



Factors of Mandibular Movements related to occlusal Morphology



Topics To Be Discussed

- **Introduction & definitions**

- **Static occlusion**

Angle's classification of occlusion

Intra-arch tooth alignment

Inter-arch tooth alignment

- > Bucco-lingual occlusal contact relationship.

- > Mesio-distal occlusal contact relationship

- **Dynamic occlusion**

Occlusal contacts during mandibular movement

- **Control of mandibular movements**

Anterior controlling factors

Posterior controlling factors

- **Vertical determinants of occlusal morphology**

Effect of condylar guidance on cusp height

Effect of anterior guidance on cusp height

Effect of the plane of occlusion on cusp height

Effect of the curve of Spee on cusp height

Effect of Bennett movement

- **Horizontal determinants of occlusal morphology**

Influence of the distance of teeth from the centre of rotation and from the midsagittal plane.

Effect of intercondylar distance

Effect of Bennett movement on ridge and groove placement

- Notes about border movements of the mandible



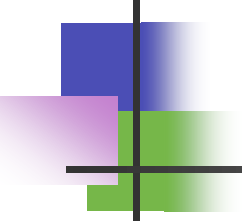
Introduction

- **Supporting cusps:** the lingual cusps of maxillary posterior teeth, and the buccal cusps of mandibular posterior teeth.

In normal adult dentition the supporting cusps maintain centric stop contacts with the opposing fossae and interproximal embrasures.

The points of contact of the supporting cusps with the opposing teeth should be well established and stable. These contact areas are called centric stops and are important for

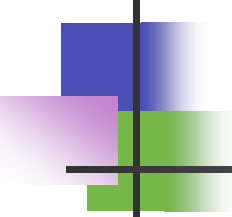
- occlusal stability which is maintained by axially directed forces which are forces applied to the centric stops.
- mastication since the contact occurs in both the inner and outer aspects of those cusps which are broad and rounded.
- they are also responsible for maintaining the vertical facial height (vertical dimension of occlusion).

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- When viewed from the occlusal their tips are located approximately $1/3^{\text{rd}}$ the distance into the total bucco-lingual width of the tooth.
 - **Guiding cusps:** the buccal cusps of maxillary posterior teeth and the lingual cusps of mandibular posterior teeth. Or they may be called non centric cusps.

They are relatively sharp with non definite tips that are located $1/6^{\text{th}}$ the distance into the total bucco-lingual width of the tooth.

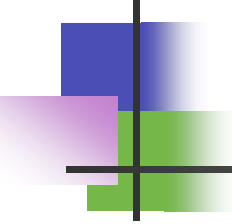
The major role of the non-centric cups is to:

1. minimize tissue impingement.
2. maintain the bolus of food on the occlusal table for mastication.
3. Give the mandible stability so that when teeth are in full occlusion there is a tight definite occlusal relationship.

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- **Guiding inclines:** They are the planes of occlusal ridges that determine the path of the supporting cusp during normal lateral and protrusive working excursions.

These are the lingual inclines of the buccal cusps of the maxillary posterior teeth the lingual inclines of maxillary anterior teeth, and buccal inclines of the lingual cusps of mandibular posterior teeth.

- **Incisal guidance:** the influence of the lingual surfaces of maxillary anterior teeth on mandibular movement. It may be expressed in degrees with the horizontal plane.
- **Condylar guidance angle:** the rate at which the condyle moves away from a horizontal reference plane.
- **Cusp angle:** the angle that is formed by the slopes of the cusp with a plane that passes through the tip of the cusp and is perpendicular to a line bisecting the cusp.
- **Curve of Spee:** the curvature of the occlusal surfaces of teeth from the tip of the mandibular canine and follows the buccal cusps of all mandibular posterior teeth.

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- **Plane of occlusion:** an imaginary plane that touches the incisal edges of mandibular central incisors and the tip of the disto-buccal cusps of mandibular second molars.
 - **Curve of Wilson:** when observing the dental arches from the frontal view, the maxillary posterior teeth have a buccal inclination and the mandibular posterior teeth have a lingual inclination.
 - **Bonwill** described the dental arches and noted that an equilateral triangle existed between the centers of the condyles and the mesial contact areas of mandibular central incisors, which has a 4 inch side.
 - **Monson** utilized Bonwill's triangle and proposed a theory that a sphere existed with a radius of 4 inch whose centre was an equal distance from the occlusal surfaces of posterior teeth and from the centres of the condyles.



