Dent 5909/5910
Mechanical Characteristics of Occlusion

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Learning Outcomes
• To recognize the types of mandibular movement
• To visualize and interpret single-plane border movements and combine them 3-dimensionally
• To identify the posterior and anterior controlling factors on occlusal morphology
• To explain how the vertical determinants of occlusal morphology affect the cusp height
• To explain how the horizontal determinants of occlusal morphology affect the direction of ridges and grooves on the occlusal surfaces

Mechanics of Mandibular Movement

• Management of Temporomandibular Disorders and Occlusion 5th edition
  • Jeffrey P. Okeson
  • Chapter 4
  • Pages 93-108

Types of Movement

Rotational Movement
Translational Movement

Rotational Movement
• Rotation: “The process of turning around an axis: movement of a body about its axis.”
• Rotation is movement between the superior surface of the condyle and the inferior surface of the articular disc

Horizontal Axis of Rotation
• Opening and closing motion
• Hinge axis
• Pure rotational movement
• Terminal hinge axis when the condyles are in their most superior position
Frontal/Vertical Axis of Rotation

- One condyle moves anteriorly out of the terminal hinge position
- Opposite condyle remains in terminal hinge position
- Does not occur naturally

Sagittal Axis of Rotation

- One condyle moves inferiorly out of the terminal hinge position
- Opposite condyle remains in terminal hinge position
- Does not occur naturally

Translational Movement

- Occurs when the mandible moves forward (protrusion)
- Teeth, condyles, and rami, all move in the same direction and to the same degree
- Occurs within the superior cavity of the joint

Single-Plane Border Movements

Sagittal Plane Border and Functional Movements
Horizontal Plane Border and Functional Movements
Frontal/Vertical Border and Functional Movements

Sagittal Plane Border & Functional Movements

- Posterior and anterior – determined by ligaments and morphology of TMJs
- Superior – determined by occlusal and incisal surfaces of teeth
- Functional – determined by neuromuscular system

Posterior Opening Border Movements

- 1st stage
- Condyles stabilized in most superior position
- Most superior condylar position from which a hinge axis movement can occur is the CR position
Posterior Opening Border Movements

- 2nd stage
- Mandible rotates for the first 20-25 mm of opening
- TM ligaments tighten
- Anterior and inferior translation of the condyles
- Maximum opening 40-60 mm

Anterior Opening Border Movements

- Closure is accompanied by contraction of the inferior lateral pterygoids
- Tightening of stylomandibular ligaments produce a posterior movement of the condyles

Superior Contact Border Movements

- Initial tooth contact in CR occurs between mesial incline of maxillary tooth and distal incline of mandibular tooth
- Muscular force results in a superoanterior movement to the intercuspal position
- CR-ICP slide present in 90% of the population
- Average distance 1.25 mm

Superior Contact Border Movements

- Contact between anterior teeth results in an anteroinferior movement of the mandible
- Edge-to-edge relationship
- Horizontal pathway is followed
Superior Contact Border Movements

- Mandible moves in a superior direction until posterior teeth contact

Superior Contact Border Movements

- Occlusal surfaces dictate pathway to maximum protrusive movement
- Connects to most superior position of anterior opening border movement

Functional Movements

- CR = ICP
- Protrusive movement immediately engages the anterior teeth and the mandible moves inferiorly

Functional Movements

- Begin and end at ICP
- Postural position – 2-4 mm below the ICP; functionally ready position maintained by the myotatic reflex
- Clinical rest position – 8 mm inferior and 3 mm anterior to the ICP; M at their lowest level of activity

Postural Effects on Functional Movement

- Upright position
  - Postural position 2-4 mm below ICP
- Extended upward
  - Tooth contact posterior to ICP
- Alert feeding position
  - Tooth contact anterior to ICP

Chewing stroke – begins at ICP, drops downward and slightly forward, returns slightly posterior
In the diagram below of Posselt's envelope of mandibular motion (sagittal section), which letter designates the protruded contact position?

- A
- B
- C
- D
- E
- F
- A-F = anterior border movement of the mandible
- C-E = rotational movement
- E-F = translational movement

Which of the following sagittal views of the Posselt's envelope is the correct tracing for a patient with coincidence of centric occlusion and centric relation?

- 1
- 2
- 3
- 4

Horizontal Plane Border and Functional Movements

- Mandibular movements in the horizontal plane produce a rhomboid shape pattern

Left Lateral Border Movements

- Contraction of the right inferior lateral pterygoid
- Left condyle – rotating/working
- Right condyle – orbiting/balancing

Continued Left Lateral Border Movements with Protrusion

- Contraction of left inferior lateral pterygoid causes left condyle to move anteriorly and to the right

Right Lateral Border Movements

- Contraction of the left inferior lateral pterygoid
- Right condyle – rotating/working
- Left condyle – orbiting/balancing
Continued Right Lateral Border Movements with Protrusion

- Contraction of right inferior lateral pterygoid causes right condyle to move anteriorly and to the left

Horizontal Plane Border Movements

- Border movements at increased openings result in increasingly smaller tracings

Functional Movements

- Functional movements most often occur near ICP

When the mandible is in its physiologic rest or postural position, the contact of the teeth is:

- Maximum
- Not present
- Premature
- Slight

In the figure below, which number designates the retruded contacting position?

