Understanding and Developing a Morphologic Occlusion

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Robert L. Schneider

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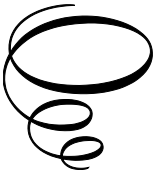

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To Norman D. French

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.

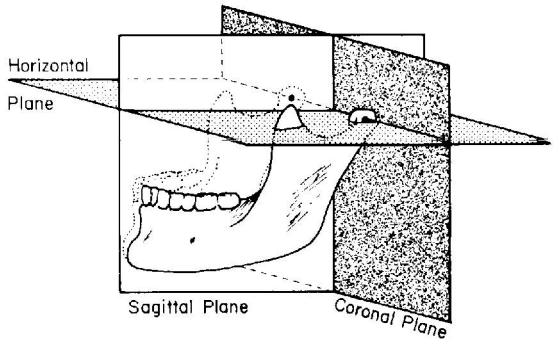
Most natural dentitions exhibit a cusp-marginal ridge relationship. The majority of prosthodontists follow the cusp-fossa concept when restoring a dentition. Each major cusp of every posterior tooth fits into a definite fossa on its opposing tooth. These cusps will seat in to their fossa without deflection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

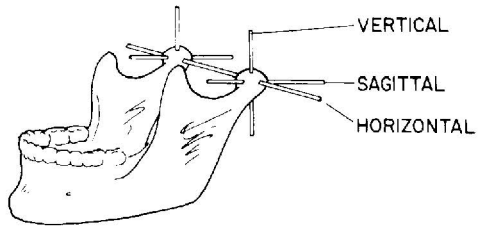
The major cusps that fit into fossae are called "**functional**" cusps and are the principal milling or chewing cusps. The functional cusps of the maxillary teeth are the lingual cusps and the functional cusps of the mandibular teeth are the buccal cusps.

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.

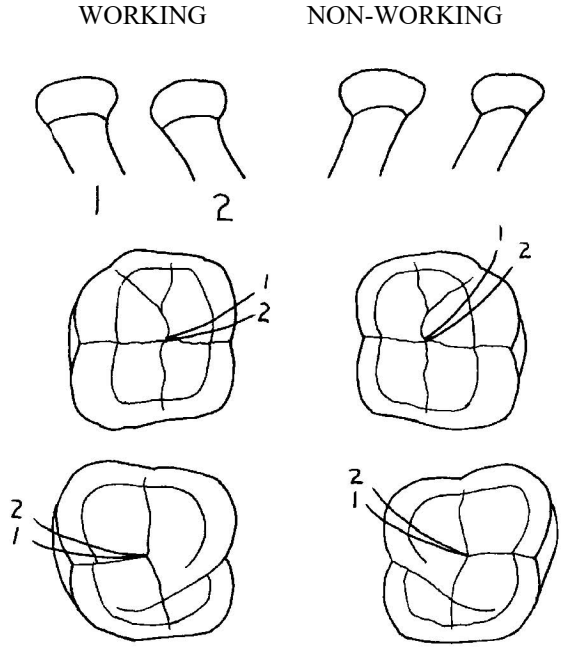
9. The greater the bennet shift the shorter the cusps **must** be. the lesser the side shift the longer the cusps **may** be.

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.

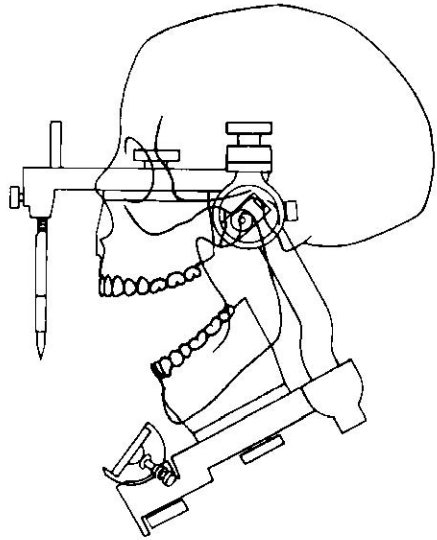
Functions of the Articulator

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.

