Biological Considerations In Jaw Relations & Jaw Movements

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Contents:

- Introduction
- Definitions
- Anatomic components of masticatory system
  - TMJ
  - Muscles of Mastication & ligaments...
- Factors regulating jaw motion
- Considerations in jaw relations
  - Vertical & Horizontal...
- Mandibular movements
  - Single plane border movements
    - Sagittal, horizontal & frontal
  - Eccentric movements
  - Chewing stroke
  - Effect of dental conditions on chewing
INTRODUCTION
Definitions:

- **Jaw relations**: any spatial relationship of maxillae to mandible
  - Any one of the infinite relationship of the mandible to maxillae.

- **Types**:
  - Orientation jaw relation
  - Vertical jaw relation
  - Horizontal jaw relation
Definitions:

- Vertical relations establish the amount of jaw separation allowable for dentures

- They are classified as:
  - Vertical dimension of occlusion
  - Vertical dimension of rest
  - Vertical dimension of speech
Definitions:

- Horizontal jaw relations are those taking place in a horizontal plane of reference.

- Horizontal jaw relations:
  - Centric
  - Eccentric
Definitions:

- **CENTRIC RELATION (GPT-8)**: the maxillomandibular relationship in which the condyles articulate with the thinnest avascular portion of their respective disks with the complex in the anterio-superior position against the shapes of articular eminencies. This position is independent of tooth contact. This position is clinically discernible when the mandible is directed superiorly and anteriorly.
● CENTRIC OCCLUSION (GPT 8) - the occlusion of opposing teeth when the mandible is in centric relation. They may or may not coincide with the maximum intercuspual position.

● TERMINAL HINGE AXIS /TRANSVERSE HORIZONTAL AXIS (GPT 8) - an imaginary line around which the mandible may rotate within the sagittal plane.

● MAXIMAL INTERCUSPAL POSITION/ MAXIMUM INTERCUSPATION (GPT 8) - the complete intercuspation of the opposing teeth independent of condylar position, sometimes referred to as the best fit of the teeth regardless of the condylar position.
Anatomical Components of Masticatory System

Temporomandibular joint:
- Complex joint
- Hinge movement
  - Ginglymoid joint
- Sliding movement
  - Arthrodial joint
- Ginglymoarthrodial joint
- Formed by
  - Glenoid fossa
  - Mandibular condyle
  - Articular disc
- Compound joint
  - 3 bones
  - 2 bones and disc (non-ossified bone)
Muscles of mastication:

- **Masseter**: Quadrilateral
  - **ORIGIN**: Zygomatic arch
  - **INSERTION**:
    - Lateral surface of mandible near angle (superficial)
    - Lateral aspect of ramus (deep)
  - **ACTION**:
    - Elevation (primary)
    - Protrusion (superficial)
    - Protrusion stabilization (deep)
**Temporalsis Muscle:** fan-shaped

- **ORIGIN**
  - Temporal fossa and lateral skull

- **INSERTION**
  - Coronoid process and anterior ascending ramus

- Anterior has vertical fibres
- Middle has oblique fibres
- Posterior has horizontal fibres

- **FUNCTION**
  - Elevation (primary)
  - Important positioning muscle
  - Anterior alone will elevate
  - Middle alone will elevate & retract
  - Posterior alone will elevate & retract slightly
  - Unilateral ipsilateral excursion
Medial Pterygoid Muscle:

- Forms muscular sling with masseter

- **ORIGIN**
  - Medial aspect of lateral pterygoid plate

- **INSERTION**
  - Medial aspect of mandible inferior border and angle

- **FUNCTION**
  - Elevation (primary)
  - Aid in protrusion
  - Contralateral excursion
Lateral Pterygoid Muscle:

- Two heads now considered to be two distinct muscles
  - Inferior Lateral Pterygoid M.
  - Superior Lateral Pterygoid M.
- Orientation of both heads or muscles is primarily horizontal
- Triangular shape
Inferior Lateral Pterygoid Muscle:

- **ORIGIN**
  - Lateral aspect of lateral pterygoid plate

- **INSERTION**
  - Neck of condyle

- **FUNCTION**
  - Protrusion (primary)
  - Depression of mandible
  - Unilateral contraction causes mediotrusive movement
Superior Lateral Pterygoid:

- Smaller muscle than inferior

- **ORIGIN**
  - Infratemporal surface of greater sphenoid wing

- **INSERTION**
  - Articular capsule
  - Articular disc
  - Neck of condyle

- **FUNCTION**
  - Active during power stroke (movements involving elevation of the mandible against resistance)
  - Inactive during opening
Digastric Muscle:

