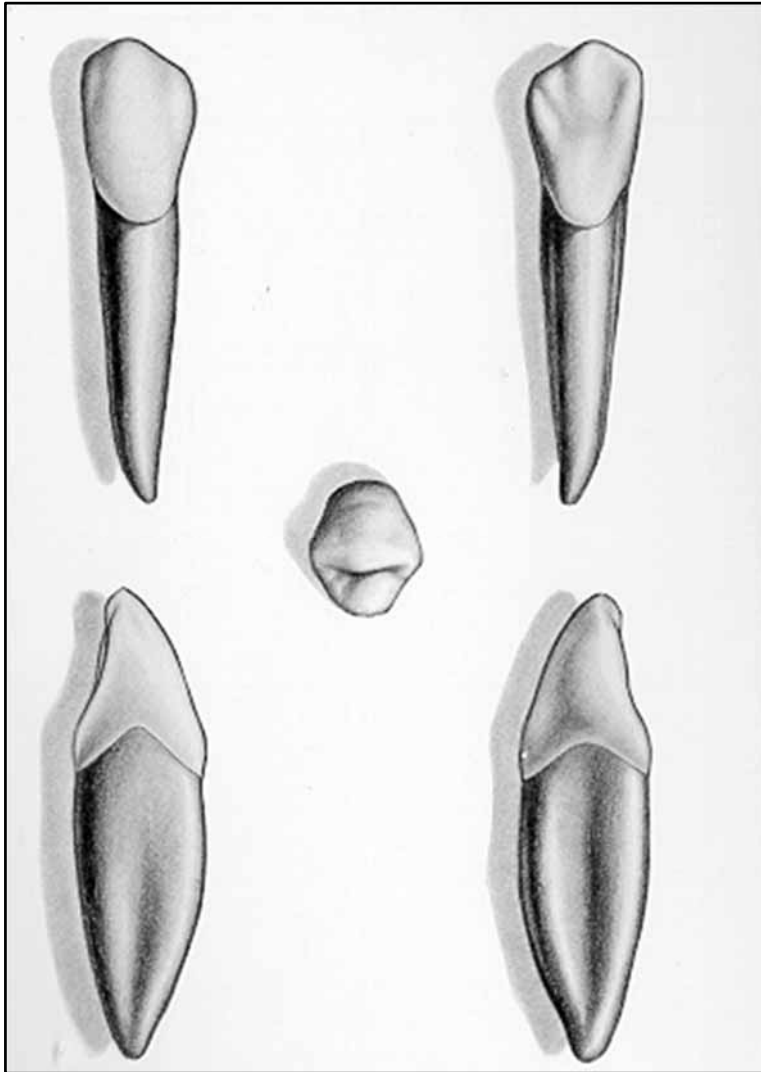
VIII. Applied anatomy

- A. Caries often occurs on the distal surface involving the contact point and requiring a restoration of the distal angle.
- B. The mandibular cuspid serves as an important abutment tooth for removable and fixed partial dentures.
- C. Eruption of the mandibular cuspid occurs at an earlier date than the eruption of the maxillary cuspid
- D. A mandibular cuspid with a bifurcated root is difficult to detect in a radiograph.

IX. How to distinguish a maxillary from a mandibular cuspid

A. Mesial aspect

1. The labial outline of a maxillary cuspid presents a prominence of the crown near the cervical margin, while the mandibular cuspid presents a continuous and characteristic arc formed by the crown and the root.
2. The bulk of the maxillary cuspid appears to the lingual of the mesio-distal plane passing through the long axis, while the mandibular cuspid presents the greater bulk to the labial of this plane.
3. The cingulum of the maxillary cuspid is larger and is much more pronounced than the cingulum of the mandibular cuspid.



The Maxillary First Premolar

I. The tooth in general

The maxillary first premolar is located distal to the cuspid and mesial to the second premolar. It is the largest of the premolar group. It normally erupts between the ages of ten and eleven years.

II. The crown in general

A. Type - The crown is complex since inclined planes, ridge and other landmarks are presented.

B. Number of lobes of development - Four: three form the buccal cusp, while the fourth lobe forms the lingual cusp.

C. Shape - A cuboidal shape is presented. Five surfaces and two cusps will be described.

D. Relationship to the long axis of the tooth - In relation to the mesio-distal plane, the bulk of the tooth is predominantly to the buccal. The tip of the lingual cusp is nearer this plane than is the tip of the buccal cusp. In relation to a bucco-lingual plane, the bulk of the crown is to the distal.

III. The root in general

A. Number - two roots are usually presented, buccal and lingual. They are sometimes united to form a single root.

B. Shape - When two roots are presented, the division is usually noted in the cervical half, forming two cone-shaped roots.

IV. Axial surfaces of the crown

A. Buccal surface

1. Shape - The buccal surface resembles the labial surface of the maxillary cuspid.

2. Mesial margin - From the mesial angle to the cervical margin, a convergence of the mesial margin is noted.

3. Distal margin - Although similar to the mesial margin, the distal margin is more convex.

4. Occlusal margin - The occlusal margin is made up of two cusp slopes. The mesial slope is usually longer than the distal slope.

5. Cervical margin - The cervical margin is convex toward the root and forms an arc of a large circle than the cervical margin of the maxillary cuspid.

6. Developmental seams - The two buccal developmental seams may be noted in the occlusal one-half, marking the junction of the three buccal lobes.

7. Ridges

(a) The buccal axial ridge runs from the tip of the cusp in a cervical direction, parallel to the long axis. It merges into the surface at about the cervical one-third.

(b) The bucco-cervical ridge is generally prominent.

8. Height of contour - The greatest convexity is in the cervical one-third.

B. Lingual surface

1. Shape - The lingual surface is oval in shape, less in area than the buccal surface and is convex in all directions.

2. Mesial margin - The mesial margin is convex. No definite junction can be noted where the lingual and mesial surfaces meet.

3. Distal margin - The distal margin is more convex than the mesial margin.

4. Occlusal margin - The occlusal margin consists of the two rounded slopes of the lingual cusp. The distal slope is the longer, directing the tip of the lingual cusp to the mesial of the bucco-lingual plane passing through the long axis of the tooth.

5. Cervical margin - The cervical margin may be greater in length than the cervical margin of the buccal surface.

6. Developmental seams - No seams are found on the lingual surface of the maxillary first premolar.

7. Ridges - Theoretically, a lingual axial ridge would extend from the tip of the cusp onto the lingual surface. Anatomically a smooth convex surface is presented.

8. Height of contour - The greatest convexity of the lingual surface is located slightly higher toward the cusp than is the greatest convexity of the buccal surface.

C. Mesial surface

1. Shape - The mesial surface should be differentiated from the silhouette outline of the mesial aspect. A four-sided figure is presented greater in width than either the buccal or lingual surface. Its greatest width is in the cervical portion.

2. Lingual margin - This margin has no definite location due to the merging of the mesial and lingual surfaces. The outline is more convex than the buccal margin.

3. Buccal margin - The buccal margin extends from the base of the mesial slope of the buccal cusp to the cervical margin. It has a slight lingual inclination in its relation to the long axis.

4. Occlusal margin - The occlusal margin is straight but is crossed by a sulcus seam (the mesial groove) forming a prominent embrasure sluice which is an outstanding characteristic of the maxillary first premolar.

5. Cervical margin - The curvature is slightly concave toward the root.

6. Position of the contact area - The contact point is located slightly to the buccal of the embrasure sluice, in the occlusal one-third.

7. Cervical area - A marked concavity is presented. This concavity is characteristic of the maxillary first premolar.

8. Height of contour - The arc denoting the line of greatest convexity starts on the lingual in the cervical one-third, rises to the contact point and drops down to the cervical one-third of the buccal outline.

D. Distal surface

The distal surface is similar to the mesial surface in its anatomical markings, but the following differences may be noted:

1. It is more convex and presents a larger surface area.
2. The lingual margin is more convex.
3. The occlusal margin is longer. An embrasure sluice is presented but not as pronounced as found on the mesial surface.
4. The contact area is broader and placed more to the lingual in relation to the mesial contact point.
5. The cervical area is flattened but does not present the marked concavity as is found on the mesial surface.

V. Occlusal surface

A. General shape - The outline of the occlusal surface is trapezoidal in form. It is bounded by four marginal ridges. The mesial and distal margins converge toward the lingual. The buccal margin is about one-third wider than the lingual margin.

1. The angles of the occlusal surface are named as follows:
 - (a) The mesio-buccal angle - almost a right angle.
 - (b) The disto-buccal angle - almost a right angle.
 - (c) The mesio-lingual angle - obtuse and rounded.
 - (d) The disto-lingual angle - slightly more obtuse than the mesio-lingual angle.

B. Marginal ridges

1. Mesial marginal ridge - The mesial marginal ridge of the occlusal surface is formed by the mesial marginal ridge that extends from the mesio-buccal angle to the mesio-lingual angle. It is crossed in its center by a sulcus groove that descends into the mesial surface.

2. Distal marginal ridge - The distal marginal ridge is longer than the mesial marginal ridge.

3. Buccal marginal ridge - The buccal marginal ridge is made up of two slopes:

- (a) The mesial slope runs in a mesio-lingual direction from the tip of the cusp to the mesio-buccal angle.
- (b) The distal slope runs in a disto-buccal direction from the tip of the cusp to the disto buccal angle. The two slopes form a continuous ridge twisted in a mesio-lingual direction.

4. Lingual marginal ridge - The lingual marginal ridge is made up of two slopes and is more rounded than the slopes of the buccal marginal ridge.

- (a) The shorter mesial slope runs from the tip of the lingual cusp in a mesial direction and merges with the mesial marginal ridge.
- (b) The longer distal slope merges with the distal marginal ridge at the disto-lingual angle.

C. Cusps - The maxillary first premolar presents with two cusps one buccal and one lingual. On the average the cusp tips are separated by a distance of 5.5 millimeters

1. The buccal cusp is the larger of the two cusps and is more angular than the lingual cusp. It is made up of four ridges and four inclined planes. Each inclined plane is named according to its location.

2. The lingual cusp is crescent shaped, smaller in area than the buccal cusp and is not as high as the buccal cusp. Its ridges are more rounded presenting three in number, with a fourth (theoretically) ridge extending onto the lingual surface. The lingual cusp tip is inclined toward the mesial.

D. Fossae - The central fossa occupies the majority of the occlusal surface forming a depression bounded by the marginal ridges.

E. Triangular ridges

1. The buccal triangular ridge runs lingually from the tip of the buccal cusp toward the center of the occlusal surface. It is angular and prominent.

2. The lingual triangular ridge runs buccally from the tip of the lingual cusp to the center of the occlusal surface. This ridge is more rounded than the buccal triangular ridge.

F. Grooves

1. Developmental

- (a) Central developmental groove - This groove runs mesio-distally between the cusps in the center of the occlusal surface from the mesial pit to the distal pit.
- (b) Mesial developmental groove - Starts in the mesial pit, runs mesially as an extension of the central groove. It crosses the mesial marginal ridge, forming an embrasure sluice, and continues for a short distance as a fine line on the mesial surface.
- (c) Distal developmental groove - This groove starts in the distal pit, runs distally as an extension of the central groove and crosses the distal marginal ridge.
- (d) Mesial triangular developmental groove - This groove begins in the mesial pit and runs mesio-buccally. It separates the buccal triangular ridge from the mesial marginal ridge.
- (e) Distal triangular groove - This begins starts in the distal pit and runs disto-buccally. It is slightly longer than the mesial triangular groove.

2. Supplemental

- (a) The supplemental grooves on the buccal and lingual cusps are similar in length. The Lingual supplemental grooves run extend from the tip of the cusp, in a disto-buccal direction to terminate in the central groove to help form the mesial and distal occlusal pits.
- (b) The buccal supplemental grooves run from the cusp tip to the lingual, terminating in the central groove also contributing to formation of the mesial and distal occlusal pits.

G. Inclined planes - four inclined planes are observed on each cusp and are named as follows:

1. Mesio-buccal inclined plane.
2. Disto-buccal inclined plane.
3. Mesio-lingual inclined plane.

4. Disto-lingual inclined plane.

- (a) Buccal cusp - The two buccal inclined planes of the buccal cusp have no occlusal contacts.
- (b) Lingual cusp - All four of the inclined planes of the lingual cusp have occlusion with the opposing inclined planes of the mandibular teeth.

H. Masticatory table - The masticatory table includes the inclined planes of the occlusal surface and a portion of the lingual inclined planes of the lingual cusp.

VI. Roots

The root generally exhibits bifurcation at about halfway between the apex and the cervical portion of the tooth.

A. The cervical half of the root is flattened mesio-distally and presents two longitudinal grooves extending from the bifurcation to near the cervix.