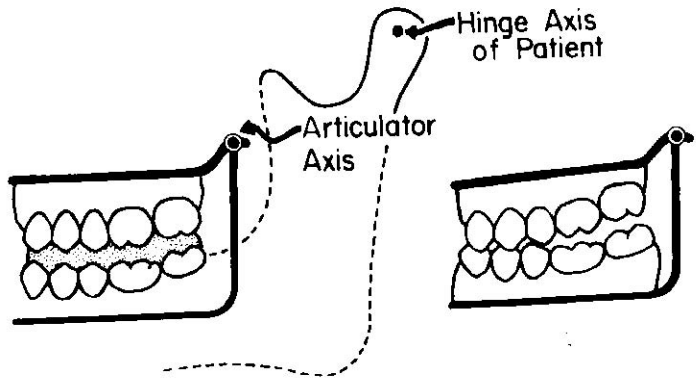
5. Accurately repeats jaw movements.
6. Maintains occlusal vertical dimension of casts.
7. Allows for alteration of the occlusal vertical dimension of casts.
8. When used with a face-bow, orients the maxillary cast in the same position to the condyles as in the patient's skull.

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.

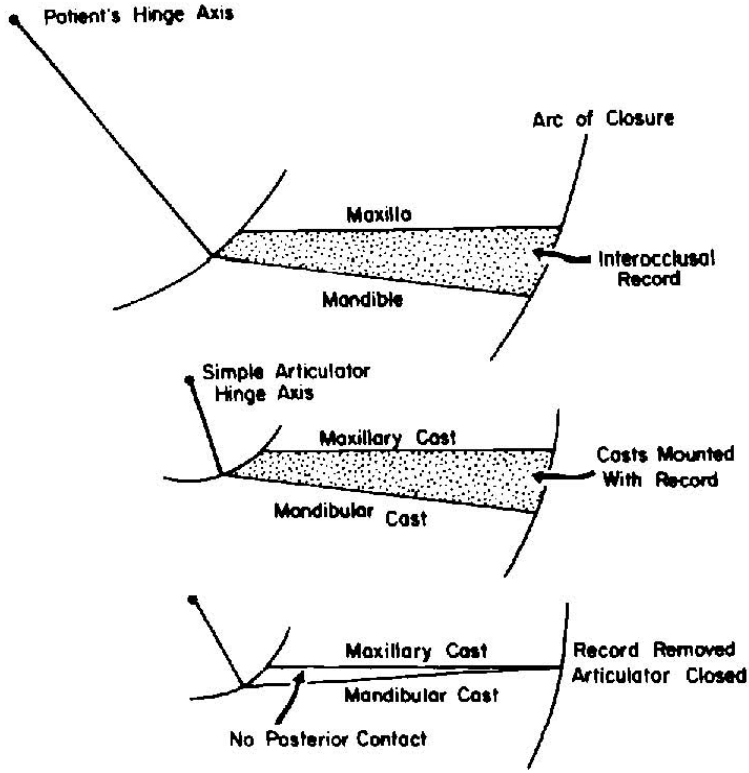


The articulator relates the patient's maxilla in the same relationship to the base of the skull and condyles. This allows the development of accurate occlusal anatomy in the same relationship that it is observed in the patient. Graphic from Teledyne-Hanau.



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.

