

Factors of Mandibular Movements related to occlusal Morphology

Topics To Be Discussed:

- **Introduction & definitions**
- **Static occlusion**
- **Control of mandibular movements,**
Anterior controlling factors
Posterior controlling factors
- **Vertical determinants of occlusal morphology**
- **Horizontal determinants of occlusal morphology**

We've already took part of today's lecture in dental anatomy coarse, 1st year.

»Introduction

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

*supporting cusps determines the vertical dimension.

They're the cusps that come in contact with the opposing arch when the patient or anyone closes his mouth.

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

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,** because as we said they maintain the vertical dimension of occlusion.
- **Mastication,** because they're the ones that penetrate the food when they come in contact with the opposing arch.

■ They are also responsible for maintaining the vertical dimension of occlusion.

*When viewed from the occlusal surface, their tips are located approximately $\frac{1}{3}$ rd the distance into the total bucco-lingual width of the crown.

Centric stops or functioning cusps are $\frac{1}{3}$ the distance.

When we practiced carving in 1st year, we used to divide the occlusal plane into thirds, and locate the functional cusps (mandibular buccal and maxillary lingual) third the distance.

Whereas,

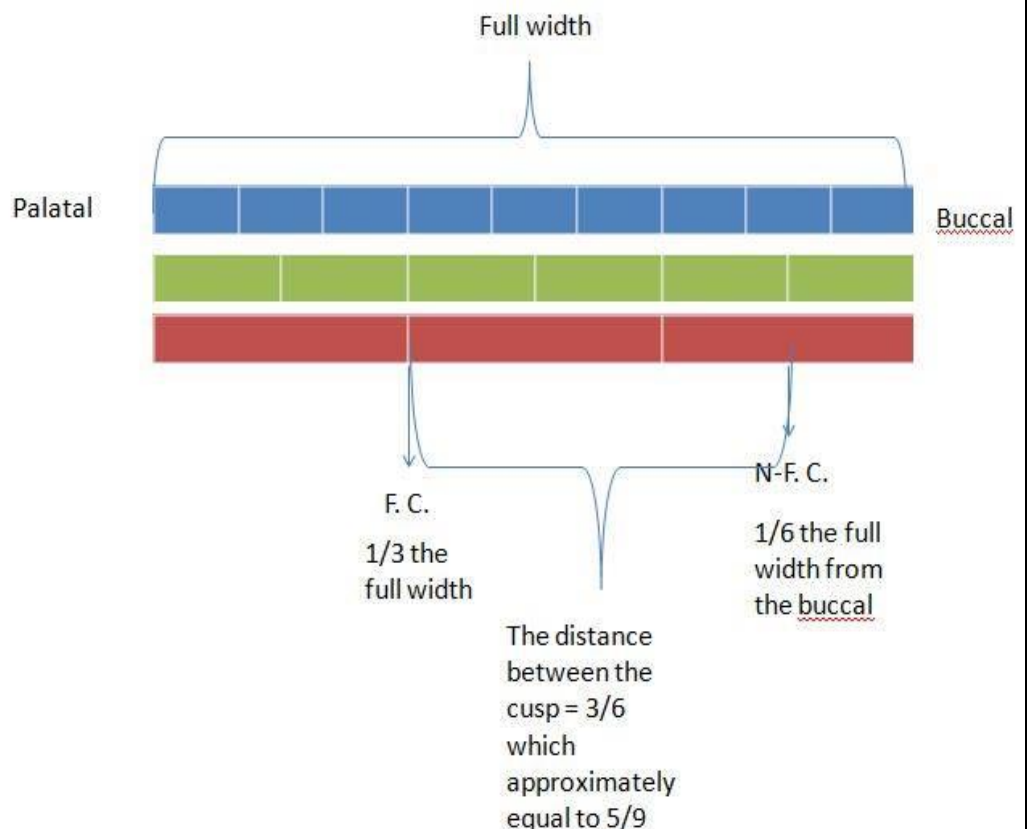
■ **Guiding cusps:** the buccal cusps of maxillary posterior teeth and the lingual cusps of mandibular posterior teeth.