B. The apical half of the root presents with two components:

1. The buccal root is usually the longer of the two and has a lingual and distal inclination.
2. The lingual root is more blunt in appearance and is generally straight, although many cases present a buccal curvature.

VII. How to distinguish a right or a left maxillary first premolar

A. The larger cusp should determine the buccal cusp.

B. The mesial surface may be determined by:

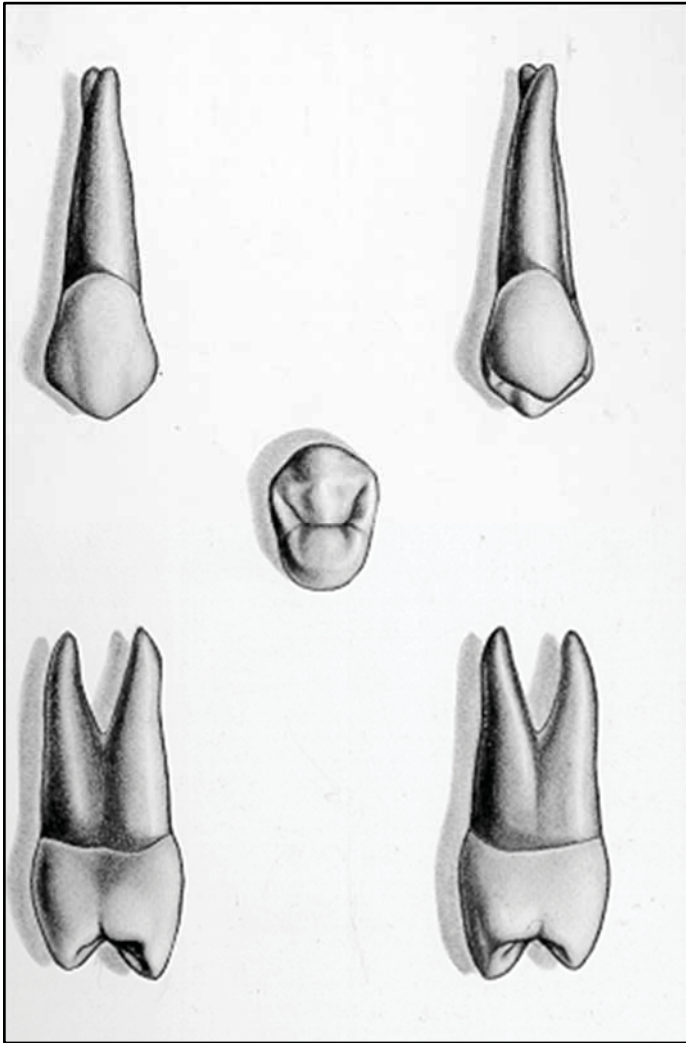
1. The tip of the lingual cusp is inclined toward the mesial.
2. A prominent embrasure sluce is present on the mesial surface.
3. The concavity in the cervical area of the mesial surface is a constant characteristic of the maxillary premolar.

VIII. Applied anatomy

A. Caries often occurs on the proximal surfaces, undermining the marginal ridges and requiring the restoration of the entire proximal surface. In such cases the correct contour and position of the contact points must be reproduced to prevent injury to the interproximal tissues.

B. The lingual cusp is occasionally fractured when caries has weakened the tooth.

C. In some selected cases of malocclusion the extraction of the first premolars may be indicated as an adjunct to orthodontic therapy.



The Maxillary Second Premolar

I. The tooth in general

The maxillary second premolar erupts between the tenth and twelfth year. It is located as the fifth tooth distal from the median line. It presents the same anatomical markings as found on the maxillary first premolar, but differs in form. Differences only are stated in the following description.

II. The crown in general

The crown is slightly smaller and is not as angular in appearance as the first premolar.

III. The roots in general

One root is usually presented although a bifurcated root is not unusual.

IV. Axial surfaces of the crown

A. Buccal surface - Differences:

1. The buccal surface is relatively wider in the cervical portion.
2. The mesial and distal slopes of the occlusal margin meet at an angle that is more obtuse in form.
3. The developmental seams of the buccal surface are not as prominent.
4. The buccal axial ridge is not as prominent and more rounded in appearance.

B. Lingual surface

The lingual surface of the second premolar is relatively larger in comparison to its buccal surface.

C. Mesial surface

The mesial surface is slightly more convex than the mesial surface of the maxillary first premolar. Rarely is a concavity presented in the cervical area. The embrasure sluice of the maxillary first premolar is not observed on the maxillary second premolar.

D. Distal surface

The distal surface is more convex than the distal surface of the maxillary first premolar.

V. Occlusal surface

A. The mesial and distal margins of the silhouette outline do not converge toward the lingual to as great an extent as observed in the maxillary first premolar.

B. The angles of the occlusal surface are more rounded.

C. The central fossa is not as deep and is shorter mesio-distally compared to the maxillary first premolar.

D. The mesial and distal pits are closed together creating a shortening of the central groove.

E. The mesial and distal developmental seams are not as prominent as the maxillary first premolar.

F. The triangular ridges are narrower than the maxillary first premolar.

G. The marginal ridges are broader than the maxillary first premolar.

H. The buccal cusp is not as prominent as the maxillary first premolar.

I. The buccal marginal ridge is usually at right angles to the bucco-lingual plane, different in this respect from the twisted marginal ridge of the maxillary first premolar.

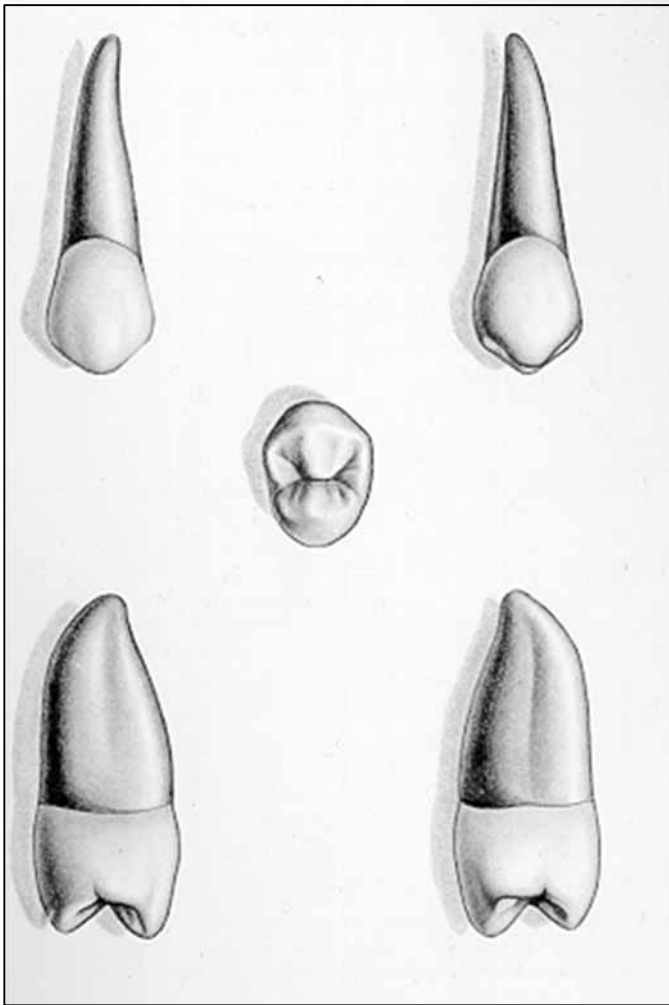
J. On the average the buccal and lingual cusp tips are separated by a distance of 6.0 millimeters.

VI. Roots

The root may be slightly longer than the root of the maxillary premolar. It is flattened on the mesial and distal surface. Linear depressions are on both the mesial and distal surfaces. The apex is blunt and is frequently curved toward the distal.

VII. How to distinguish a right or a left maxillary second premolar

- A. The buccal cusp is the larger of the two cusps.
- B. The tip of the lingual cusp is inclined toward the mesial



The Mandibular First Premolar

I. The tooth in general

The mandibular first premolar is the smallest of the premolars and differs greatly in form when compared with the maxillary premolars. It is the fourth tooth distal from the median line. Eruption occurs between the tenth and twelfth year following the exfoliation of the first deciduous molar.

II. The crown in general

A. Type - The crown is complex in type, but due to its form the function of the tooth is more similar to a cuspid than a typical premolar.

B. Number of lobes - Four: the fourth lobe or lingual cusp is very small compared to the three buccal lobes.

C. Shape - The crown has many characteristics of the cuspid.

D. Relationship to the long axis of the tooth - The tip of the buccal cusp is located on a mesio-distal plane passing through the long axis of the tooth.

III. The root in general

A. Number - one is usually presented.

B. Shape - The root is slender and tapering and is broader through its buccal portion.

IV. Axial surfaces of the crown

A. Buccal surface

1. Shape - The buccal surface presents three outstanding characteristics:

(a) A relatively constricted neck.

(b) A prominent cusp.

(c) A prominent axial ridge.

2. Mesial margin - the mesial margin converges rapidly from the base of the mesial slope of the occlusal margin to the cervical margin.

3. Distal margin - The distal margin is slightly more convex than the mesial margin.
4. Occlusal margin - The two slopes of the occlusal margin form a right angle at their junction.
5. Cervical margin - An arc of a small half-circle is presented.
6. Developmental seams - The two buccal developmental seams are often prominent.
7. Ridges
 - (a) The buccal axial ridge is prominent in the occlusal two-thirds of its length.
 - (b) The buccal cervical ridge is short, somewhat crescent shaped and presents a decided convexity.
8. Height of contour - The greatest convexity is noted in the cervical third.

B. Lingual surface

1. Shape - The lingual surface is about one-half the size of the buccal surface and is irregular in shape.
2. Mesial margin - The mesio-lingual developmental seam marks the junction of the mesial and lingual surfaces.
3. Distal margin - No definite location can be stated as to where the lingual surface joins with the distal surface.
4. Occlusal margin - The short slopes of the lingual cusp form the occlusal margin.
5. Cervical margin - The cervical margin is short with no curvature.
6. Height of contour - The greatest convexity is located near the occlusal border of the surface.

In viewing the tooth from a lingual aspect, most of the lingual portion of the buccal cusp may be seen.

C. Mesial surface

1. Shape - The outline of the mesial surface forms a figure almost triangular in form. It resembles the proximal surface of a mandibular cuspid.
2. Lingual margin - The lingual margin is short, appearing as a continuation of the occlusal margin.
3. Buccal margin - The buccal margin inclines toward the lingual. An acute angle is formed at its junction with the occlusal margin.
4. Occlusal margin - the occlusal margin slopes abruptly from the mesio-buccal angle toward the lingual margin. It follows the crest of the mesial marginal ridge, and exhibits the mesial portion of the central groove crossing the marginal ridge to the occlusal one-third of the surface.
5. Cervical margin - The curvature is slight with the cervical line sloping from lingual to buccal.
6. Position of the contact area - The contact area coincides with the mesio-distal plane passing through the long axis, and is located near the bucco-occlusal angle. It gives the appearance of a prominent projection.
7. Cervical area - The cervical area is flattened with the crown and root almost continuous in form.

D. Distal surface

1. Shape - Similar to the mesial surface but wider bucco-lingually.
2. Lingual margin - The lingual margin is short, and appears as a continuation of the occlusal margin.
3. Buccal margin - The buccal margin inclines toward the lingual, and is very similar to the mesial surface.
4. Occlusal margin - The occlusal margin differs from the mesial surface in that there is not as prominent a developmental groove crossing the distal marginal ridge.
5. Cervical margin - The curvature is slight with the cervical line sloping from lingual to buccal, slightly less than the mesial.

6. Position of the contact area - The contact area is less prominent than the mesial contact area. It occupies a slightly broader area than the mesial and is slightly more lingually placed in the bucco-occlusal angle.

7. Cervical area - The area is more pronounced than the mesial surface due to the increase of enamel in the disto-buccal developmental lobe.

V. Occlusal surface

A. General shape - The occlusal surface presents an outline somewhat egg shaped in form, with the greatest width being in the distal half. The mesio-buccal, disto-buccal and disto-lingual angles of the occlusal surface are prominent, while the mesio-lingual angle appears flattened and is crossed by a sulcus groove.

B. Marginal ridges

1. Mesial marginal ridge - The mesial marginal ridge is made up of a thickened roll of enamel. It slopes downward from the mesio-buccal angle, and is separated from the lingual marginal ridge by the mesio-lingual groove.

2. Distal marginal ridge - The roll of enamel is shorter and narrower than the mesial marginal ridge. It is placed at right angles to the long axis of the tooth.

3. Buccal marginal ridge - This ridge is the longest of the marginal ridges and is made up of the two slopes of the buccal cusp. It is almost straight from mesial to distal.