Classification of Occlusion

For many years the standard for classification of occlusion has been Angle's classification of malocclusion.

The problem with angle classification is that it doesn't consider TMJ position or condition to mandibular arch.

It has been used routinely to denote the relationship of the mandibular arch to the maxillary arch.

Angle's class I is to depict a normal relationship of the maxillary and mandibular arches of teeth.

Class II or III indicate abnormal relationship of arches
Angle's class II the mandibular arch is too distal
In class III the mandibular arch is forward.



Angle class I

- The m,b cusp of mandibular first molar occludes with the embrasure area between max second premolar and first molar
- The m,b cusp of max first molar is aligned over the buccal groove mandibular first molar
- The m,l cusp of maxillary first molar occludes with the central fossa area of mandibular first molar
- In this relationship each mandibular tooth occludes with its counterpart and the adjacent mesial tooth.



Angle class II

- In some people the maxillary arch is large or advanced anteriorly or the mandibular arch is small or positioned posteriorly.
- This will result in mandibular first molars to be positioned distal to the class I molar relationship.
 1. M_b cusp of mandibular first molar occludes with the central fossa of maxillary first molar and is aligned with the buccal groove of maxillary first molar.
 2. The d_l cusp of maxillary first molar occludes with the central fossa of mandibular first molar.



Angle class III

- Often found corresponding to a predominant growth of the mandible.
- The mandibular molars are mesial to the maxillary molars as seen in class I
 1. The d,b cusp of mandibular first molar is in the embrasure between the maxillary second premolar and ,maxillary first molar
 2. The m,b cusp of maxillary first molar is positioned over the embrasure between mandibular first and second molars
 3. M,l cusp of maxillary first molar is situated in the mesial pit of the mandibular second molar.



Analysis of any occlusion requires the careful inspection of maximal inter-cuspatation position in relation to both the position and condition of the TMJ.

Class I arch relationship allows good esthetics, function and stability if it is in harmony with the completely seated position of the condyles.

If displacement of one or both of the TMJ is needed to achieve a class I occlusion the result is not ideal because the deflective inclines have the potential of hyperactivating incoordinated muscle activity.

The potential for muscle hyperactivity and pain is highest if the deflective contact is unilateral.

Class II, & III may achieve optimum stability and equilibrium with the joints and musculature and so be the best occlusion for some patients.



Pullinger and colleagues observed that occlusal factors do contribute to TMD.

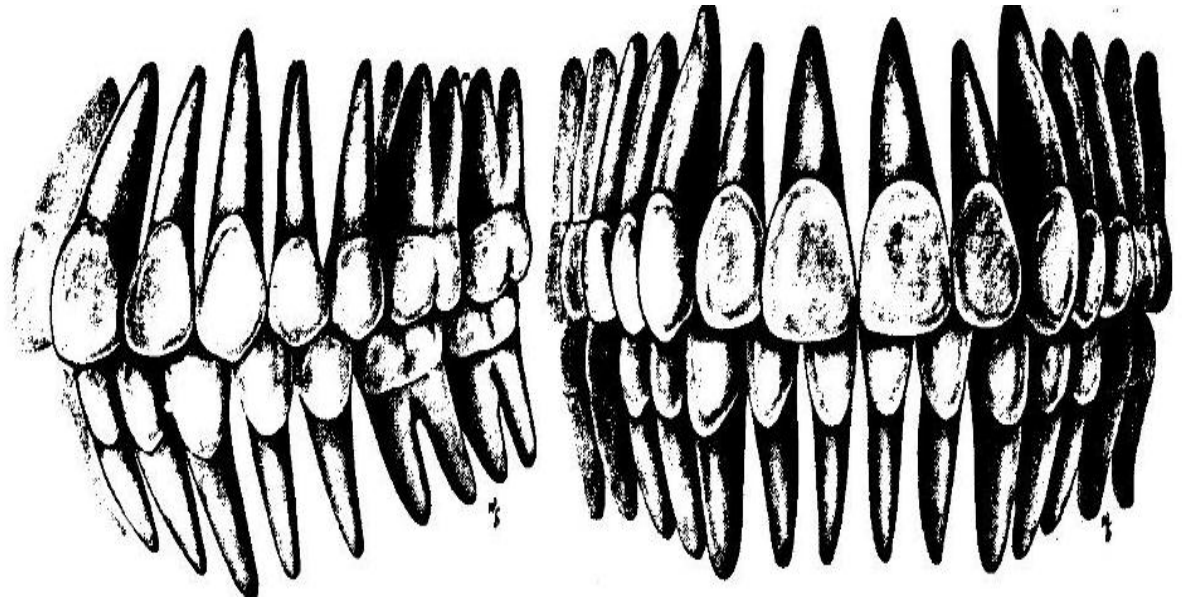
Deflective interferences to complete seating may be a normal characteristic in some patients, but it can also be problematic.