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

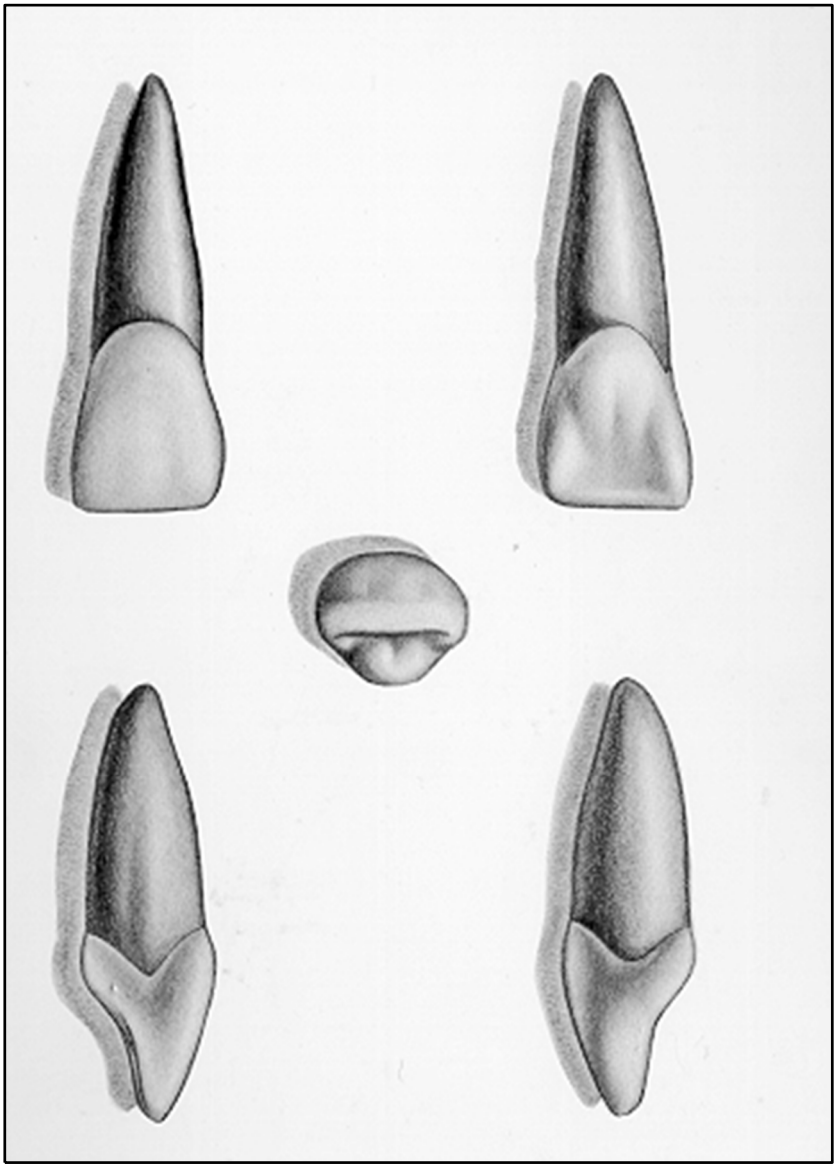
A. The linguo-cervical ridge may be important in its function of deflecting food over the crest of the gingiva on the lingual.

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.

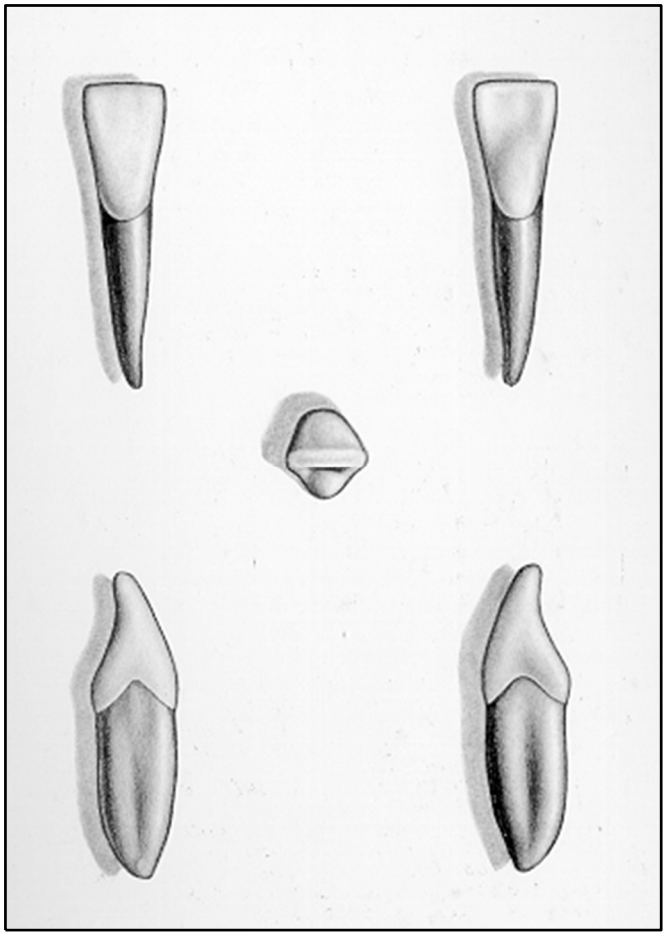
VII. Applied anatomy

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 cuspid. 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.