4. Lingual marginal ridge - The two short slopes of the lingual cusp form the lingual marginal ridge.

C. Cusps - The buccal and lingual cusp tips, on the average are separated by a distance of 2.8 millimeters

1. The buccal cusp presents a typical pyramidal form. The four ridges extending from the tip of the cusp are prominent and meet at right angles. The buccal cusp occupies four-fifths of the crown of the tooth.

2. The lingual cusp is small, sometimes appearing more like a tubercle than a cusp.

D. Fossa - A significant difference is noted in the fossa formation in comparison to the maxillary premolars.

1. Two distinct fossae are usually presented. They are separated by a transverse ridge running from the tip of the buccal cusp to the tip of the lingual cusp.

2. The distal fossa forms a triangular shaped depression larger in area and more regular in form than the mesial fossa. It also functions in occlusion while the elongated mesial fossa has no occlusion with an opposing tooth.

E. Triangular ridges - The triangular ridge of the buccal cusp is prominent and is continuous with the short triangular ridge of the lingual cusp. This continuous ridge is a typical transverse ridge characteristic of the mandibular first premolar.

F. Grooves

1. Developmental

(a) Central groove - Is usually divided by the transverse ridge into a mesial and distal half. The mesial half is often indistinct and is seldom sulcated. In some types however, the central groove may be deeply sulcated dividing the two triangular ridges, in which case a transverse ridge is not presented.

(b) Distal groove - Is short and not well defined.

(c) Distal triangular groove - Runs diagonally in a buccal direction. It is usually well defined and sulcated. The distal formative pit is found at the junction of the distal, the triangular and the central grooves.

(d) Mesio-lingual groove - Is usually deeply sulcated, and runs in a bucco-lingual direction and extends onto the lingual surface.

2. Supplemental grooves

(a) The buccal cusp supplemental grooves are significantly longer than the lingual cusp due to its size differential. They travel from the buccal cusp tip, lingually and terminate in the central groove to help form the mesial and distal occlusal pits.

(b) The supplemental grooves on the lingual cusp are indistinct and rarely present, except with a well-defined triangular ridge.

G. Inclined planes

1. Buccal cusp - Three inclined planes of the buccal cusp have occlusion with opposing inclined planes of the maxillary teeth, and are:

- (a) Disto-buccal
- (b) Disto-lingual
- (c) Mesio-buccal

The mesio-lingual inclined plane has no occlusion.

2. Lingual cusp - The disto-buccal inclined plane is the only functional plane of this cusp.

H. Masticatory table - Since the mandibular first premolar functions partly similar to mandibular cuspid, the masticatory table does not include the mesial fossa.

VI. Root

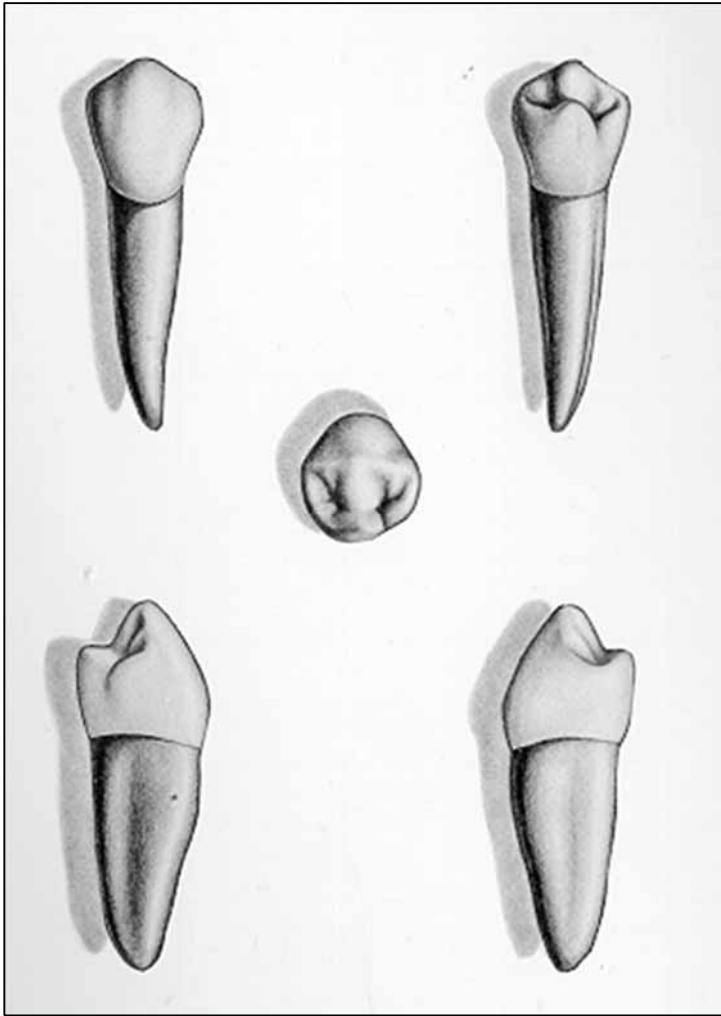
The root of the mandibular premolar tapers gradually from the cervix to the apex. A cross-section at the cervix presents an outline triangular in form. The buccal half is wider than the lingual half.

VII. How to distinguish a right or a left mandibular first premolar

- A. The buccal surface is easily determined by the large buccal cusp.
- B. The mesial surface may be distinguished by viewing the crown from an occlusal aspect and noting the silhouette outline. The constricted portion of the egg-shaped outline determines the mesial half.
- C. The extension of the mesio-lingual seam is located at the mesio-lingual angle.
- D. The prominence of the mesio-lingual developmental groove denotes the mesial portion of the mandibular first premolar.

VIII. Applied anatomy

- A. The formative pit of the distal fossa and the susceptible area below the bucco-cervical ridge are often subject to carious lesions.
- B. Because of the bell-shaped crown, the preparation of the tooth for a full crown restoration may necessitate extensive removal of tooth structure.
- C. Because of the short lingual walls of the crown the mandibular first premolar is a less than an ideal abutment for a partial veneer restoration, due to lack of retention and resistance form.
- D. Since the mesial fossa is not involved in occlusion it provides an excellent location for the rest seat area of a clasp for a removable partial denture.



The Mandibular Second Premolar

I. The tooth in general

The mandibular second premolar is larger than the mandibular first premolar and also significantly differs in form from the maxillary premolar. The mandibular second premolar is the fifth tooth from the medial line. Eruption occurs between the tenth and twelfth year following the exfoliation of the second deciduous molar.

II. The crown in general

A. Type- The crown is complex since inclined planes, ridges and other landmarks are presented.

B. Number of lobes of development - Four to five: three labial lobes of development with variation in the lingual lobes from one to two.

C. Shape - Generally similar to the mandibular first premolar, however it resembles a small molar.

D. Relationship to the long axis - The buccal cusp tip is centered mesio-distally, and the lingual inclination of the crown and of its buccal surface is not quite as great as on the mandibular first premolar.

III. The root in general

A. Number - The tooth usually has one root.

B. Shape - In general, the root is larger in the bucco-lingual than in the mesio-distal direction. The root, in cross section, is similar to the mandibular first premolar, and tapers evenly to the apex. In cross section it is slightly oval.

IV. Axial surfaces of the crown

A. Buccal surface

1. Shape - The mandibular second premolar resembles the mandibular first premolar except:

- (a) The crown and root are slightly larger than the mandibular first premolar, and the buccal cusp is not as sharp or high as the first premolar.
- (b) The buccal cusp is centered mesio-distally making the buccal cusp slopes equal in length.

2. Mesial margin - The mesial margin resembles the mandibular first premolar. It converges rapidly from the base of the mesial slope of the occlusal margin to the cervical margin.

3. Distal margin - The distal margin is slightly more convex than the mesial margin.

4. Occlusal margin - The two slopes of the occlusal margin form a right angle at their junction.

5. Cervical margin - An arc of a small half-circle is presented, similar to the mandibular first premolar.

6. Developmental seams - The two buccal development seams are often prominent.

7. Ridges

- (a) The buccal axial ridge is prominent in the occlusal two-thirds of its length.
- (b) The buccal cervical ridge is not as short as the mandibular first premolar and not quite as convex.

8. Height of contour - The greatest convexity is noted in the cervical third slightly more occlusal than with the mandibular first premolar.

B. Lingual surface

1. Shape - The lingual surface is about one-half the size of the buccal surface and is irregular in shape.

2. Mesial margin - The mesio-lingual developmental seam marks the junction of the mesial and lingual surfaces.

3. Distal margin - The disto-lingual developmental seam marks the junction of the mesial and lingual surface.

4. Occlusal margin - The short slopes of the two lingual cusps form the occlusal margin

5. Cervical margin - The cervical margin slopes occlusally from mesial to distal in a small arc.

6. Height of contour - The greatest convexity is located near the occlusal one-third of the surface.

C. Mesial surface

1. Shape - The outline of the mesial surface is not as triangular as the mandibular first premolar, and is larger in area.

2. Lingual margin - The lingual margin appears relatively continuous with the margin of the root, which places the linguo-cervical junction nearer the long axis than the linguo-occlusal margin.

3. Buccal margin - The buccal margin inclines toward the lingual, however not as rapidly as in the mandibular first premolar. An acute angle is formed at its junction with the occlusal margin.

4. Occlusal margin - The occlusal margin slopes abruptly from the mesio-buccal angle toward the lingual margin.

5. Cervical margin - The curvature is more pronounced than the mandibular first premolar with a slight arc toward the occlusal from buccal to lingual.

6. Position of the contact area - The contact area is located near the bucco-occlusal angle in the occlusal one-third.

7. Cervical area - The cervical area is similar to the mandibular first premolar, and is flattened with the crown and root almost continuous in form.

D. Distal surface

1. Shape - The outline of the distal surface is not as triangular as the mandibular first premolar, and is larger in surface area than the mesial aspect.

2. Lingual margin - The lingual margin is slightly shorter than the mesial aspect.

3. Buccal margin - The buccal margin inclines toward the lingual, however not as acutely as the mandibular first premolar.
4. Occlusal margin - The occlusal margin slopes abruptly from the disto-buccal angle toward the lingual margin. It follows the crest of the distal marginal ridge.
5. Cervical margin - The curvature is similar to the mesial with the line sloping from lingual to buccal.
6. Position of the contact area - The contact area is slightly larger in area than the mesial and somewhat ovoid. The area is located in the occlusal one-third toward the buccal line angle, but not as far as the mesial contact area.
7. Cervical area - The cervical area is relatively flat with the crown and root almost continuous in form.

V. Occlusal surface

A. General shape - The occlusal surface present an outline almost square. The mesial and distal are nearly parallel and the buccal and lingual surfaces with the exception of the buccal middle developmental lobe being prominent, define the outline.

B. Marginal ridges

1. Mesial marginal ridge - Starts at the mesio-buccal angle, and runs slightly disto-lingual to join the lingual marginal ridge at the mesio-lingual angle.
2. Distal marginal ridge - Similar to the mesial marginal ridge, except runs slightly mesio-lingual to join the lingual marginal ridge at the disto-lingual angle.
3. Buccal marginal ridge - This ridge is the longest of the marginal ridges and is made up of the mesial and distal slope of the buccal cusp. It is almost straight from mesial to distal.
4. Lingual marginal ridge - The four slopes of the two lingual cusps form the lingual marginal ridge. This marginal ridge is considerably longer mesial-distal than the mandibular first premolar.

C. Cusps - The buccal and mesio-lingual cusp tips are separated, on the average a distance of 5.0 millimeters

1. The buccal cusp presents a pyramidal form. The four ridges extending from the tip of the cusp are prominent, although not as prominent as the mandibular first premolar and meet at right angles.

2. The lingual cusp may take two basic forms:

(a) Two cusp - Most common form. Two small lingual cusps with the mesial being approximately twice as large in surface area as the distal cusp.

(b) One cusp - Frequently the single cusp is offset toward the mesial and is not nearly as prominent as the buccal cusp. This development occurs less frequently than the two-cusp form.

D. Fossae - A significant difference is noted in the fossa formation in comparison to the mandibular first premolars.

1. Two distinct fossae are usually presented, mesial and distal. They are separated by the triangular ridge running from the tip of the buccal cusp to the central groove separating the mesial and distal lingual cusps. The mesial and distal fossae are irregular, triangular in shape and shallow. They are larger in area than the mandibular first premolars.

E. Triangular ridges - Each of the three cusps presents with a triangular ridge.

1. Triangular ridge of the buccal cusp - this ridges run from the tip of the cusp in a lingual direction, ending in the junction of the central groove and the lingual groove which separates the two lingual cusps. It extends more lingual than one-half the distance to the lingual marginal ridge. It is the most prominent triangular ridge of the three cusps.

2. Triangular ridge of the mesio-lingual cusp - This ridge is the most prominent of the lingual cusp triangular ridges and runs from the tip of the cusp in a disto-buccal direction to the central groove.