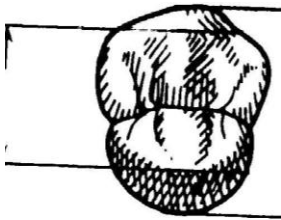
Intra-arch tooth alignment

The occlusal planes in the dental arch are curved in a manner to permit maximum utilization of the tooth contacts during function.

The curvature of the occlusal plane is a result of the fact that teeth are positioned in the arches at varying degrees of inclination.

In the mandibular arch both anterior & posterior teeth are mesially inclined. In the maxillary arch the anterior teeth are mesially inclined and posterior teeth generally are distally inclined.





Occlusal table of a maxillary p

The occlusal surfaces of posterior teeth can be divided into several areas. The area of tooth between the buccal and lingual cusps is called the occlusal table. It is to which the forces of mastication are applied. The occlusal table represents 50-60% of the total bucco-lingual dimension. It is considered the inner aspect of the tooth since it lies between the inclines.

The occlusal area outside the occlusal table is called the outer aspect.

The inner and outer aspects of teeth are made from inclines that extend from the cuspal tip to either the central fossa or the height of contour on the labial and lingual surfaces of teeth.

The inner and outer inclines are further defined by the cusps of which they are part. They are also described with respect to the surfaces toward which they are directed (mesial or distal).



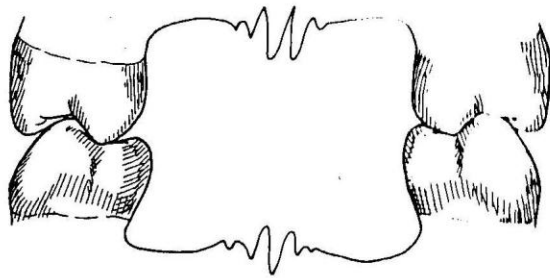
Inter-arch tooth alignment

Refers to the relation of the teeth in one arch to those in the other. When the two arches come in contact the occlusal relationship of teeth is established.

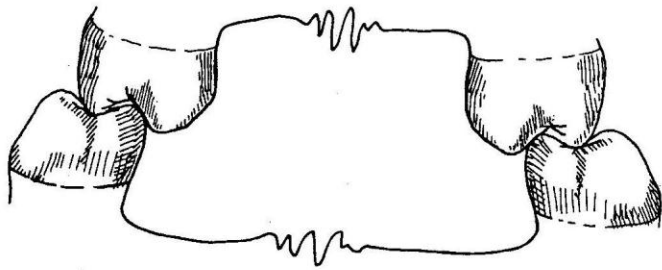
The maxillary and mandibular teeth occlude in a precise manner.

Arch length. Both arch have approximately the same length with the mandibular arch being slightly smaller. This is due to the narrower mesio-distal distance of the mandibular incisors.

Arch width. The width of the mandibular arch is slightly less than that of the maxillary arch. So when these arches occlude the maxillary teeth are more facially positioned. So the normal occlusal relationship for the buccal cusps of mandibular teeth to occlude along the central fossa areas of the maxillary teeth and the maxillary lingual cusps to occlude along the central fossa of mandibular teeth.



This relationship protects the surrounding soft tissue. The buccal cusps of maxillary teeth prevent cheek and lip biting during function. The lingual cusps of mandibular teeth do the same for the tongue.