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

That's why they used to tell us that if we want to locate the buccal cusp of a maxillary tooth, we measure the total bucco-lingual width and go $\frac{5}{9}$ of the distance from lingual cusp, this is

what the Dr. said, but I think she meant that the distance between the functional and non-functional cusp is $\frac{5}{9}$ the full width. The illustration aids what I claim.

MANY THANKS TO ALI AL-SHARA FOR THE ILLUSTRATION HE MADE.



Their role is to:

1. Minimize tissue impingement, because usually they're out of occlusion, going or facing outward.

E.g. lingual cusps of mandibular posterior teeth are out of occlusion, so they retract the tongue from the area of function.

The same concept is applied for the maxillary buccal cusps that retract the cheeks.

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.

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

I.e. when we do lateral and protrusive movements, the inclines located on the cusps-which are the triangular ridges- plus the mesial and distal ridges of the cusp that guide that cusp into lateral or protrusive are called guiding inclines.

▪ **Incisal guidance:** the influence of the lingual surfaces of maxillary anterior teeth on mandibular movement, during protrusive movement.

We already know the two components of it, which are the:

1- Overjet: horizontal component, horizontal distance between incisal edges of maxillary anteriors and incisal edges or labial surfaces of mandibular anteriors.

2- Over bite: vertical overlap, it guides the mandible to move in an angle during protrusive movement, and this's what we call the incisal guidance angle.

▪ **Condylar guidance angle:** the rate at which the condyle moves away from a horizontal reference plane.

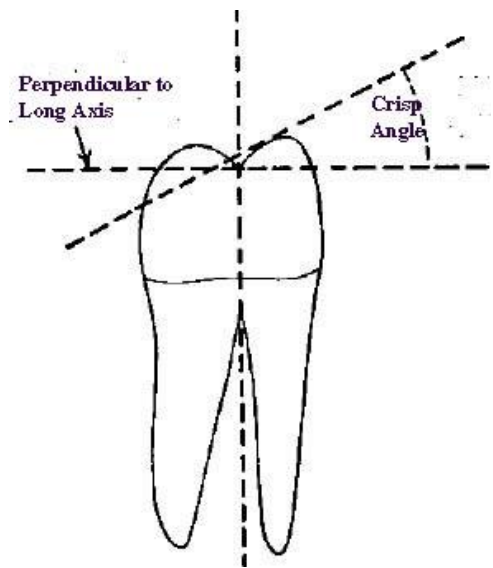
The condyle is located in the articulating fossa, anterior to the fossa is the articular eminence that has specific steepness that varies among humans-

could be steep or shallow.

When the condyles move from hinge to translation during mouth opening, they go downward and little bit forward, so they make an angle with the horizontal plane to move along the articular eminence, this angle is called the condylar guidance angle.

▪ **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.

In other words, the slope of the cusp with a horizontal line.

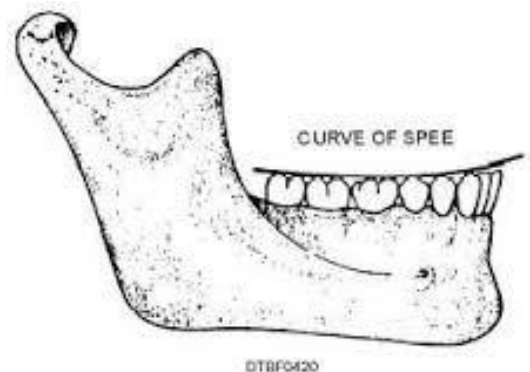


☐ **Curve of Spee:** curvature that is followed by the buccal cusps of the maxillary and mandibular posterior teeth, usually it's a curved plane not horizontal, and the curve is convex towards the mandible, concave towards the maxilla.

This curve aids in disocclusion between posterior teeth during different movements.