- Not really a muscle of mastication but has important influence

**POSTERIOR BELLY**

- **Origin**
  - Mastoid notch

- **Insertion**
  - Intermediate tendon of hyoid bone

**ANTERIOR BELLY**

- **Origin**
  - Fossa on lingual of mandible at midline

- **Insertion**
  - Intermediate tendon of hyoid bone

**FUNCTION**

- Mandibular depression
- Elevate hyoid bone
- Assist in swallowing
**TM capsule and ligaments:**
- Capsular ligament
- TM ligament
- Collateral ligament

**Accessory ligaments:**
- Sphenomandibular ligament
- Stylomandibular ligament
Factors that regulate jaw motion

- **Opposing tooth contacts**
  - Even contacts - no deflection/displacement
  - Cusp inclines - harmony with CG & IG

- **TMJ**
  - Compartments...
  - Ligamentous attachments...
  - Condylar guidance...

- **Axes of mandibular Rotation**
● **Muscular involvement**

- Temporalis- centric contacts
- Lateral pterygoid- forward movement, lateral & protrusive..., stabilize on elevation (superior)

● **Neuromuscular regulation of mandibular movement**

- Proprioceptors....PDL, muscles & ligaments.
- **Mesencephalic nucleus**
  - Thalamus- sensorimotor cortex- voluntary...
  - Reflex arch- motor n. of TG n- mandi. Musc.- involuntary...
  - Combination-
- Loss of receptors...
Vertical jaw relations:

- In dentulous:
  - Mandibular musculature
  - Occlusal stops

- In edentulous:
  - Mandibular musculature
  - Gravity

- **Vertical dimension of rest/physiologic rest position**: is the postural position of mandible when individual is resting comfortably in upright position & associated muscles are in a state of minimal contractual activity.
  - Active
  - Passive
  - Alternative
• Cephalometric & electromyographic studies: VDR
  - not constant
    - Head & neck posture
    - Emotional state
    - Pain/ psychic tension
    - Age
    - Phases of respiration cycle

• Postural rest position- 8mm inf. & 3mm ant.
Horizontal jaw relations:

- **CR** - bone to bone
- **CO** - tooth to tooth

**Features:**

- **CR** determined by TMJ struct. & not dentition
- Teeth separated...centric.
- Fixed axis only in centric...
Significance:

- Dentures fail... CR & CO don’t coincide...
- D/D of TMJ disorders... CR necessary
- Occlusal treatment predictability...

Recording centric... 2 concepts:
- Minimal closing pressure...
- Heavy closing pressure...
Mandibular Movements

- 2 types:
  - Hinge - inferior cavity
  - Translatory - superior cavity

- Mostly combination... limited by...

- Border movements - at limits dictated by anatomic structure, as viewed in a given plane

- Functional movements - those during speech, mastication...
- Sagittal axis of rotation
- Horizontal axis of rotation:
  - Hinge movement
- Frontal axis of rotation:
Single plane border movements:

- **Sagittal plane border movements:**
  - Post. Opening border movement
  - Ant. Opening border movement
  - Superior contact border- occ. & incisal surfaces
  - Functional

`ligaments & morphology of TMJ`
Mandibular Movement Sagittal Plane Border
Movements

What determines the shape of this superior portion of Posselt’s diagram?

- Overbite
- Overjet
- Cusp inclines
- Lingual morphology
- CR & MI variation
- It is a tooth directed shape.
Effect of posture on functional movements...
Mandibular Movement Horizontal Plane Border Movements

- Gothic arch tracing
- Recording plate is attached to maxillary anterior teeth
- Stylus attached to mandibular teeth
  1. left lateral movement
  2. left lateral with protrusive movement
  3. right lateral movement
  4. right lateral with protrusive movement
Mandibular Movement

Horizontal Plane Border Movements

- Red dot represents the position of the mandible in CR
- Right L. Pterygoid contracts
- Right condyle moves medially and inferiorly
- Left condyle stays in CR as left L. Pterygoid is relaxed
- Right condyle is orbiting (non-working side)
- Left condyle is rotating (working side)
- Results in left border movement
Mandibular Movement

Functional range of movement falls within the border restrictions in all planes.

Diagram shows a discrepancy between CR and ICP.

EC = early chewing
LC = late chewing
EEP = edge to edge position of incisors

Superior view of the functional range of movement in the horizontal plane.
Frontal border & functional movements:

- Shield shape...
- 4 components:
  - Left lateral superior border
  - Left lateral opening border
  - Right lateral superior border
  - Right lateral opening border
• Morphology, interarch relationship of teeth...
• Condyle-disc-fossa rela. & morphology of TMJ
Ligaments tighten & prod. medial movement...
‘Envelope of Motion’
Eccentric Mandibular Movements:

- **Condylar translation...**

- **2 types:**
  - **Protrusive movement**
    - Sagittal protrusive condylar path
    - Sagittal protrusive incisal path
  