Sometimes due to discrepancy in arch sizes or eruption patterns, the teeth occlude in a way that maxillary buccal cusps contact in the central fossa of mandibular teeth. This is referred to as cross-bite.



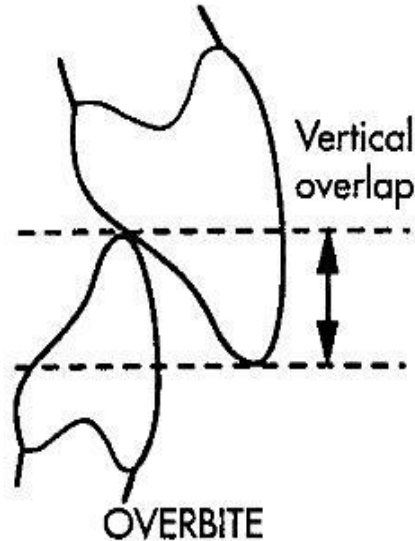
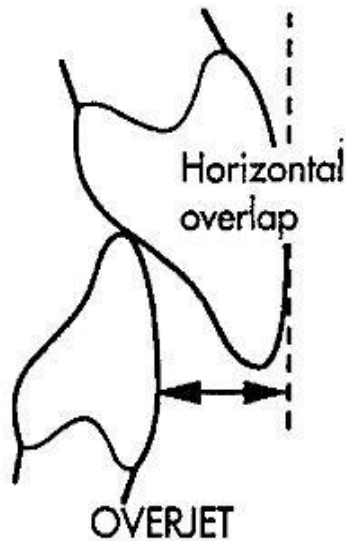
Mesio-distal occlusal contact relationship

- Centric cusps contact opposing teeth in central fossa areas, marginal ridge and embrasure areas.
- Cusp tip fossa contacts: when two unlike surfaces meet only certain portions come in contact at a time, leaving other areas as spillways for the substance being crushed.
- When the cusps contact the marginal ridges which are slightly convex. In this relation the cusp can penetrate food.
- Each tooth in the dental arch occludes with two opposing teeth except? This relationship helps in distributing occlusal forces to several teeth and therefore the entire arch.
- Mandibular teeth are usually positioned slightly lingual and mesial to their counterparts. This applies for both posterior and anterior teeth.



Common occlusal relationships of anterior teeth

- Maxillary anterior teeth are normally positioned labial to mandibular anterior teeth (overjet).
- Both maxillary and mandibular anterior teeth are labially inclined on avg 12-28 degrees.
- Normally the incisal edge of mandibular incisors contacts the lingual fossa of maxillary incisors approximately 4 mm gingival to the incisal edge.(overbite)
- Contacts on anterior teeth in centric occlusion are much lighter (and sometimes absent) than that on posterior teeth?
- The labial inclination of teeth does a different function from that found in posterior teeth. They guide the mandible through the various lateral movements.
- The guidance provided by anterior teeth is called anterior guidance. It plays an important role in the function of the masticatory system.
- Anterior teeth also provide the initial act of mastication. They incise food as it is introduced into the oral cavity. Also they play important role in speech



- In some people the normal anterior tooth relationship doesn't exist. Variations result from different growth patterns of the maxilla and mandible.
- In class II relation (underdeveloped mandible) mandibular anterior teeth contact the gingival 3rd of the lingual surfaces of maxillary teeth (deep overbite). Division I, II
- In class III or pronounced mandibular development mandibular anterior teeth are usually positioned forward and contact the incisal edges of maxillary anterior teeth (end to end or edge to edge relationship).
- Another relation is where anterior teeth do not contact (anterior open bite)



Occlusal contacts during mandibular movement

- The masticatory system is extremely dynamic. The TMJ and associated muscle permit the mandible to move in three planes sagittal horizontal and frontal.

- Along with these movements come potential tooth contacts which are called eccentric contacts.

- Three basic eccentric movements are present
 1. Protrusive.
 2. Retrusive.
 3. Latero-trusive.