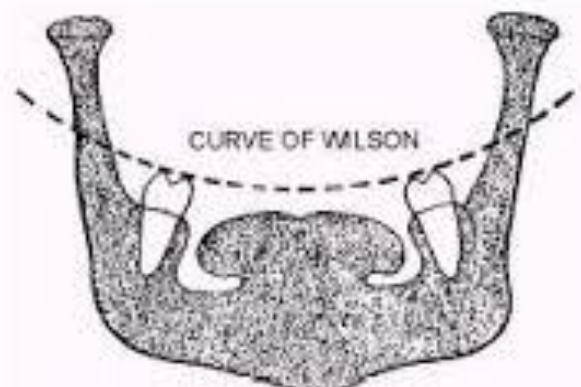
This is the occlusion we should have in normal dentition and some restorations (having separation between posteriors during movements) or we'll have interference.

Keep in mind that this's not the case in complete dentures and some types of RPDs.



▪ **Plane of occlusion:** imaginary plane on the mandible that touches all the buccal cusps of mandibular posterior teeth and incisal edges.

▪ **Curve of Wilson:** teeth are aligned in different angulations in the arch, so when you observe them from the frontal view, draw a line that connect the buccal and lingual cusps of the 1st molar on the right



side for instance with the buccal and lingual cusps of the 1st molar on the left side, this is curve of Wilson.

This curve is also important, and it's related to the angulation of teeth in the dental arches.

We all know that the maxillary lingual cusps are usually in contact with mandibular teeth, whereas the buccal cusps are bit higher, and you may've noticed that we applied this when we set the teeth in prosth. lab, we set the maxillary disto-lingual cusp bit higher than the mesio-lingual one, and the buccal cusps higher than both , and vice versa for the mandible to preserve the curve of Wilson.

Bonwill and Monson viewed the dental arch in 3-D.

▪ **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.

We benefited from this in the average value articulator because it's based on Bonwill's theory that the distance between the condyles and mid incisal point of the mandible was an equilateral triangle of 4 inch side.

▪ **Monson** utilized Bonwill's triangle and proposed a theory that a sphere existed with a radius of 4 inch whose center was an equal distance from the occlusal surfaces of posterior teeth and from the centers of the condyles.

I.e. they converted Bonwill's into 3-D, and placed a point of a sphere that has equilateral distance from the center of rotation and central incisors.

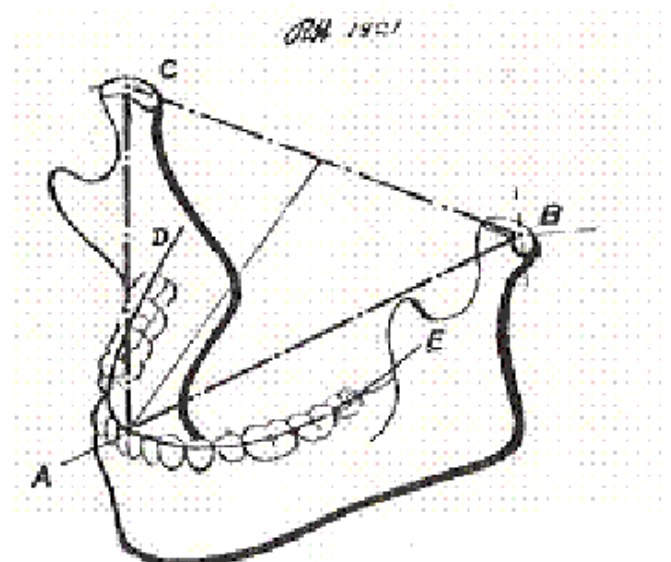
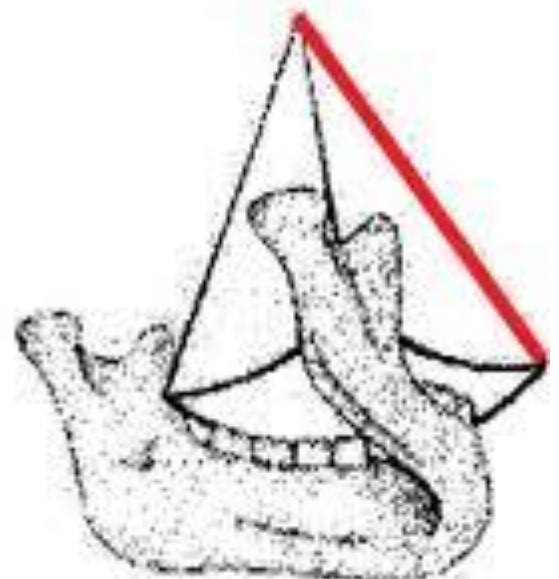


Fig. 16.—Bonwill triangle.