  - **Lateral movement**
    - Sagittal lateral condylar path
    - Immediate & progressive mandibular movement
    - Laterotrusion
    - Lateral incisal path
Protrusive movements

- **Sagittal protrusive condylar path:**
  - Mandible & condyle disk assembly - translates...
  - In Sagittal plane - 'S-shaped'
  - Condylar guidance ...(avg. 33)

- **Sagittal protrusive incisal path:**
  - Maxillary lingual anatomy
  - Protrusive incisal path...
  - Incisal guidance - 50-70
Lateral movements:

- **Sagittal lateral condylar path:**
  - Orbit of non-working condyle
  - Fischer’s angle - Sagittal laterotrusive condylar path & Sagittal lateral condylar path - 5 deg.
  - Sagittal inclination of lateral condylar path...

- **Immediate & progressive mandibular movement:**
  - 2 components:
    - Immediate - mesial - non-working - 0 - 2.6mm (Hobo & Mochizuki)
    - Progressive - translation - non-working - 1.5 - 3.6mm
  - Bennet angle: 2 - 44 deg
Chewing in the Frontal Plane- The Chewing Stroke

- one cycle of chewing, with an opening and a closing movement, is called a chewing stroke
- tear-drop shaped pattern
- can be divided into phases
  - opening phase
  - closing phase
    - crushing phase
    - grinding phase
Chewing in the Frontal Plane

- 1) opening phase-
  - jaw drops open 16-18 mm from MI
  - mainly straight downwards

- 2) closing phase begins-
  - jaw slides laterally ~ 5-6 mm as closure begins
  - amount of lateral shift depends on stage of mastication & type of food
  - early stages of chewing & harder foods show a greater amount of shift

- 3) crushing phase-
  - jaw closes against food bolus
  - food is trapped between teeth & crushed
  - jaw drifts back somewhat toward midline
Chewing in the Frontal Plane

4) grinding phase -
- guided by occlusion
- mandible ~ 3mm open
- mandible ~ 3-4 mm lateral to initial position
- buccal cusps lined up end to end on working side
- tooth/teeth come into or approach contact - “reverse working movement” - grind food in between as they pass by each other
- ends back at MI
Intercuspal Position (M.I.)

Centric occlusion

Grinding phase of closure

Beginning of tooth contacts

Opening phase

Crushing phase of closure

16 - 18 mm

5 - 6 mm
Chewing in the Sagittal Plane

- at mandibular incisor:
  - 1) opening phase-
    - mandible shifts anteriorly- incises food
    - amount of anterior shift depends on location of incisors, type of food being chewed & stage of mastication
  - 2) closing phase-
    - follows a posterior pathway
    - shifts back anteriorly into MI at grinding phase
Chewing Stroke-Working Side

- Molar on Working side follows same pathway as incisor-
- Working condyle shifts as well, as teeth close into Maximum intercuspation - upward, forward & inward
- Working side condyle returns to initial position before Non-Working one does
Chewing Stroke-Working Side

- Working condyle pathway on closure is inferior to opening pathway
- food bolus acts as a fulcrum, decreases interarticular pressure, causing more separation between Working side joint surfaces- condyle drops, disc rotates forward to maintain contact
Chewing Stroke- Non-working Side

- Molar on Non-Working side follows more nearly vertical path for both opening & closing - no anterior shift into Maximum intercuspation.
- Non-Working condyle travels along virtually same path on both opening & closing movements - no inferior separation, as joint is fully loaded on Non-Working side.
- Non-Working condyle doesn’t move posterior to MI - no anterior shift into Maximum intercuspation.
Forces of Mastication

- max. biting force varies within a population
- men generally bite with more force than women
- adults bite harder than children
- dental mal-alignments can reduce the amount of biting force that can be generated
- biting force in the molar region is several times greater than in the anterior region
- most chewing takes place in the 1st molar/2nd premolar area
- avg. chewing force about 35% of max. biting force
- people with complete dentures have a biting force and chewing efficiency only ~1/4 as much as people with teeth have
Effect of Food Type/Consistency

- **harder food** = broader, more lateral chewing stroke
- affects amount of lateral & anterior shift - the harder the food, the more the shift
- in most people, the harder the food, the more chewing strokes needed
Effect of Dental Condition on Chewing

- People with heavily worn teeth show more lateral chewing movements, more mandibular side shift, less stable MI, & more erratic initial opening & final closing movements.
- Sharp, unworn teeth result in a more vertical chewing stroke, with a better defined MI position.
- Persons with malocclusions tend to have more irregular, less repeatable chewing patterns.
- Persons with TMJ pain have slower, shorter, irregular yet repeatable chewing pathways.
Conclusion...

To understand the vertical and horizontal movements of the stomatognathic system one needs to have a sound knowledge of the biological factors associated with it.
JAI HIND