3. Triangular ridge of the disto-lingual cusp - This ridge is the least prominent of the lingual cusp triangular ridges and runs from the tip of the cusp in a mesio-buccal direction to the central groove and terminates slightly more buccal than the triangular ridge of the mesio-lingual cusp.

F. Grooves - Three occlusal groove patterns can present on the mandibular second premolar and are named for their shape. The most common is the "Y" type and gives rise to the three-cusp configuration. This configuration will be described below. The other two less common configurations are the "U" and "H" patterns most often associated with the single lingual cusp. The grooves that determine this configuration are developmental grooves.

1. Developmental

- (a) Central groove - Extends from the mesial portion of the mesial marginal ridge and extends to the distal marginal ridge in an irregular fashion roughly dividing the occlusal surface in to a buccal two-thirds and lingual one-third arrangement. The central groove can also be divided into the mesial and distal portion.
- (b) Lingual groove - Separates the two lingual cusps. Begins in junction with the central groove at the base of the buccal cusp triangular ridge and runs over the lingual marginal ridge to the occlusal one-third of the axial surface

2. Supplemental

- (a) All three cusps have supplemental grooves on the mesial and distal surfaces of their triangular ridge. The buccal cusp has the most prominent supplemental grooves with the grooves on the mesial and distal lingual cusp less prominent due to their size.

G. Inclined Planes - The inclined planes within the distal fossa are all functional planes and occlude with the inclined planes of the lingual cusps of the maxillary second premolar. The inclined planes of the mesial fossa are usually non-functional.

H. Masticatory table - The masticatory table includes a portion of the buccal inclined planes of the buccal cusp in addition to the inclined planes of the occlusal table.

VI. Root

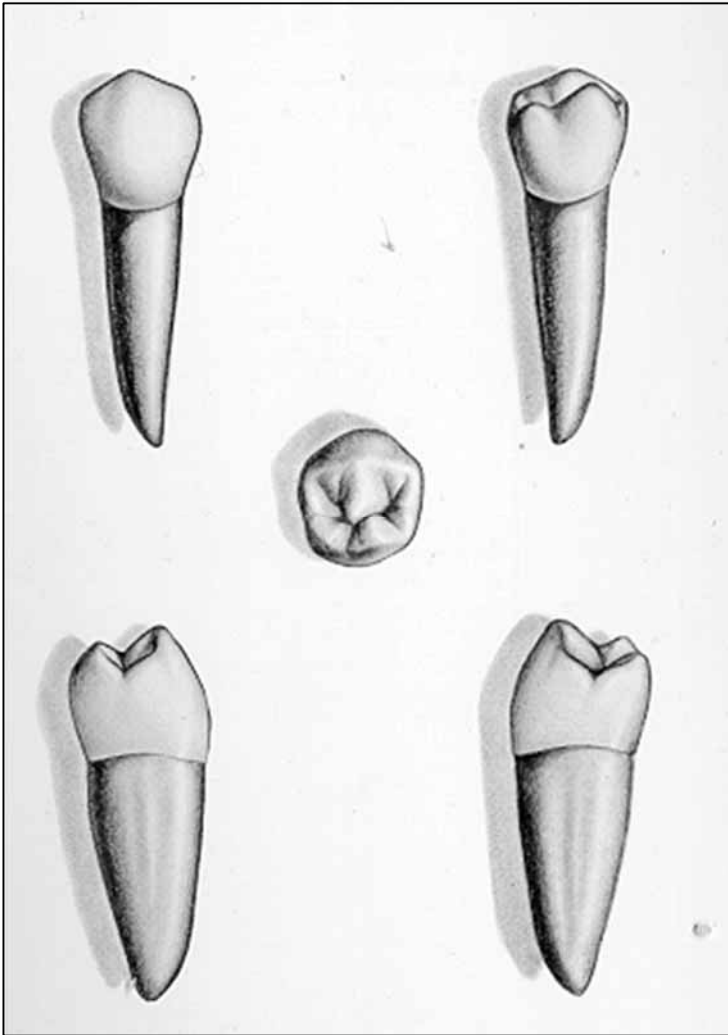
The root of the mandibular second premolar tapers evenly from the cervix to the apex and has a slight distal inclination. A cross section at the cervix presents an oval form. The root is very similar overall to the mandibular first premolar, only larger. Occasionally two root canals are present.

VII. How to distinguish a right or a left mandibular second premolar

- A. The buccal surface is easily determined by the large buccal cusp.
- B. When two lingual cusps are present the larger of the two is located on the mesial.
- C. If one lingual cusp is present distinguishing right from left is very difficult.
- D. The root usually has a distal curvature.

VIII. Applied anatomy

- A. Due to the reasonably large crown and root the mandibular second premolar is frequently used for an abutment in fixed and removable prosthodontics.
- B. The mandibular premolars are occasionally congenitally missing with the patient exhibiting retained deciduous molars.
- C. Because the mesial fossa is frequently non-functional it is an excellent area to place a rest seat for a removable partial denture.



The Molars in General

The most complex type of tooth are the molars both maxillary and mandibular. The occlusal surfaces are larger in area than the pre-molars and present a greater number of grooves and ridges. Greater efficiency is developed in the function of grinding and triturating food. Since a greater amount of stress is exerted upon these teeth, a provision has been made by nature to strengthen their support by the addition of an increased number of roots, and by a thickening of the alveolar process.

A difference in the development of the premolar and molars is noted by the location of the developmental lobes. Each cusp of a molar is developed from a single lobe, while the buccal cusp of a premolar is formed from three lobes.

The maxillary and mandibular molars differ greatly in form. A few of the noted differences are:

- The height of contour.
- The shape and outline of the occlusal surface.
- The number and location of the cusps.
- The number and location of the grooves
- The size and shape of the fossae.
- The number and location of the roots.

The Maxillary First Molar

I. The tooth in general

The first molar is often called the "six year molar" because of the age at which it erupts. It takes its position in the arch just distal to the deciduous second molar. It is the sixth tooth distal to the median line. The correct development of the permanent arch is largely dependent on the occlusion of the maxillary and mandibular first molars.

Caries frequently occurs on the occlusal surface or buccal pit of a newly erupted tooth due to an imperfect union of the lobes. The caries progress is

rapid and, if neglected, may result in a carious exposure of the pulpal tissue remedied only by endodontic therapy or extraction of the tooth. The earliest possible care should therefore be observed to preserve not only the tooth, but to prevent a mutilated dental arch.

II. The crown in general

A. Type - complex, presenting five surface and many anatomic markings are present.

B. Number of lobes of development - Five: four main lobes are present with a small fifth lobe, sometimes only rudimentary, which is observed on the lingual aspect of the mesio-lingual cusp.

C. Shape - The crown is cuboidal, with the axial surfaces meeting at two obtuse and two acute angles.

D. Relationship to the long axis of the tooth - The mesial aspect of the tooth shows the lingual surface inclining more to the buccal, placing the tip of the mesio-lingual cusp nearer the long axis than the tip of the mesio-buccal cusp.

III. The roots in general

A. Number - The tooth usually has three roots.

B. Shape - In general, all three roots are of conical shape with a flattened oval cross section.

IV. Axial surfaces of the crown

A. Buccal surface

1. Shape - Trapezoidal, with the cervical portion narrower than the occlusal portion. Its mesio-distal width is greater than its length. In relation to the lingual surface, the buccal surface is placed more mesially, producing an obtuse angle at its union with the distal surface.

2. Mesial margin - Almost straight with a slight convergence toward the cervix. It is important that the correct location of this margin be established.

3. Distal margin - More convex than the mesial margin with a convergence toward the cervix.

4. Occlusal margin - Made up of four slopes of the two buccal cusps. The distal slopes of both the mesio-buccal and disto-buccal cusps are longer than the mesial slopes.

5. Cervical margin - Straight, curving slightly at its mesial and distal extremities to meet the mesial and distal margins. Sometimes an arrow-like deflection is observed at the junction of the two buccal roots, pointing occlusally.

6. Ridges - Two axial ridges and a bucco-cervical ridge are found on the buccal surface.

(a) The buccal axial ridge of the mesio-buccal cusp is prominent, running from the tip of the mesio-buccal cusp toward the cervix, parallel to the buccal groove, and ending in the cervical one-third of the surface.

(b) The buccal axial ridge of the disto-buccal cusp is not as prominent and ends slightly short of the cervical one-third of the surface.

(c) The bucco-cervical ridge runs parallel with the cervical margin. Its crest follows the height of contour.

7. Developmental seams - The buccal groove is located near the center of the surface. The groove runs between the cusps in a cervical direction and ends about one-half the distance between the occlusal and cervical margins.

8. Height of contour - A line representing the height of contour begins at a point slightly below the junction of the mesial slope of the mesio-buccal cusp and the mesial margin drops toward the cervix to a point represented by the junction of the buccal axial ridge of the mesio-buccal cusp with the bucco-cervical ridge. It follows the crest of the cervical ridge, then rises to a point slightly below the junction of the distal margin with the distal slope of the disto-buccal cusp.

B. Lingual surface

1. Shape - The lingual surface is larger in area and more convex both mesio-distally and occluso-cervically in comparison with the buccal surface.

2. Mesial margin - Convex and appears to be continuous with the outline of the lingual root.

3. Distal margin - Convex and very similar to the mesial margin.

4. Occlusal margin - Formed by the four rounded slopes of the two lingual cusps. This margin is not as regular in its mesio-distal extent as the occlusal margin of the buccal surface.

5. Cervical margin - Straight, and is not as prominent as found on the buccal surface. This margin is longer than the cervical margin of the buccal surface.

6. Ridges - Theoretically two axial ridges run from the tip of the lingual cusps. Anatomically two convex elevations are present.

7. Developmental seams

(a) The axial portion of the disto-lingual groove crosses the occlusal margin between the two lingual cusps and extends about halfway down on the lingual surface.

(b) A mesio-lingual groove may be presented when the fifth cusp is well developed

8. Height of contour - A line marking the height of contour would be located in the cervical one-third running from mesial to distal.

9. The fifth cusp- This cusp varies in size from a rudimentary bulge to a well-defined elevation. It is located in the mesial half of the lingual surface in the middle third and may be separated from the mesio-lingual cusp by a crescent shaped groove, convex toward the occlusal, which sometimes joins with the disto-lingual groove. This cusp is named the "Cusp of Carabelli".

C. Mesial surface

1. Shape - The mesial surface presents a flattened appearance especially in the cervical half. It is wider in its bucco-lingual extent and has its greatest convexity in the occlusal third. The mesio-bucco-occlusal angle is prominent.

2. Lingual margin - Convex, with a buccal inclination of the occlusal two-thirds. The junction of the mesial and lingual surfaces form an obtuse angle. A pronounced convexity produced by the fifth cusp is often observed in the cervical half at the junction of the mesial and lingual surfaces.

3. Buccal margin - Straight with a slight lingual inclination. The mesial surface joins the buccal surface at a slightly acute angle.

4. Occlusal margin - Almost straight or slightly concave toward the cervix. It is sometimes crossed by a groove from the occlusal surface.

5. Cervical margin - The curvature is slight.

6. Position of the contact area - The contact area is located in the occlusal one-third. It is ovoid in shape and near the occluso-mesio-buccal line angle.

7. Cervical area - The cervical area is flattened bucco-lingually almost appearing as a concavity near the cervical margin.

8. Height of contour - The line formed is irregular, rising from the cervical one-third on the buccal to the contact area, then dropping down to the cervical third of the lingual margin.

D. Distal surface

1. Shape - The distal surface is more irregular than the mesial surface. A decided convexity similar in shape to a segment of a sphere is presented and a concave area is found on the buccal half in the cervical third.

2. Lingual margin - The lingual margin is decidedly convex.

3. Buccal margin - Slightly concave in the cervical one-half.

4. Occlusal margin - Slightly V-shaped, more concave than the mesio-occlusal margin and crossed by the distal portion of the disto-lingual groove in its buccal half.

5. Cervical margin - A slight curvature is presented.

6. Position of the contact area - Located more to the lingual and to the cervical in relation to the position of the mesial contact area.

7. Cervical area - A concavity is observed in the buccal half. The lingual half is convex.

8. Height of contour - The line forms an irregular arc with the crest to the lingual of the center of the surface.

V. Occlusal surface

A. General shape - The outline formed by the marginal ridges presents a rhomboidal figure, having two opposite angles obtuse and the other two opposite angles acute. The surface as a whole is placed more to the buccal of the silhouette outline of the crown when viewed from the occlusal aspect

1. Angles of the occlusal surface:

- (a) Mesio-buccal: slightly acute, and slightly rounded.
- (b) Disto-buccal: obtuse and rounded.
- (c) Mesio-lingual: obtuse and rounded.
- (d) Disto-lingual: acute, slightly rounded.