»Classification of Occlusion

For many years the standard for classification of occlusion has been **Angle's classification of malocclusion**. (It's used so much in ortho)

We consider the relation of maxillary and mandibular 1st molars in addition to the relation of maxillary and mandibular central incisors to each other.

Normal relation of maxillary and mandibular arches is that the maxillary arch is slightly larger than the mandibular arch, and there's over jet and overlap, this relation is considered to be the normal because it provides the best profile and esthetics.

Class II or III indicate abnormal relationship of arches:

Class II: the mandibular arch is too distal, usually the mandible is small, maxilla is large, or a combination of both.

Class III: the maxilla is more mesial, usually the maxilla is large, mandible is small, or a combination of both. Also the chin is usually square.

Angle class I

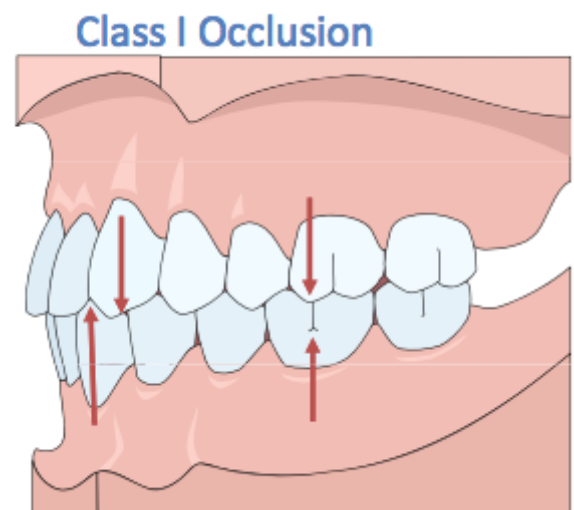
The m,b cusp of mandibular first molar occludes with the embrasure area between max second premolar and first molar.

The m,b cusp of max first molar is aligned (not occluding) 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. Except the mandibular central incisors and the maxillary 2nd molars or 3rd molars if presented, they only occlude with one tooth.

And that's because the mandibular centrals mesio-distal width is small, and



the last molars are distal to the other teeth in the arch.

Angle class II and III

Maxillary teeth are more mesial, whereas in class III mandibular teeth are more mesial.

The **problem in angle's classification** is that it considers the relation between the teeth, but it doesn't take into consideration the position of the condylar head into the articulating fossa.

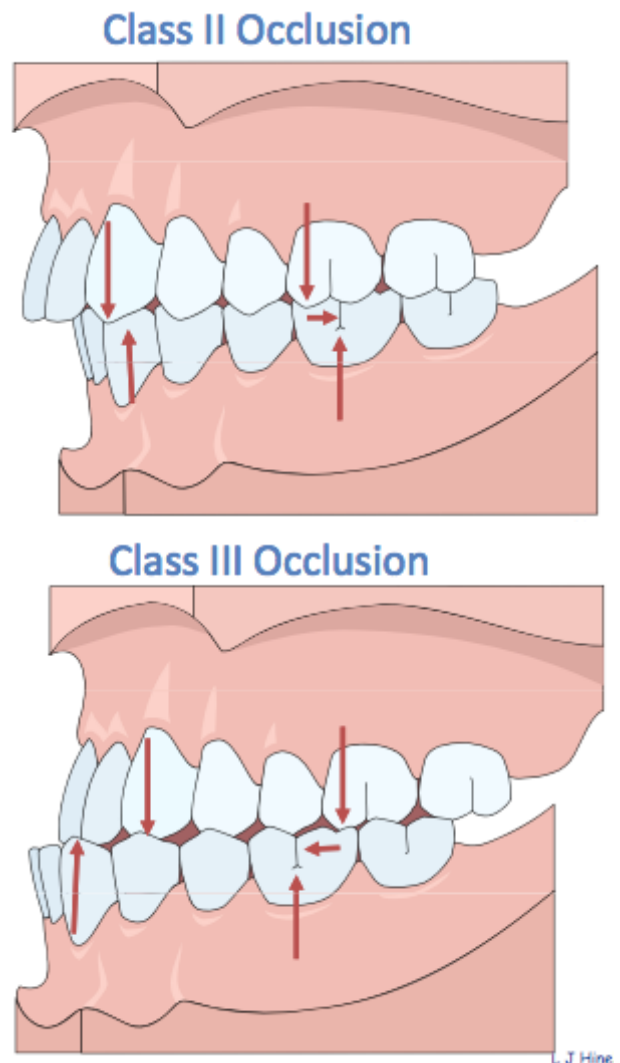
That's why sometimes when we have stable occlusion of the teeth that's not in relation with the fully seated position (condylar head fully seated in the fossa and the disk interposed between them), this occlusion can be sometimes problematic to the patient. We'll take it in further details in 5th year.