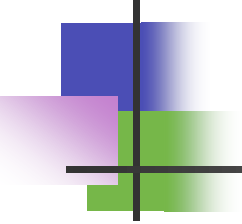
Protrusive mandibular movement

- Protrusive contact.
- In normal occlusal relationship the predominant occlusal contacts that occur are on anterior teeth between the incisal edges of mandibular incisors and the lingual fossa areas and incisal edges on maxillary anterior teeth. These are considered the guiding inclines of anterior teeth.
- On posterior teeth the protrusive movement causes the mandibular centric cusps to pass anteriorly across the occlusal surfaces of maxillary teeth.
- Posterior protrusive contacts occur on the distal inclines of maxillary lingual cusps and mesial inclines of the opposing fossae and marginal ridges.
- They can also occur between the mesial inclines of mandibular buccal cusps and the distal inclines of the maxillary opposing fossae and marginal ridges.



Latero-trusive mandibular movements

- The right and left mandibular posterior teeth move across their opposing teeth in different directions.
- During left lateral movement contact occurs on two incline areas. One between the inner inclines of maxillary buccal cusps and outer inclines of mandibular buccal cusps and other is between the outer inclines of the maxillary lingual cusps and the inner inclines of the mandibular lingual cusps, both these contacts are called later-trusive. The term working contact is also used.
- During the same left lateral movement mandibular teeth on the right side assume a medial movement across their opposing teeth.

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- The potential site for occlusal contacts are between the inner inclines of maxillary lingual cusps and the inner inclines of mandibular buccal cusps. These are called medio-trusive contacts or non working side as the function occurs on the left side.
 - Anterior teeth play an important guiding role during left and right mandibular movement. In a normal occlusal relationship maxillary and mandibular canines contact during right and left lateral movement and so have latero-trusive contacts which occur between the labial surfaces and incisal edges of mandibular canines and the lingual fossa and incisal edges of maxillary canines.



Retrusive movement

- This movement occurs when the mandible moves posteriorly from centric occlusion.
- Centric relation position is posterior to centric occlusion. The distance is normally limited to 1-2mm.
- During this movement the buccal cusps of mandibular teeth move distally across the occlusal surface of their opposing maxillary teeth.
- Areas of potential contact occur between the distal inclines of mandibular buccal cusps and mesial inclines of the opposing fossae and marginal ridges.
- In the maxillary arch retrusive contacts occur between the mesial inclines of the lingual cusps and the distal inclines of opposing fossae and marginal ridges.



It is necessary to understand the relationship between mandibular movement and occlusal morphology.

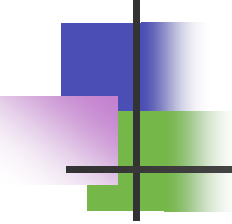
The occlusal contact pattern strongly influence the muscular control of mandibular postion.

When closure of the mandible in the musculo-skeletal stable position creates an unstable occlusal condition, the neuromuscular system quickly feeds back appropriate muscle action to locate a mandibular position that will result in a more stable occlusal condition.



Optimal occlusal condition during mandibular closure will be achieved by:

- even simultaneous contact of all possible teeth.
- Forces applied to teeth should be directed along the long axis of the tooth and this is achieved by two methods:
 1. Tooth contacts occur either on the cusp tips or relatively flat surfaces that are perpendicular to the long axis of the tooth. Flat surfaces may be the crests of marginal ridges or the bottoms of the fossae.
 2. Tripodization which requires that each cusp opposing fossa in three points surrounding the actual cusp tip.

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- TMJ permits lateral and protrusive excursions, which allow teeth to contact during different types of eccentric movement. This allows horizontal forces to be applied to teeth.
 - These horizontal forces are not well accepted by the supporting structures of the tooth.
 - The lever system of the mandible can be compared to a nut cracker, greater forces can be applied to objects as they are placed closer to the fulcrum (greater forces can be applied to posterior teeth than to anterior teeth).
 - Withstanding off axial loading by anterior teeth.



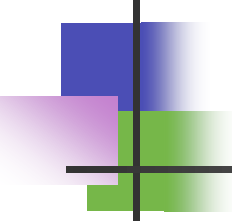
- Canines:

Longest and largest roots (crown/root ratio).

Dense compact bone surrounding them.

Fewer muscles are active when canines contact during eccentric movements than when posterior teeth contact.