B. Marginal ridges

1. Mesial marginal ridge - This ridge is short and broad, and is important in preventing food from lodging in the interproximal space. It starts at the mesio-buccal angle, ends at the mesio-lingual angle, and is crossed in the center of its length by an extension of the mesial groove as a fine line.

2. Distal marginal ridge - Longer and more concave than the mesial marginal ridge and crossed in its buccal half by an extension of the distal portion of the disto-lingual groove.

3. Buccal marginal ridge - This ridge is prominent, forming the buccal boundary of the occlusal surface. It is made up of four slopes of the two cusps and is crossed by the buccal groove in the center of its length.

4. Lingual marginal ridge - Made up of four rounded slopes of the two lingual cusps. At the base of the distal slope of the mesial-lingual cusp, the continuity of the marginal ridge is broken by its union with the oblique ridge. The axial portion of the disto-lingual groove crosses the lingual marginal ridge slightly to the distal of the center of its length.

C. The cusps - The mesial and distal separation of the buccal and lingual cusp tips average 5.0 millimeters. The buccal and lingual cusp tips are separated, on the average by a distance of 6.5 millimeters

1. Mesio-buccal cusp - Occupies the mesio-buccal portion of the occlusal surface. The cusp is angular, presenting the typical cusp anatomy of four ridges and four inclined planes.

2. Mesio-lingual cusp - Largest of the four cusps, but more rounded in appearance. This cusp acts as a pestle in the mortar formed by the fossa of the mandibular first molar.

3. Disto-buccal cusp - Slightly smaller than the mesio-buccal cusp and usually appears more pointed and slightly longer.

4. Disto-lingual cusp - Occupies the disto-lingual portion of the occlusal surface. The distal inclined planes of this cusp are larger in area than its mesial inclined planes.

5. Fifth cusp - The Cusp of Carabelli varies in size from a rudimentary bulging to a fairly prominent cusp on the lingual surface of the mesio-lingual cusp.

D. Fossae - Two fossae are found on the occlusal surface of the maxillary first molar.

1. The central, or sometimes called the mesial fossa, occupies about two-thirds of the occlusal surface. It is somewhat triangular in shape with the apices of the triangle located at the tips of the mesio-buccal, the mesio-lingual and the disto-buccal cusps. The central inclines of these cusps make up the fossa.

2. The distal fossa is ovoid in shape and occupies the distal one-third of the occlusal surface. It is bounded on the distal by the distal marginal ridge and on the mesial by the oblique ridge. The mesial and distal slopes of the disto-lingual cusp form the lingual boundary, while the buccal boundary is formed by the distal slope of the disto-buccal cusp.

E. Triangular ridges

1. Triangular ridge of the mesio-buccal cusp - This ridge runs from the tip of the mesio-buccal cusp in a slight disto-lingual direction into the central fossa, ending distally in the center of the mesial groove.

2. Triangular ridge of the disto-buccal cusp - Runs lingually to the distal groove and forms the buccal half of the oblique ridge.

3. Triangular ridge of the mesio-lingual cusp - Runs buccally and slightly distal from the tip of the cusp to the mesial groove meeting the triangular ridge of the mesio-buccal cusp at its base. This ridge is flattened and rounded in appearance.

4. Triangular ridge of the disto-lingual cusp - A short, rounded ridge that runs in a buccal direction into the distal fossa.

E. The oblique ridge (*found only on maxillary molars*) - It is a modified transverse ridge made up of the triangular ridge of the disto-buccal cusp and a continuation of this ridge called the lingual portion of the oblique ridge. The lingual portion starts at the point marked by the crossing of the distal groove, and runs in an oblique (mesio-lingual) direction to the base of, and continuous with, the distal slope of the mesio-lingual cusp. The triangular ridge of the mesio-lingual cusp is entirely separate from the oblique ridge. The oblique ridge separates the central and distal fossae.

F. Grooves

1. Developmental

- (a) Buccal groove - Originates in the center of the central fossa from the central pit, runs upward in a buccal direction, crosses the buccal marginal ridge and extends down on the buccal surfaces. The groove may be more specifically described by dividing it into an occlusal portion and an axial portion.
- (b) The crescent shaped mesio-lingual groove as observed on the lingual aspect of the mesio-lingual cusp, varies in prominence, depending upon the size of the fifth cusp. When the lobe formation is lacking, the mesio-lingual groove is classified as a supplemental groove.
- (c) Central groove extends in a mesio-distal direction connecting the mesial and distal pits, and carries over the mesial and distal marginal ridges. It becomes less distinct over the oblique ridge and thus can be divided into a mesial and distal portion.
- (d) Disto-lingual groove runs from the distal pit, obliquely onto the lingual surface separating the mesio-lingual cusp from the disto-lingual cusp, and paralleling the oblique ridge to the distal aspect of it.

2. Supplemental grooves

- (a) All maxillary molar cusps have supplemental grooves except the Cusp of Carabelli.
- (b) The disto-lingual cusp exhibits the shortest supplemental grooves that run from the tip of the cusp mesially toward the central pit.
- (c) The disto-buccal and mesio-buccal triangular ridge supplemental grooves are located on the mesial and distal surface from the convexity of the triangular ridges, with the disto-buccal cusp's distal supplemental groove running into the distal pit and connecting with the distal lingual developmental groove. The supplemental grooves of the mesio-buccal cusp angle distal lingual from the tip of the cusp with the mesial groove almost paralleling the central groove.
- (d) Two supplemental grooves are found on the mesial and distal of the triangular ridge of the mesial lingual cusp and are the longest on the tooth, due to the large size of the cusp and triangular ridge. The grooves run almost parallel from the tip of the cusp to the central pit and central developmental groove

G. Inclined planes - Each of the four cusps present four inclined planes. Two additional inclined planes are also presented by the lingual portion of the oblique ridge, known as the mesial and distal inclines of the lingual portion of the oblique ridge.

H. Masticatory table - The masticatory table includes a portion of the lingual planes of the lingual cusps in addition to the planes of the occlusal surface.

VI. Roots

The maxillary first molar presents with three divergent roots, two on the buccal and one on the lingual that projects from a common root trunk.

A. Mesio-buccal root - Located under the mesio-buccal cusp. This root is flattened on its mesial and distal surfaces. It inclines toward the mesial in the cervical one-half of its length, while the apical one-half inclines to the distal. A cross-section shows an egg-shaped outline with the greatest width through the buccal portion. Viewed from a mesial aspect, the mesio-buccal root appears to overlap the lingual root at their junction.

B. Disto-buccal root - Located under the disto-buccal cusp. This root appears more circular in outline. It is smaller than the mesio-buccal root. The cervical one-half is straight, while the apical one-half may have either a mesial or a distal inclination.

C. Lingual (palatal) root - Located under both the mesio-lingual and disto-lingual cusps. This root is the largest and longest of the three roots. It is broad mesio-distally and flattened on its buccal and lingual surfaces, sometimes presenting prominent longitudinal grooves on these surfaces. The cervical one-half inclines slightly to the lingual, while the apical one-half generally has a buccal inclination. Some specimens present a widely divergent lingual root projecting beyond the plane of the lingual surface of the crown. Viewed from a distal aspect the lingual root overlaps the disto-buccal root at their junction.

VII. How to distinguish a right or left maxillary first molar

A. The angles of the occlusal surface should be determined as those forming acute or obtuse angles. The mesio-buccal and disto-buccal angles are acute.

B. The larger fossa is located in the mesial portion of the occlusal surface, and contains the mesial and buccal grooves that are approximately at right angles to each other.

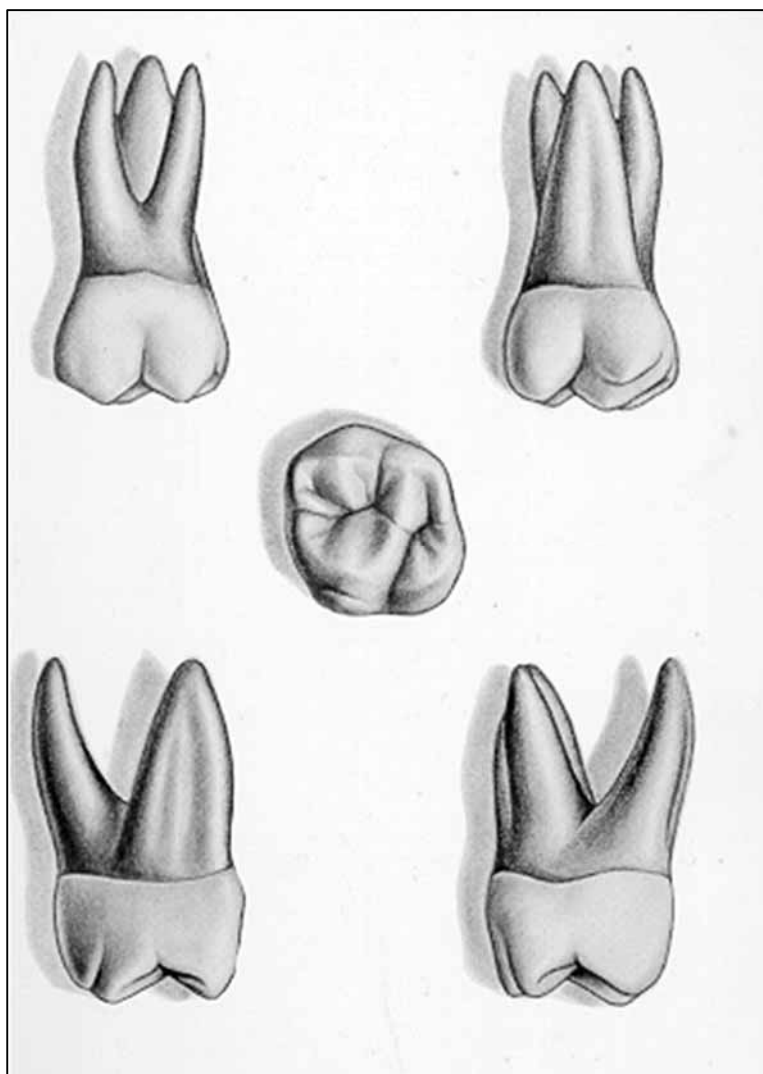
C. The buccal aspects shows the two roots.

D. Most often the mesial lingual will present with a Cusp of Carabelli.

E. The oblique ridge is located in the distal portion of the occlusal surface.

VIII. Applied anatomy

More restorative dentistry is necessary on the first molars than any other teeth. Due to the size of the crown and size and configuration of the roots the first molar is an excellent abutment tooth for fixed restorations.



The Mandibular First Molar

I. The tooth in general

The mandibular first molar differs greatly from the maxillary first molar both in form and descriptive anatomy. It is the sixth tooth distal from the median line. This tooth erupts at six years of age, but may precede the maxillary molar by several months.

II. The crown in general

A. Type - Complex, presenting five surfaces, five cusps and five developmental lobes.

B. Number of lobes of development - Five: three buccal and two lingual.

C. Shape - Cuboidal

D. Relationship to the long axis of the tooth - From the mesial aspect the crown appears inclined to the lingual in relation to the long axis, placing the buccal cusps nearer the mesio-distal than are the lingual cusps closer to the mesio-distal plane than the lingual cusps.

III. The root in general

A. Number - The tooth usually has two roots, one mesial and one distal.

B. Shape - In general, both roots are wider bucco-lingually and have mesial and distal developmental depressions or root concavities that present a flattened oval in cross section.

IV. Axial surfaces of the crown

A. Buccal surface

1. Shape - Trapezoidal, appearing relatively wider mesio-distally than the buccal surface of the maxillary first molar.

2. Mesial margin - Converges slightly toward the cervix.

3. Distal margin - More convex than the mesial margin, with the distal surface having the appearance of overhanging the cervix.

4. Occlusal margin - This margin is the longest of the margins found on the crown of the mandibular first molar. It is made up of five slopes of three cusps. The mesial slope of the distal cusp is considered a portion of the occlusal margin.

5. Cervical margin - Straight from mesial to the distal, often presenting a slightly pointed projection in the center of its length.

6. Grooves - Two grooves are found on this surface:

(a) Buccal groove - Located slightly to the mesial of the center of the occlusal margin, but if extended would cut the cervical margin at its center, and would correspond to the bifurcation of the roots. This groove is an extension of the buccal groove of the occlusal surface. After crossing the occlusal margin, it descends parallel to the long axis, and ends in the cervical one-third of the buccal surface.

(b) Disto-buccal groove - Appears on the buccal surface in its distal third. After crossing the occlusal margin, between two cusp slopes, it descends in a slight disto-cervical direction to the cervical third of the surface. If extended, this groove would coincide with the distal border of the distal root.

7. Ridges

(a) Buccal axial ridge of the mesio-buccal cusp - Runs from the tip of the cusp to the cervical third of the buccal surface, and is parallel to the buccal groove.

(b) Buccal axial ridge of the disto-buccal cusp - Runs from the tip of the cusp parallel with the buccal groove. These two axial ridges are similar in shape and length.