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Frontal/Vertical Border and Functional Movements

- Shield-shaped pattern
Left Lateral Superior Border Movement
- Primarily determined by morphology and occlusal relationship of the teeth
- Secondarily by the condyle-disc-fossa relationship

Left Lateral Opening Border Movements
- Laterally convex path until maximum opening

Right Lateral Superior Border Movement
- Mandible moves to the right in a inferiorly concave path

Right Lateral Opening Border Movements
- Laterally convex path until maximum opening

Functional Movements
- Begin and end at the ICP
- Mandible drops inferiorly to desired opening and shifts up on the side of the bolus until ICP is reached

Envelope of Motion
- Combine mandibular border movements from the 3 planes to produce a 3-dimensional envelope of motion
- Superior surface — determined by tooth contacts
- Other borders — determined by ligaments and joint anatomy
This is a frontal border tracing of a patient with a canine-guided occlusion.

- Which letter on the diagram defines the only point where posterior tooth contact occurs?
  - A
  - B
  - C
  - D

Viewed anteriorly, which diagram represents a chewing stroke?

- 1
- 2
- 3
- 4
- 5

Determinants of Occlusal Morphology

- Management of Temporomandibular Disorders and Occlusion 5th edition
  - Jeffrey P. Okeson
  - Chapter 6
  - Pages 127-146

Posterior Controlling Factors

- Protrusive condylar path
  - Balancing/orbiting condyle
    - Bennett Angle
  - Working/rotating condyle
    - Laterotrusion

Protrusive Condylar Path

- In protrusion, the condyle descends along the articular eminence
- Condylar guidance angle – larger for balancing/orbiting path than protrusive path
  - Medial wall of mandibular fossa is steeper than the articular eminence of the fossa
- Condylar guidance is a fixed factor
Protrusive Condylar Path Adjustment on the Hanau

- Protrusive record
- Maxillary cast/denture is placed into the record and the condylar guidance slot mechanism is rotated until the maxillary cast/denture fits the record exactly

Balancing Condyle Bennett Angle

- Angle formed between the sagittal plane and the average path of the advancing/balancing condyle as viewed in the horizontal plane during lateral mandibular movements
- Balancing condylar movement is downward, forward, and medial

Balancing Condyle Bennett Angle on the Hanau

- Lateral condylar guidance is calculated by classic Hanau formula: \( L = \frac{H}{8} + \frac{12}{12} \)
- Transferred to the instrument by rotating the condylar posts

Working Condyle Laterotrusion

- Condylar movement on the working side in the horizontal plane
- Bodily shift of the mandible in the direction of the working condyle
- Formerly known as Bennett's movement

Working Condyle Laterotrusion on the Hanau

- Working condylar movement is built into the machine and varies only in amount
- Working condylar ball remains in the original position but the intercondylar pin moves laterally through the ball
- Produces an upward, backward, and lateral, working condylar motion
- \( \uparrow BA = \uparrow \text{Laterotrusion} \)
Condylar guidance is a factor which:

- Is totally controlled by the dentist
- Is totally dictated by the patient
- Is partially dictated by the patient but can be adjusted by the dentist if necessary
- Can be adjusted by the laboratory technician

Anterior Controlling Factors

- In protrusion, the incisal edges of the mandibular teeth occlude with the lingual surfaces of the maxillary anterior teeth
- This is a variable factor that can be altered

Understanding the Controlling Factors

- Morphology of the posterior teeth must be in harmony with the opposing teeth during eccentric movements
- Occlusal surfaces consist of cusps with vertical and horizontal dimensions

Vertical Determinants of Occlusal Morphology

Effect of Condylar Guidance on Cusp Height

- Function of the relationship between the maxillary and mandibular anterior teeth

Effect of Anterior Guidance on Cusp Height
Effect of the Plane of Occlusion on Cusp Height

- Plane of Occlusion
  - Parallel to Camper’s Plane or the Ala-Tragus Line
  - Line running from the inferior border of the ala of the nose to the superior border of the tragus of the ear
- As the plane of occlusion becomes more parallel to the angle of the eminence, the posterior teeth must be made shorter

Effect of the Curve of Spee on Cusp Height

- A more acute plane of occlusion requires shorter posterior cusps

Effect of Mandibular Lateral Translation Movement on Cusp Height

- Bodily side shift of the mandible
- Greater the amount, the more immediate the timing, and the more superior the direction, the shorter the posterior cusps must be

Horizontal Determinants of Occlusal Morphology

- Relationships that influence the direction of ridges and grooves on the occlusal surfaces

Effect of Distance from the Rotating Condyle on Ridge and Groove Direction

- Greater the distance from the rotating condyle, the wider the angle
Effect of Distance from the Midsagittal Plane on Ridge and Groove Direction

- Greater the distance from the midsagittal plane, the wider the angle

Effect of Mandibular Lateral Translation Movement on Ridge and Groove Direction

- Increased lateral translation, wider the angle

Effect of Intercondylar Distance on Ridge and Groove Direction

Relationship between Anterior and Posterior Controlling Factors

- Negligible evidence to support a correlation between ACF and PCF
- They are independent of each other yet function together in dictating mandibular movement

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