Therefore in left and right laterotrusion movements of the mandible canines are appropriate teeth to contact and dissipate horizontal forces while disoccluding posterior teeth, this is called canine guidance.

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- Group function guidance: the most favorable alternative to canine guidance. Several teeth on the working side contact during latero-trusive movement. The most favorable group consist of canines, premolars and the mesio-buccal cusp of first molar.

Any contact more posterior to that is not desirable because of the increased amount of force that can be placed due to closeness to the fulcrum.

Buccal cusp to buccal cusp is more desirable contact during movement than lingual cusp to lingual cusp.

It is important that canine or group function provide enough guidance to disclude teeth on the non working side which are not desirable contacts

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- During protrusive movement only anterior teeth should contact and not posterior teeth.

- As a summary:

both anterior and posterior teeth act differently.

Posterior teeth can withstand forces applied during closure of the mouth. They are positioned well in the arches to accept forces applied to their long axes.

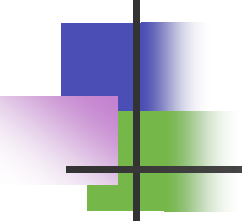
Anterior teeth are not positioned well in the arches to accept heavy forces during closure of the mandible? (posterior bite collapse). But they are well suited for accepting forces of eccentric mandibular movement.

Control of mandibular movement



- Structures that control mandibular movement can be divided into two types:
 1. Those that influence the movement of posterior part of the mandible (posterior controlling factors), they are considered as fixed factors TMJ
 2. Those that influence the movement of the anterior part of the mandible (anterior controlling factors). Which is considered a variable factor and can be influenced by dental procedures or pathologic conditions and is determined by the steepness of the lingual surfaces of anterior teeth

The rate at which the mandible moves inferiorly as it is being protruded depends on the steepness of the articular eminence.

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- The morphologic characteristics of each posterior tooth must be in harmony with those of its opposing tooth or teeth during all eccentric mandibular movements. The exact morphology of the tooth is influenced by the pathway it travels across its opposing teeth.
 - The relationship of a posterior tooth to the controlling factors influences the precise movement of each tooth. So the nearer the tooth to the TMJ the more its eccentric movements will be influenced by the anatomy of the joint.
 - Mandibular movement has both vertical and horizontal components.
 - The angle of deviation from the horizontal reference plane is what we study in mandibular movement.
 - ACF,PCF

Vertical determinants of occlusal morphology



- Factors that determine the heights of the cusps and depths of the fossae are the vertical determinants of occlusal morphology.
 1. Anterior controlling factors
 2. Posterior controlling factors.
 3. The nearness of the cusp to these factors.

- Effect of condylar guidance on cusp height
- Effect of anterior guidance on cusp height
- Effect of the plane of occlusion on cusp height
- Effect of the curve of Spee on cuspal height
- Effect of Bennett movement on cusp height



Effect of condylar guidance on cusp height

As the eminence is steeper greater vertical movement of the condyle occurs, longer cusps can be present without causing interferences in eccentric movements.

Steeper angle allows for longer cusps.

Effect of anterior guidance on cusp height



- Anterior guidance has both a vertical and horizontal components.
- As horizontal overlap increases the anterior guidance angle decreases.
- Increased vertical overlap increases the incisal guidance angle, steeper posterior cusps.
- Increased horizontal overlap leads to decreased anterior guidance angle, less vertical component of mandibular movement, flatter posterior cusps.



Effect of the plane of occlusion on cusp height

- The relation of the plane of occlusion to the angle of the eminence influences the steepness of cusp height.
- As the plane of occlusion becomes more nearly parallel to the angle of eminence the posterior cusps should be made flatter.

Effect of Bennett movement on cusp height

- Bennett movement has three attributes:
 1. amount
 2. timing and
 3. direction.
- **Amount and timing are dictated by**
 1. the degree to which the medial wall of the mandibular fossa is away from the orbiting condyle.
 2. The degree of movement of the rotating condyle determined by the tightness of the TM ligament.
- The direction of movement depends on the direction taken by the rotating condyle during body movement.



Effect of the amount of Bennett movement

As Bennett movement increases, the body shift of the mandible dictates that the posterior cusps should be shorter.