(c) The axial ridge of the distal cusp - Is a short ridge and is not well defined. In location it coincides with the ling angle marking the junction of the buccal and distal surfaces.

(d) The bucco-cervical ridge - Is prominent and may be important in deflecting food over the gingival crest.

8. Height of contour - The greater portion of the line runs from mesial to distal in the cervical third of the surface and follows the crest of the bucco-cervical ridge.

B. Lingual surface

1. Shape - Trapezoidal, wider through the occlusal portion than in the cervical portion. The surface in general is smaller in area than the buccal surface, and exhibits more of a rounded appearance.
2. Mesial margin - Converges toward the cervix, and is relatively flat.
3. Distal margin - Is very similar to the mesial margin.
4. Occlusal margin - Made up of four slopes of the two lingual cusps, of which the central inclines are the longer. The tip of each lingual cusp presents a typical rounded peak appearing as a slight projection.
5. Cervical margin - Straight, with practically no overhang of enamel.
6. Ridges - Theoretically, two lingual axial ridges would be present on the lingual surface. Anatomically, two rounded and circular elevations are found.
7. Grooves - The lingual groove is located between the central inclines of the two lingual cusps, dividing the lingual surface into equal halves. This groove, after crossing the occlusal margin, descends in a cervical direction parallel to the long axis and ends half-way between the occlusal and cervical margins. It is not as prominent on the lingual surface as the buccal groove of the buccal surface. A very fine line is often presented.
8. Height of contour - A line denoting the height of contour would be straight from the mesial to distal and located in the occlusal half of the surface.

C. Mesial surface

1. Shape - This surface presents a flattened appearance with the greatest convexity in the occlusal third. Its outline is a parallelogram, with the acute angles placed at the bucco-cervical and lingo-occlusal junction.
2. Lingual margin - Appears continuous with the lingual margin of the root placing the linguo-cervical junction nearer the long axis than the linguo-occlusal junction.
3. Buccal margin - Presents a slightly convex appearance, and inclines toward the lingual.

4. Occlusal margin - Presents a slight concave appearance and inclines toward the lingual.
5. Cervical margin - The curvature is slight.
6. Position of the contact area - Located in the bucco-occlusal third of the surface, oval in shape.
7. Cervical area - Presents a flattened almost concave appearance.
8. Height of contour - The crest of the line denoting the greatest convexity is marked by the contact point. The lingual termination is located near the middle of the surface, while the buccal termination is in the cervical one-third.

D. Distal surface

1. Shape - The distal surface of the mandibular first molar is decidedly convex in its occlusal two-thirds. It is less in area than the mesial surface.
2. Lingual margin - Similar to the lingual margin of the mesial surface.
3. Buccal margin - Located more to the lingual in relation to the buccal margin of the mesial surface.
4. Occlusal margin - Includes the distal slope of the distal cusp, forming a shorter occlusal margin than that of the mesial surface. The distal groove of the occlusal surface crosses over the occlusal margin slightly to the lingual of its center.
5. Cervical margin - The curvature is slight.
6. Position of the contact area - Located nearer the disto-buccal angle, and slightly lower than the mesial contact point to the occlusal margin, and slightly larger in surface area than the mesial.
7. Cervical area - Presents a concavity caused by the overhang of the occlusal portion of the distal cusp.
8. Height of contour - The line varies, depending upon the location of the distal cusp.

V. Occlusal surface

A. General shape - The outline formed by the marginal ridges present a figure trapezoidal in shape with the buccal boundary representing the longest dimension. The surface, as a whole, is narrower than the silhouette outline of the crown and is placed to the lingual in relation to the crown outline.

1. The angles of the occlusal surface:

- (a) Mesio-buccal: slightly acute of a right angle.
- (b) Mesio-lingual: slightly obtuse or a right angle.
- (c) Disto-buccal: slightly obtuse and rounded formed by the distal cusp.
- (d) Disto-lingual: slightly obtuse.

B. Marginal ridges

1. Mesial marginal ridge - Starts at the mesio-buccal angle, and runs in a slightly disto-lingual direction to join with the lingual marginal ridge at the mesio-lingual angle.

2. Distal marginal ridge - Starts at the tip of the distal cusp and includes the disto-lingual slope of the distal cusp. It joins with a short distal marginal ridge and meets the lingual marginal ridge forming an obtuse and convex angle. The ridge, as a whole is somewhat convex toward the distal.

3. Buccal marginal ridge - The buccal marginal ridge is the longest of the marginal ridges. It runs from the mesio-buccal angle in a distal direction parallel to the mesio-distal plane, and joining with the distal marginal ridge at the disto-buccal angle. It is composed of five slopes of the three cusps.

4. Lingual marginal ridge - This ridge is formed by the four slopes of the two lingual cusps, but is not as long as the buccal marginal ridge. The two are parallel.

C. The cusps - The mesio-buccal and disto-buccal cusp tips are separated by a distance of 5.0 millimeters. The mesial and distal lingual cusp tips are separated by 6.0 millimeters. The mesial buccal and lingual cusp tips are separated by 6.0 millimeters. The distance between the distal and disto-lingual cusp tips is 5.0 millimeters.

1. Mesio-buccal cusp - The mesio-buccal cusp may be slightly larger in area than the disto-buccal cusp. Typical ridges and inclined planes are presented.

2. Disto-buccal cusp - Equal in height to the mesio-buccal cusp, but less in area mesio-distally in its occlusal portion.

3. Distal cusp - Located at the disto-buccal angle, this cusp. This cusp differs in form when compared with the two buccal cusps. The mesial and distal slopes of the distal cusp form an arc when viewed from an occlusal aspect. The buccal-axial ridge is barely visible due to the overhang of the cusp in relation to the cervix. The buccal axial ridges of the two buccal cusps are visible in their entire length from the occlusal. The distal cusp is generally not as high or prominent as the other buccal cusps of the mandibular first molar.

4. Mesio-lingual cusp - Appear more pointed than the buccal cusps. A line connecting the tips of the lingual cusps is parallel to the mesio-distal plane.

5. Disto-lingual cusp - The two lingual cusps are about equal in size and in height.

D. Fossae - Two fossae are found on the occlusal surface of the mandibular first molar.

1. The central fossa occupies the portion of the occlusal surface distal to the triangular ridges of the two mesial cusps.

2. A mesial supplemental fossa is presented in the mesial portion of the occlusal surface. This depression lies distal to the mesial marginal ridge and mesial to the triangular ridges of the mesial cusps. It is broad from buccal to lingual, and narrow in its mesio-distal extent.

E. Triangular ridges - Each of the five cusps presents with a triangular ridge.

1. Triangular ridge of the mesio-buccal cusp - This ridge runs from the tip of the cusp in a lingual direction, ending at the mesial groove which is located an equal distance between the tips of the mesial cusps.

2. Triangular ridge of the mesio-lingual cusp - This ridge is more prominent than the triangular ridge of the mesio-buccal cusp. From the tip of the mesio-lingual cusp, it runs in a disto-buccal direction. Sometimes a transverse ridge is formed accentuating the mesial supplemental fossa.

3. Triangular ridge of the disto-buccal cusp - The triangular ridge of this cusp is the longest of the triangular ridges, running from the tip of the cusp in a slightly mesio-lingual direction, and ending at the V-shaped deflection formed by the junction of the mesial, distal and lingual grooves.
4. Triangular ridge of the disto-lingual cusp - This ridge is slightly longer than the triangular ridge of the mesio-lingual cusp, and runs from the tip of the disto-lingual cusp to a point marked by the junction of the distal and disto-buccal groove.
5. Triangular ridge of the distal cusp - This ridge is shorter and more rounded in comparison to the other triangular ridges. It runs in a variable direction depending upon the location of the distal cusp. From the tip of the cusp, which marks the disto-buccal angle of the occlusal surface, the ridge usually runs in a mesio-lingual direction, ending at the base of the triangular ridge of the disto-lingual cusp.

F. Grooves

1. Developmental

- (a) Mesial groove - Originates in the deepest portion of the central fossa and is made up of two parts. The first one-third runs diagonally in a mesio-buccal direction to join with the buccal groove. The remaining or two-thirds runs mesially, separates the triangular ridges of the mesial cusps at their bases, runs through the mesial supplemental fossa, and crosses the mesial marginal ridge as a very fine line.
- (b) Buccal groove - Starts at its junction with the mesial groove in the central fossa. It runs buccally and upward in a direction approximately at right angles to the mesial portion of the mesial groove, crosses the buccal marginal ridge between the mesio-buccal and disto-buccal cusps, descends upon the buccal surface and ends in the cervical one-third of the buccal surface. A fault in the groove is often found near its termination that is called the buccal pit.
- (c) Distal groove - Originates at its junction with the lingual and mesial groove and has two parts. The first half runs diagonally in a disto-buccal direction joining with the disto-buccal groove at this point. The second or distal half runs distally and crosses the distal marginal ridge as a very fine line.

- (d) Lingual groove - Originates in the common pit formed by the junction of the mesial, distal, and lingual grooves. It runs lingually and upward in a direction parallel to the buccal groove, crosses the lingual cusp ridges between the lingual cusps, and descends on the lingual surface. The lingual portion is not as prominent as the grooves found on the buccal surface.
- (e) Disto-buccal groove - Originates at its junction with the distal groove, in the distal portion of the central fossa. It runs upward and buccal with a slight distal deflection, crosses the buccal marginal ridge between the disto-buccal and distal cusps, and descends on the buccal surface. If extended, the groove would coincide with the distal margin of the distal root.

2. Supplemental grooves

- (a) The mesio-buccal triangular and the mesio-lingual triangular grooves are located in the mesial supplemental fossa. Originating at their junction with the mesial groove, each supplemental groove runs toward the angles designated by their names. The mesio-buccal triangular groove separates the triangular ridge of the mesio-buccal cusp from the mesial marginal ridge, while the mesio-lingual triangular groove separates the triangular ridge of the mesio-lingual cusp from the mesial marginal ridge.
- (b) Two supplemental grooves are occasionally found near the distal marginal ridge running in a disto-buccal and disto-lingual direction and joining with the distal groove.
- (c) Shallow supplemental grooves are to be found on either side of the crest of the triangular ridges. These are especially prominent on the lingual cusps.

G. Inclined planes - The inclined planes within the fossae are all functional planes and occlude with the inclined planes of the lingual cusps of the maxillary first molar and the maxillary second premolar. Portions of the buccal inclined planes of the buccal cusps occlude with the lingual inclined planes of the buccal cusps of the maxillary first molar and second premolar.

H. Masticatory table - The masticatory table includes a portion of the buccal inclined planes of the buccal cusps in addition to the inclined planes of the occlusal table.

VI. The roots

The mandibular first molar presents with a mesial and a distal root. The bifurcation is located nearer the crown than the bifurcation of the roots of any of the other teeth.

A. Mesial root - This root is broad bucco-lingually and flattened mesio-distally. As observed from the mesial aspect, the lingual outline of the mesial root appears continuous with the lingual outline of the crown. The buccal outline is slightly curved from the cervix to the apex. Two longitudinal grooves are presented on the mesial and distal surfaces of the root. The mesial root is curved, inclining first to the mesial in the cervical one-half and then to the distal in the apical one-half. Two separate root canals are usually found in the mesial root.

B. Distal root - The distal root is similar in shape to the mesial root, but is more convex on its distal surface and presents a longitudinal groove on its mesial surface only. The apical one-third appears more tapering, and the apex is more pointed. The distal root inclines slightly to the distal, but is generally straight. One root canal is usually found in the distal root.