So all what we have to know is that the problem of Angle's classification is that it doesn't consider the relation of the condylar head in the fossa and the disk, it only considers the relation of the teeth.

Pullinger and colleagues and other scientists 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.

some people have deflective contacts for their whole life and they're normal and don't have any problem, but in a certain time for some reason it can turn to be problematic (maybe because of stress factors, or because they exceeded the tolerance rate of the muscles, teeth or the supporting structures), so we can't determine when the deflective will turn problematic to a certain patient.



L. J. Hine

»Intra arch tooth alignment

Teeth in the same arch aren't all vertical, they have angulations.

E.g. maxillary central incisors are labially inclined, maxillary posterior teeth are buccally inclined.

And for the mesio-distal alignment, maxillary centrals are a slightly mesially inclined, maxillary canines are vertical, maxillary posterior teeth are mesially inclined except for the 1st 2nd and 3rd molars which are slightly distally inclined.

For the mandibular teeth, mandibular anterior teeth and premolars are buccally and mesially inclined, all the mandibular posterior teeth are mesially inclined, but the mandibular 1st 2nd and 3rd molars are slightly lingually inclined.

The occlusal surfaces of posterior teeth:

we said that the functional cusp of a maxillary posterior tooth is 1/3 the bucco-lingual width of the crown, whereas the guiding cusp is 1/6 the distance.

Occlusal table: The area of tooth between the buccal and lingual cusps.

Outer aspect: The occlusal area outside the occlusal table, this means that any part beyond or outside the buccal or lingual cusp is called outer aspect.

Inner aspect: area from the buccal cusp to the lingual cusp.

It's important, because when we say the inner incline of maxillary buccal cusp we should know that it extends from the cusp to the center, whereas the outer incline of the maxillary buccal cusp of the maxillary 1st molar is from the cusp tip into the buccal surface outward.

The inner and outer inclines 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.

The maxillary and mandibular teeth occlude in a precise manner.

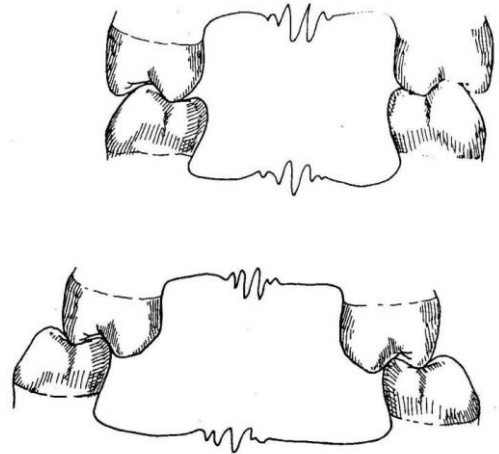
The shape of the dental arches is usually U shaped to oval.

Arch length: if we want to measure it we choose two teeth (the one and its opposing on the other side), for example the mesial surfaces of maxillary 2nd molars on the right and left side, then we draw a line mesial to each surface connecting all the teeth in between.

Arch width: usually it's from the lingual surface of one tooth to the lingual surface of same tooth on the other side.