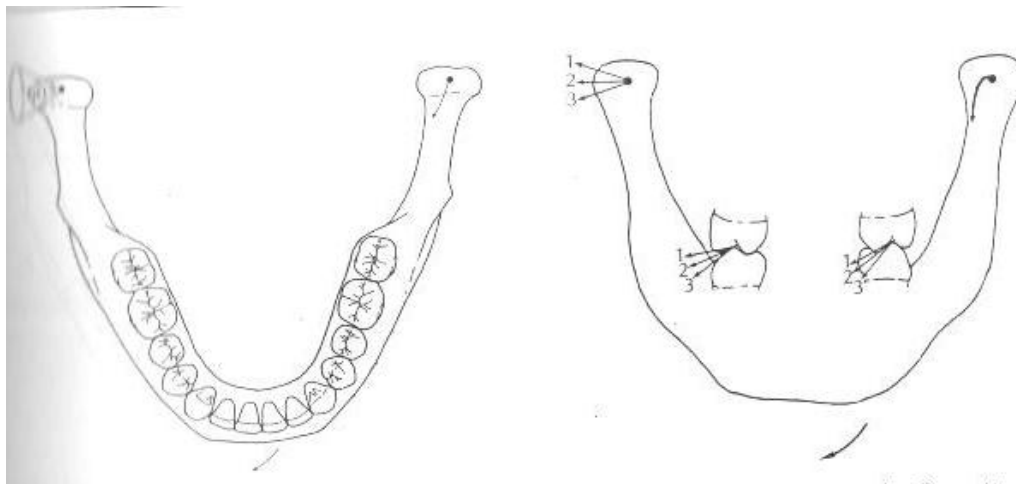
Effect of the direction of Bennett movement

The movement occurs within 60 degree cone whose apex is located at the axis of rotation.

In addition to lateral movement we may have superior, inferior, anterior, and posterior direction, or a combination of these.

One important determinant of the cusp height is the vertical movement of the rotating condyle.

Latero-superior component requires shorter cusps than straight lateral or latero-inferior.



Effect of the timing of Bennett movement

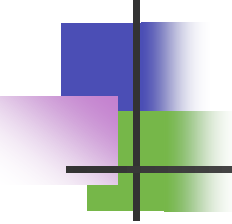


- It is a function of the
 1. medial wall of the fossa of the orbiting condyle
 2. and the tightness of attachment of the TM ligament.
- This factor has the greatest influence on the morphology of posterior teeth.
- If the movement occurs late it has little effect on the occlusal morphology.
- If it occurs early it has great influence.
- The more the immediate side shift the shorter the cusps should be.



Horizontal determinants of occlusal morphology

- They include the relationships that influence the direction of ridges and grooves.
- Since during mandibular eccentric movement cusps pass between ridges and over grooves, then they influence the placement of cusps as well.
- Each centric cusp tip generates both latero-trusive and medio-trusive pathways across its opposing tooth. The angles formed by these pathways can be compared



Influence of the distance of teeth from the centre of rotation and from the midsagittal plane

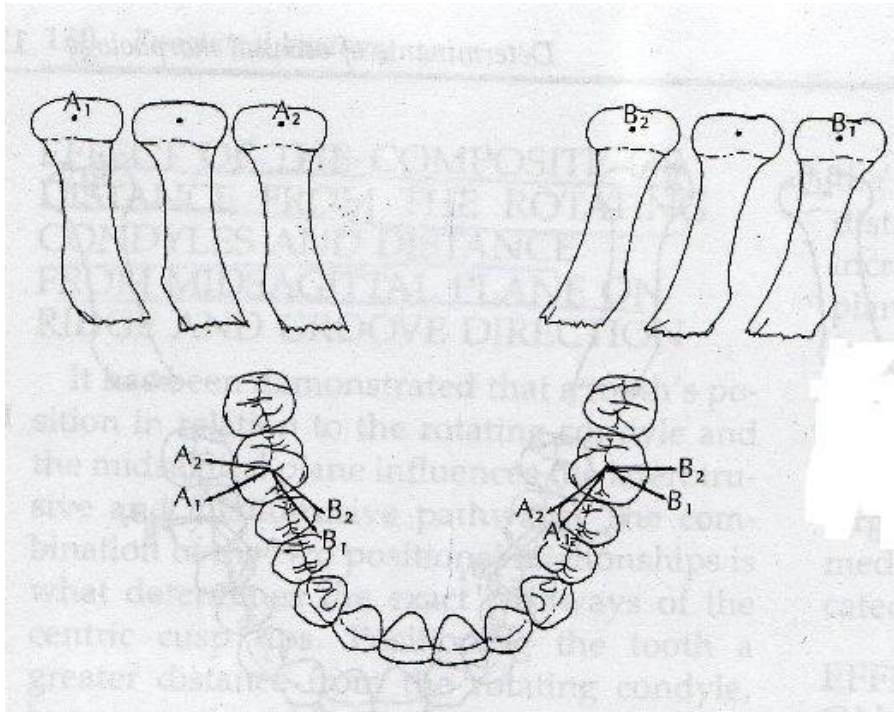
- The greater the distance of teeth from the midsagittal plane or from the centre of rotation the greater is the angle between the latero-trusive and medio-trusive pathways. This is consistent for both maxillary and mandibular cusps.