VII. How to distinguish a right or left mandibular first molar

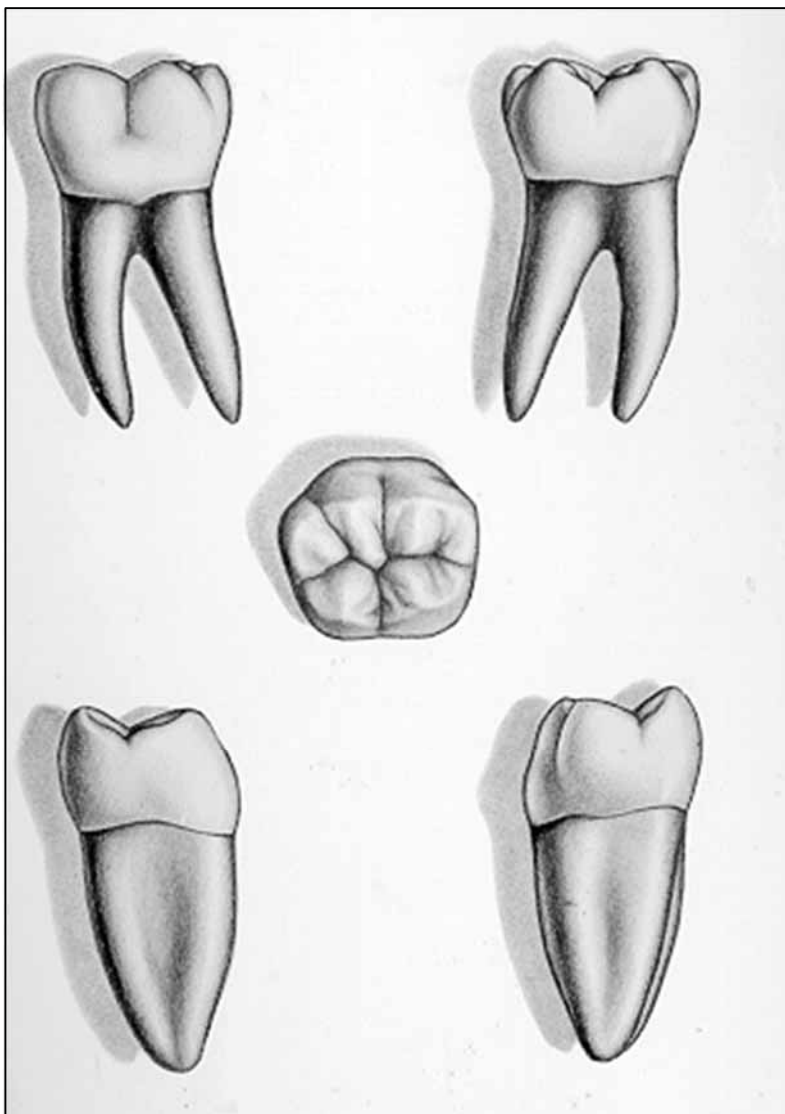
A. Since the mandibular first molar erupts at six years of age, it is occasionally mistaken for a deciduous tooth. Existing caries may be ignored, with the idea that it will soon be replaced by another tooth by the lay person.

B. The three buccal cusps are present with the most distal being the smallest and least prominent.

C. The larger of the two roots is usually the distal and usually curves to the distal

VIII. Applied anatomy

More restorative dentistry is necessary on the first molars than any other teeth. Due to the size of the crown and size and configuration of the roots the first molar is an excellent abutment tooth for fixed restorations.



The Maxillary Second Molar

I. The tooth in general

The maxillary second molar is similar to the maxillary first molar, in that the same anatomic marks are presented with the exception of the fifth cusp, which is rarely found on the typical second molar. The second molar is the seventh tooth distal from the median line. Several outstanding differences are to be noted in the form of the tooth as compared with the form of the maxillary first molar.

II. The crown in general

The crown is smaller than the maxillary first molar, especially in the disto-lingual portion, due to a smaller disto-lingual cusp.

III. The root in general

A. Number - The tooth usually has three roots, occasionally the tooth possesses four roots.

B. Shape - In general, all three roots are conical and occasionally fused into an overall conical shape.

IV. Axial surfaces of the crown

The axial surfaces are generally more convex than the first molar especially the distal surface.

A. Buccal surface - The mesial portion is relatively larger in comparison with the distal portion. The axial ridge of the mesio-buccal cusp is prominent especially in the cervical one-third. The mesio-buccal cusp is longer than the disto-buccal cusp.

B. Lingual surface - Relatively smaller, especially in the distal one-half. This surface inclines more toward the buccal than does the lingual surface of the maxillary first molar.

C. Mesial surface - The mesial surface is continuous with the outline of the mesio-buccal root. Its occlusal half appears to overhang the cervical area.

D. Distal surface - Smaller in area than the mesial surface. The distal surface is more convex than the mesial and is shorter occlusal-cervically than the mesial.

V. Occlusal surface

A. General shape - The outline of the occlusal surface presents a mesio-buccal angle more acute than the mesio-buccal angle of the maxillary first molar. The disto-lingual angle is less acute, forming almost a right angle.

B. Cusps - The mesio-lingual cusp is more angular in appearance and more pointed in comparison with the mesio-lingual cusp on the maxillary first molar. The mesio-buccal cusp presents a prominent triangular ridge not unlike the triangular ridge of the buccal cusp of the maxillary first premolar. The disto-buccal and disto-lingual cusps are relatively smaller. The oblique ridge is not present on maxillary second molars. A distance of 5.0 millimeters separates the mesial and distal buccal cusp tips. The same is true for the lingual cusp tips, in their mesial-distal separation. Both the buccal cusp tips and lingual cusp tips are, on the average, 6.5 millimeters apart.

C. Fossae - The central fossa is irregular in form, but relatively larger in comparison with the distal fossa.

D. Grooves - The disto-lingual groove is not as pronounced as that of the first molar, and is sometimes almost absent in its lingual extent. The mesial and buccal grooves form a right angle at their interaction. The distal groove is generally more pronounced, crossing the distal cusp ridge of the mesio-lingual cusp as a sulcated groove. A characteristic marking the maxillary second molar is noted in the prominence of the mesio-buccal supplemental groove, hereby accentuating the triangular ridge of the mesio-buccal cusp and the mesial marginal ridge.

VI. The roots

A. The roots of the maxillary second molar are the same in number as the first molar or occasionally numbering four.

B. Sometimes the roots are fused together forming a single cone-shaped root or the mesio-buccal and lingual roots may be fused presenting a broad, and flattened mesial root surface.

C. Due to the acuteness of the angle formed by the junction of the mesial and buccal surfaces of the crown, the disto-buccal root is placed more to the lingual in comparison to the relative position of the disto-buccal root of the maxillary first molar.

VII. How to distinguish a right or left maxillary second molar

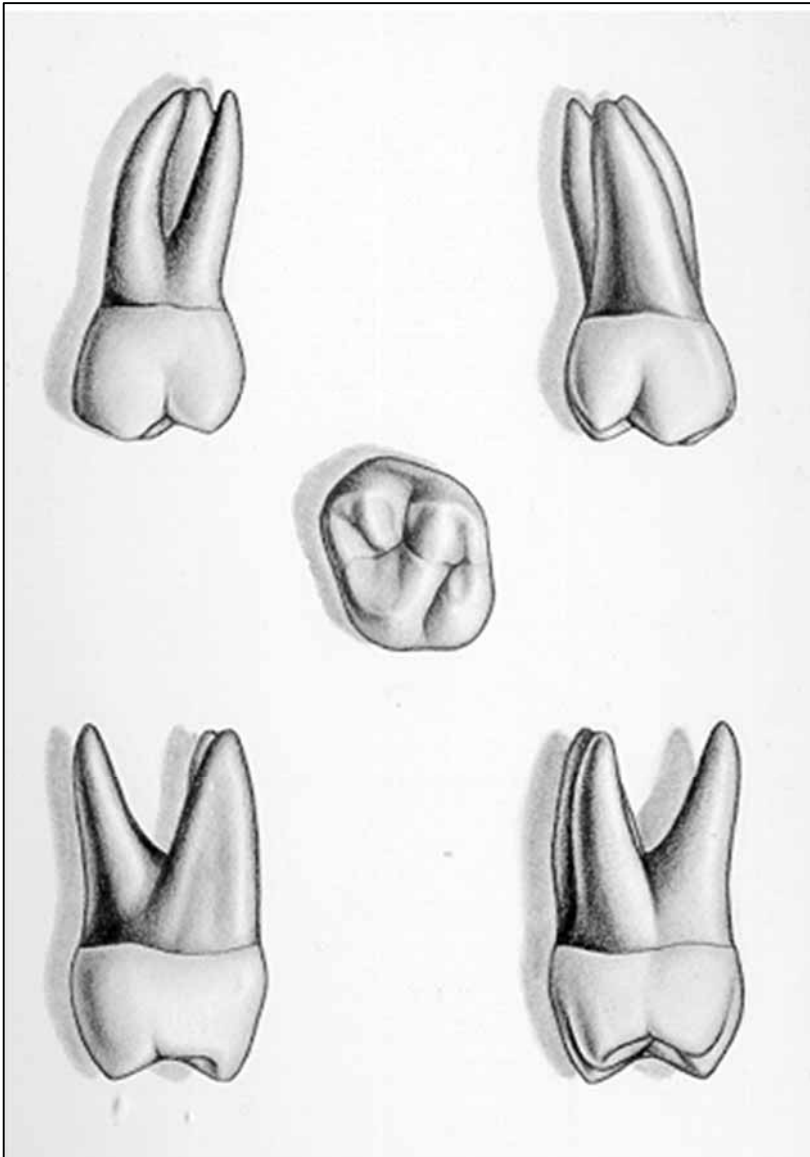
The same distinguishing features as applied to the maxillary first molar may be used in determining a right or left maxillary second molar.

VIII. Applied anatomy

A. The maxillary second molar erupts at about twelve years of age, and is sometimes called the "twelve year molar".

B. Caries occurring on the occlusal surface can involve both the mesial and distal fossae.

C. Rarely does a maxillary second molar have a Cusp of Carabelli.



The Mandibular Second Molar

I. The tooth in general

The mandibular second molar is smaller than the mandibular first molar, but is similar in general appearance. It is the seventh tooth distal to the median line. It erupts about twelve years of age.

II. The crown in general

A typical mandibular second molar generally presents four cusps, although a distal buccal cusp is sometimes observed. Five surfaces and four developmental grooves are also present.

III. The root in general

A. Number - The tooth usually has two roots, one mesial and one distal.

B. Shape - In general, both roots are wider bucco-lingually and present with a flattened oval in cross section.

IV. Axial surfaces of the crown

A. Buccal surface

1. Shape - Rectangular.
2. Mesial margin - Converges slightly to the cervix.
3. Distal margin - More convex than the mesial margin.
4. Cervical margin - Straight from mesial to distal.
5. Occlusal margin - Made up of four slopes of the two buccal cusps.
6. Grooves - The buccal groove is located near the center of the buccal surface.
7. Ridges - Two buccal axial ridges are presented, of which the axial ridge of the mesio-buccal cusp is the more prominent, especially in its cervical half. The bucco-cervical ridge is prominent in its mesial half.

8. Height of contour - The greatest cervical depth of the line designating the height of contour is located at the junction of the buccal axial ridge of the mesio-buccal cusp with the bucco-cervical.

B. Lingual surface - The lingual surface of the mandibular second molar is similar in shape to the lingual surface of the mandibular first molar. In its mesio-distal extent, it is usually as large as its buccal surface, but differs in contour.

C. Mesial surface - Similar in shape to the mesial surface of the mandibular first molar, but more convex in all directions.

D. Distal surface - The distal surface of the mandibular second molar is smaller in area than its mesial surface, and is more convex.

V. Occlusal surface

A. General shape - The marginal ridges of the mandibular second molar present an outline of a parallelogram form. The silhouette outline of the crown demonstrates a convergence of the buccal surface toward the distal. The prominent of the buccal axial ridge of the mesio-buccal cusp may be noted in viewing the tooth from an occlusal aspect. The convex forms of the buccal and lingual embrasures are also noted.

1. Angles of the occlusal surface - The four angles of the occlusal surface form almost right angles.

B. Marginal ridges - The buccal and lingual marginal ridges are made up of four slopes each. They are almost equal in length, and run parallel to each other. The distal marginal ridge is slightly more convex than the mesial marginal ridge.

C. The cusps - Four cusps are presented in the typical tooth, and are named according to their location. The mesio-buccal and mesio-lingual cusps are slightly larger than the disto-buccal and disto-lingual cusps. The mesio-buccal, disto-buccal, mesio-lingual and disto-lingual cusp tips are separated mesial-distally by a distance of 5.0 millimeters. The corresponding buccal and lingual cusp tips are usually about 6.0 millimeters apart.

D. Fossae

1. The central fossa lies in the center of the occlusal surface.

2. A mesial supplemental fossa is generally found in the mesial portion of the occlusal surface. The triangular ridges of the mesial cusps form its distal boundary, while the mesial marginal ridge forms its mesial boundary.

E. Triangular ridges

Four triangular ridges are found on the occlusal surface. The triangular ridges of the distal cusps run buccally and lingually, but generally have a slight mesial inclination. These ridges are soon worn in the adjustment of functional occlusion.

F. Grooves

1. Developmental

- (a) Buccal groove - Originates in the central pit, runs buccally and upward, crosses the bucco-marginal ridge between the two buccal cusps and descends on the buccal surface, ending in the cervical one-third of the buccal surface.
- (b) Lingual groove - Originates in the central pit, runs lingually and upward, crosses the lingual marginal ridge between the two lingual cusps and descends on the lingual surface. This groove runs parallel to the buccal groove, but may be located either to the mesial or the distal of its origin.
- (c) Mesial groove - Runs in a mesial direction from its origin in the central pit, and crosses the mesial marginal ridge in a fine line.
- (d) Distal groove - Runs in a distal direction parallel to, and sometimes continuous with, the mesial groove. This groove generally ends near the distal marginal ridge, seldom crossing it.