We said that the buccal cusps of mandibular posterior teeth and lingual cusps of maxillary posterior teeth are the ones that occlude with the opposing fossa, embrasure, marginal ridge or whatever.

The buccal cusps of maxillary teeth are facing or going outwards, that's why they prevent cheek and lip biting during function. Sometimes this relationship is reversed as in class III, and we call it 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.

That means if we have cusp tip with fossa, the cusp tip is convex and the opposing fossa is concave, but the surfaces that come in contact are not like hole and key, they are not complementary in shape, so they only meet at certain points.

The best contact is when we have 3 points of contact between the cusp tip and the opposing fossa, and this is what we call **tripodization of contact**, and it's the most stable.

If we have cusp tip with opposing marginal ridge then we're having convex surface contacting another convex surface, in this relation the mastication is more efficient because we'll have much more cutting.

And as we said the surfaces are not alike, so we'll have contact on certain points only and the other areas will be spaced, this space is important for the escape of food, because if the contact was too tight, mastication won't be easy.

»Common occlusal relationships of anterior teeth

Maxillary anterior teeth are normally positioned labially to the mandibular anterior teeth (overjet). Usually overjet is 2-4 mm.

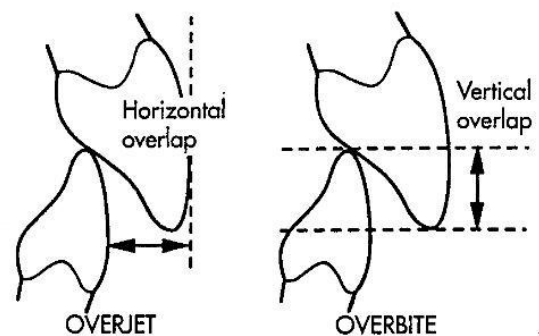
Both maxillary and mandibular anterior teeth are labially inclined on avg 12-28 degrees.

Normally the incisal edge of mandibular incisors contacts the lingual fossa of maxillary incisors approximately 4 mm gingival to the incisal edge. (Overbite) usually 2-4mm.

for the anterior teeth to incise the food, we'll have protrusive movement of the mandible, mandibular and maxillary anterior teeth come in edge to edge for the incision of food, that's why they're called incisors.

The picture shows the overjet and the overbite, usually mandibular incisor touches the cingulum of the maxillary incisor, if it touches higher point then we have what's called **deep overbite**.

We measure the horizontal overlap (overjet) from the labial surface of maxillary incisor to the labial surface of mandibular incisor.



»Occlusal contacts during mandibular movement

Teeth in the masticatory system during movements don't remain in centric occlusion, they must move.

Three basic eccentric movements are present

1. Protrusive, or forward movement for the incision of food or for speech (s sound).
2. Retrusive, backward movement.
3. Latero-trusive, lateral movement.

Protrusive mandibular movement

Mandibular incisors move along the lingual surfaces and they touch the incisal edges of maxillary central incisors.

The contact must be on the anterior teeth, and it could be on the canines.

Usually we should have disocclusion of all posterior teeth, if we have contact on the posterior teeth but it doesn't interfere with the movement then it's called posterior contact, and it's not deflection because it didn't interfere with the smooth movement of the mandible.

Posterior contact isn't favorable, but sometimes it's presented with no interference.

If the contact did interfere with the normal relationship of the anterior teeth (it may cause disocclusion in anterior teeth), then it's called deflective contact.

Latero-trusive mandibular movements

The most favorable condition is to have contact on the canines on the working side to which the mandible moves.

If the contact was on the canine and the premolars, it's called **group function guidance**.

On the non-working side we must have complete disocclusion, but if we have contact that doesn't interfere with the movement it's called non-working side contact, and if it did interfere with the normal sliding movement laterally it's called non-working side interference.

Retrusive movement

This movement occurs when the mandible moves posteriorly from centric occlusion to centric relation.

*Centric relation position is posterior to centric occlusion. The distance is normally limited to 1-2mm.