Effect of intercondylar Distance

- It is important to consider how the intercondylar distance influences the relation of the tooth to the rotating condyle and the mid-sagittal plane.

As the intercondylar distance increases, the distance between the condyle and the tooth in a given arch configuration increases, but it will be placed nearer to the midsagittal plane.

As the intercondylar distance increases a smaller angle is present between laterotrusive and mediotrusive pathways.



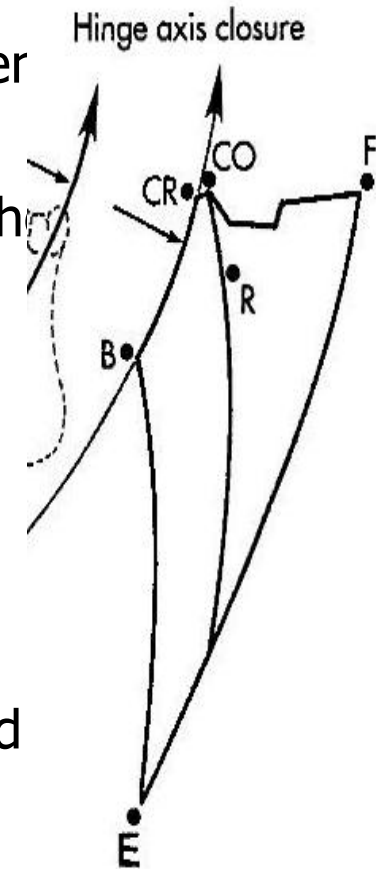


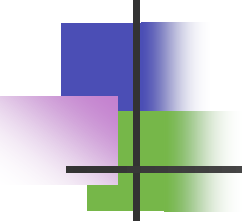
Effect of Bennett movement on ridge and groove placement

- As the amount of movement increases, the angle increases.
- The direction of the rotating condyle shift also influences the direction of latero-trusive and medio-trusive pathways and so the resultant angle.
- If the condyle shifts laterally and anteriorly, the angle will decrease on both maxillary and mandibular teeth.
- If the condyle moves laterally and posteriorly the angle will increase.

Border movements of the mandible

- During posterior opening border movement the axis of rotation of the mandible shifts during translational movement into the bodies of the rami. The exact location of the axes of rotation is likely to be the area of attachment of the speno-mandibular ligament.
- Maximum opening is reached when the capsular ligaments prevent further movement at the condyles.
- Maximum protrusive position is determined in part by the stylo-mandibular ligament.



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- The superior contact border movement is determined by the characteristics of occluding surfaces of teeth. Changes in the teeth will result in changes in the nature of border movement.

 - Its precise shape depends on:
 1. The amount of variation between CR, CO
 2. The steepness of the cuspal inclines of posterior teeth.
 3. The amount of overjet and overbite in anterior teeth.
 4. The lingual morphology of maxillary anterior teeth.
 5. The general inter-arch relationship



References

- Occlusion second edition "Ramfjord and Ash". Chapter 4
- Fundamentals of occlusion and temporomandibular disorders "Jeffrey Okeson" chapters 3,4,5,6.