2. Supplemental grooves

- (a) Two triangular supplemental grooves are found in the mesial supplemental fossa, uniting with the mesial groove to form a mesial pit.
- (b) Shallow supplemental grooves are to be found on either side of the crests of the triangular ridges.

VI. The roots

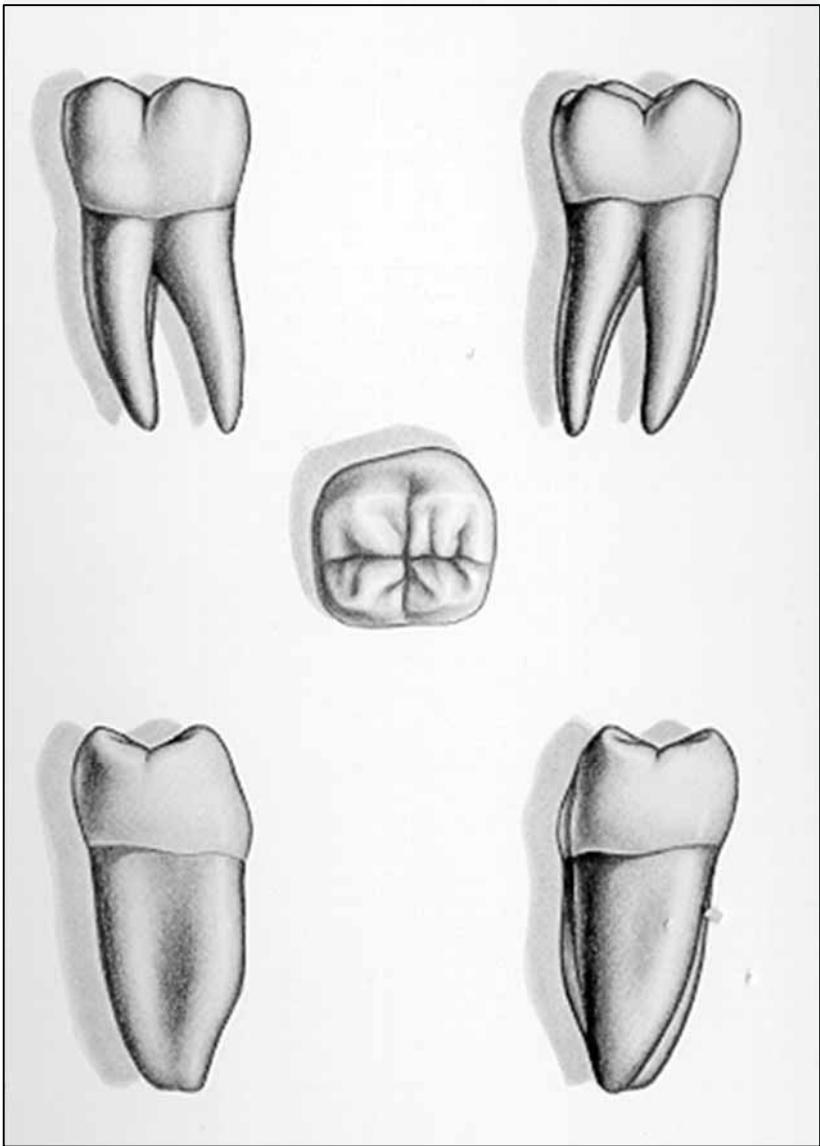
The roots of the mandibular second molar are similar in shape to the roots of the mandibular first molar. They are less divergent, and both roots present a distal inclination. Occasionally a single cone-shaped root is presented.

VII. How to distinguish a right or a left mandibular second molar

- A. The buccal surface may be determined by the convexity in its buccal third.
- B. The mesial portion of the crown is wider in its bucco-lingual extent.
- C. The roots have a distal inclination.

VIII. Applied anatomy

- A. The occlusal portion of the lingual groove is often fissured.
- B. Due to the relatively frequent loss of the first molar due to extensive caries the second molar is used as an abutment for fixed and removable prostheses
- C. Fibrous food often impacts between the mandibular second and third molars, when an incompletely erupted third molar produces an incorrect proximal contact position.



The Maxillary Third Molar

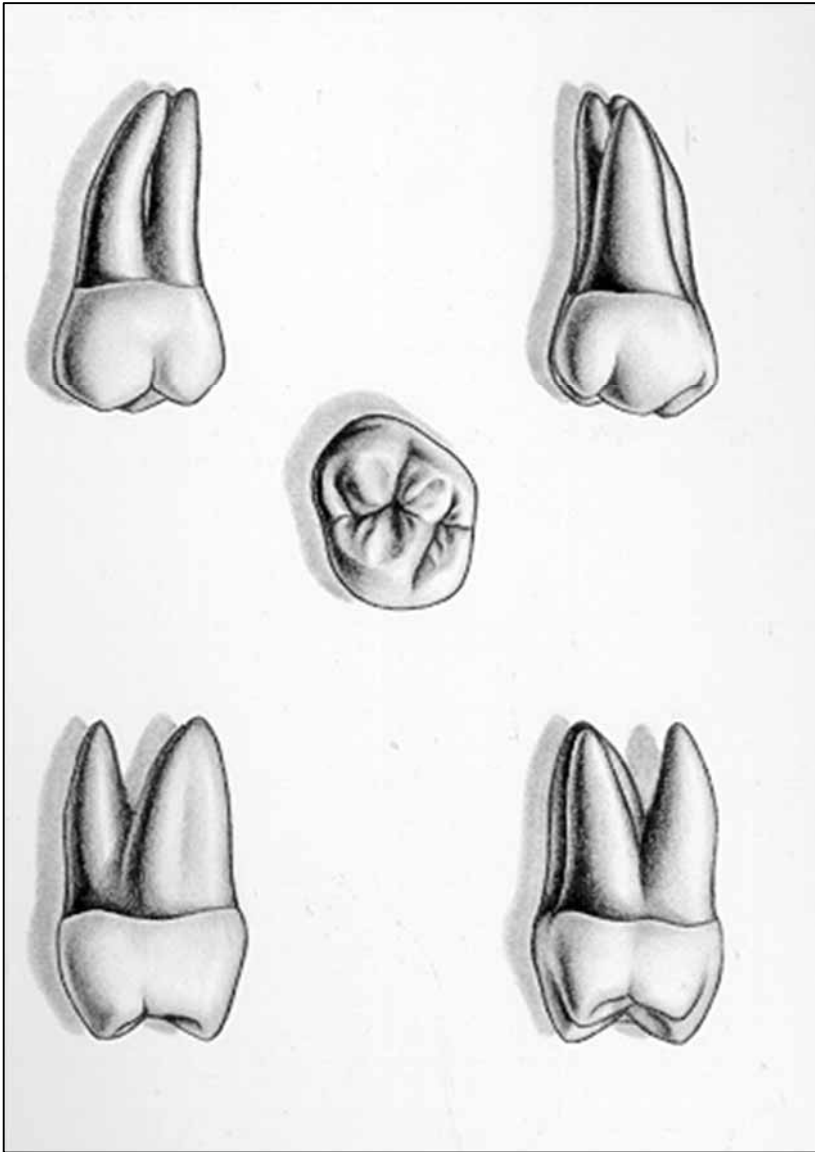
The maxillary third molar is similar to the maxillary second molar in many of its anatomical markings, but differs in form and contour. This tooth may be classed as either a typical third molar presenting characteristic third molar form, or as being atypical, in which type many variations are presented as to anatomy and form. The third molar is the eighth tooth distal to the median line.

I. Typical type

- A. The crown is not as large as the crown of the maxillary second molar.
- B. The axial surfaces are similar in shape, but are more convex than the axial surfaces of the maxillary second molar.
- C. The occlusal surface presents an outline more triangular in form.
- D. The disto-lingual cusp is usually very small, and is often entirely lacking.
- E. Supplemental grooves and ridges are usually presented on the occlusal surface.
- F. The height of contour is variable, sometimes following a line that encircles the tooth about midway between the occlusal and cervical margins on all surfaces.
- G. Three roots distally inclined are generally presented, but are often fused together.

II. Atypical type

- A. A tooth diminutive in size, sometimes presenting a single cone-shaped crown.
- B. An over-developed crown, which may be associated with either long or short roots.
- C. When the occlusal surface presents additional cusps.
- D. When more than three roots are present, or when the roots are abnormally curved. Sometimes as many as seven distinct roots are found.



The Mandibular Third Molar

The mandibular third molar is similar to the mandibular second molar in many of its anatomical markings, but differs in form and contour. The third molar is the eighth tooth distal to the median line. As in the maxillary arch this tooth can be classified as either typical or atypical, in which many variations are presented as to anatomy and form.

I. Typical type

A. The four lobed type - Resembles the mandibular second molar in anatomical markings, but differs in form. This type is usually associated with satisfactory occlusion, when in correct alignment.

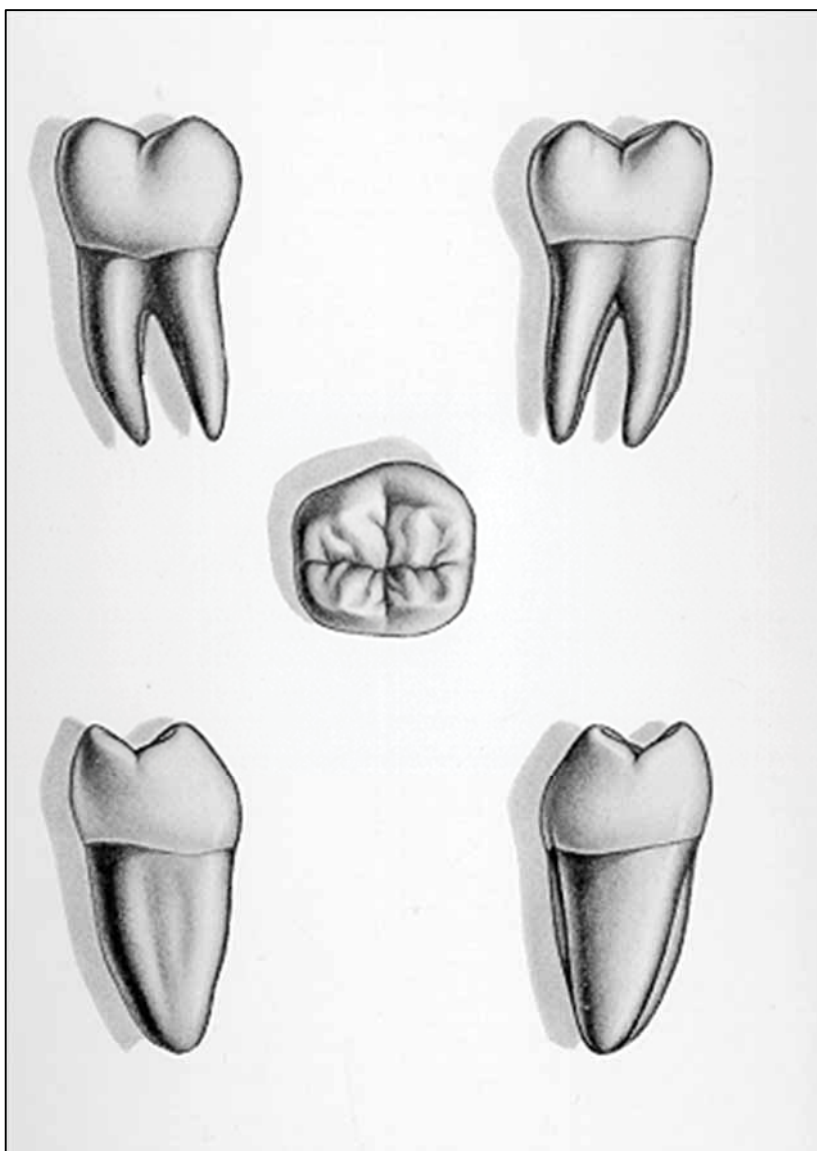
1. The axial surfaces are more convex than those of the second molar.
2. The distal cusps are relatively smaller than those of the second molar.
3. Supplemental grooves generally radiate from the central pit.
4. The roots are generally shorter and less divergent.

B. The five lobed type - resembles the mandibular first molar in anatomical markings, but differs in form.

1. The axial surfaces are more convex.
2. The crown is often larger than that of the mandibular second molar, but smaller than that of the mandibular first molar.
3. The distal cusp is generally located nearer the distal surface, or more to the lingual than the distal cusp of the mandibular first molar.
4. The tip of the disto-buccal cusp is placed more to the buccal in relation to the tip of the mesio-buccal cusp.
5. The five-lobed third molar is subject to mal-positioning more than the four-lobed type.

II. Atypical type

This type of tooth may present with supplemental lobes, varies crown form and accessory roots. These deviations are not as commonly found as in the maxillary third molar.



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