The mandibular teeth slide against the mesial inclines of the maxillary teeth and they go backward into 1-2 mm until the tissues stop the movement and we can't move further.

Optimal occlusal condition during mandibular closure will be achieved by:

-Even simultaneous contact of all possible teeth, mainly on posteriors, lighter on anteriors.

-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. The inclines of the cusp -not the cusp tip- are in contact with the opposing fossa.

-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. What makes them acceptable is that usually the horizontal forces are only on the canines when we have canine guidance, and canines can accept horizontal forces very well because of their long roots and position at the corner of the arch and the dense compact bone surrounding it.

-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 non axial loading by anterior teeth during protrusive movement, because they are a lot away from the centers of rotation (center of the lever system).

It's not favorable to have contact on posterior teeth during protrusive movement because there're horizontal forces, and they are close to the center of rotation, so they'll be under high forces.

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 laterotrusive movements of the mandible, canines are appropriate teeth to contact and dissipate horizontal forces while disoccluding posterior teeth, this is called **canine guidance**.

☒ **As a summary:**

Both anterior and posterior teeth act differently. Posterior teeth can withstand forces applied during closure of the mouth, that's why we don't like anterior teeth to contact during the closure of mandible.

In centric occlusion we have light contact anteriorly, because the anterior teeth are inclined so the forces won't be along the long axis of those teeth. We'll have off axial loading all the time on the anteriors if we placed a very tight restoration, or if the posterior teeth are missing.

If the posteriors are missing, the anteriors will go forward and the vertical dimension will be reduced due to the change in teeth angulation.

»Control of mandibular movement

Two controlling factors:

1-Teeth, anterior controlling factor.

The effect of the controlling factors depends on the position of the teeth, posterior teeth are closer to the TMJ so the controlling factors are higher there. The case is reversed in the anteriors.

2-TMJ, posterior controlling factor.

-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.

That's why we have different types of teeth morphologies for the teeth we use for the dentures, we can choose either flat teeth or ones with cusps depending on the case and its controlling factors that we'll mention below.

»Vertical determinants of occlusal morphology

They determine the height of the posterior teeth cusps.

All the factors should be taken into consideration, we don't deal with one factor separately.

*Effect of condylar guidance on cusp height:

steep condylar guidance »» higher disocclusion »» longer cusps

*Effect of anterior guidance on cusp height

Anterior guidance has two components; vertical and horizontal, so it depends on the amount of overjet and overlap.

As horizontal overlap increases the anterior guidance angle decreases »» shorter cusps

-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 the curve of Spee on cuspal height,

the more curvature »» the higher the cusps that we can provide.

*Effect of Bennett movement on cusp height

-Bennett movement has three attributes:

1. Amount.
2. Timing (progressive or immediate).
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. (Roominess of the fossa ... اتساع.... And how much the fossa is away from the orbiting condyle).

2. The degree of movement of the rotating condyle determined by the tightness of the TM ligament (ligament on the capsule). If it's not tight the distance will be more than if it's tight, tightness of the ligament limits the movement.

-The **direction of movement** depends on the direction taken by the rotating condyle during body 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:

Direction of Bennett movement in the vertical plane is upward, straight or downward.

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. We don't care if it's anterior or posterior, we care if it's superior, just directly to the side or inferior.

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.

We usually don't measure all these factors clinically in a precise manner, we observe them by observing the amount of disocclusion when we move to the right or left.

»Horizontal determinants of occlusal morphology

They include the relationships that influence the direction of ridges and grooves.

The Dr. said that she's only going to mention them without going deeply because it's a little complicated.

1- Influence of the distance of teeth from the center of rotation and from the midsagittal plane.

2- Effect of intercondylar Distance.

3- Effect of Bennett movement on ridge and groove placement, you have to know that the anterior and posterior movements do matter here.

4- Border movements of the mandible » we already took it.

قال رسول الله صلى الله عليه وسلم:
(من سلك طريقا يبتغي فيه علما سهل الله له طريقا إلى الجنة، وإن الملائكة لتضع
أجنحتها لطالب العلم رضا بما يصنع)

Best Of Luck

Your Colleague: Rawan F. Za'atreh

