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The Temporomandibular Joint - Anatomy/Physiology

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Definition

- The temporomandibular joint (TMJ) is a freely moveable (diarthrodial) articulation between the condyle of the mandible and the temporal bone. It is a true synovial joint and, therefore, has much in common with the other synovial joints of the body. It does, however, possess certain unique developmental, anatomical, and functional characteristics which distinguish it from other joints of this type.
Definition

- Temporomandibular joint disorder, TMJD (in the medical literature TMD), or TMJ syndrome, is an umbrella term covering acute or chronic pain, especially in the muscles of mastication, and/or inflammation of the temporomandibular joint, which connects the mandible to the skull. The primary cause is muscular hyper-or parafunction, as in the case of bruxism, with secondary effects on the oral musculoskeletal system, like various types of displacement of the disc in the temporomandibular joint. The disorder and resultant dysfunction can result in significant pain, which is the most common TMD symptom, combined with impairment of function. Because the disorder transcends the boundaries between several healthcare disciplines - in particular, dentistry and neurology - there are a variety of treatment approaches. (From Wikipedia)

Unique because of:

- Uses: Speaking, mastication (chewing), swallowing, facial expressions, musical instruments, kissing, yawning, laughing, smiling
- Influences on both sides of body
- Variety of professionals that treat it
- Symptoms
Symptoms

- Symptoms associated with TMJ disorders may be:
  - Biting or chewing difficulty or discomfort
  - Clicking, popping, or grating sound when opening or closing the mouth
  - Dull, aching pain in the face
  - Earache
  - Headache
  - Hearing loss
  - Migraine
  - Jaw pain or tenderness of the jaw
  - Reduced ability to open or close the mouth
  - Neck and shoulder pain
  - Dizziness
  - Eye pain
  - Difficulty swallowing
  - Blurred vision
  - Teeth malalignment
  - Tinnitus

Occurrence

- Incidence/prevalence
  - 75% of the population has one sign of TMD
  - 33% of the population has one symptom that would cause them to seek treatment
  - Increasing due to increased stress, use of computers, and dentists being more aware of symptoms
Professionals Involved with TMD

- Treatment
  - Primary referrals from: Dentist, oral surgeon, orthodontist, doctor, psychologist, neurologist, ear/nose/throat specialist
  - Treatment: Physical therapist, dentist (mouth guard), doctor (medication-primarily muscle relaxers), psychologist (stress reduction and biofeedback), chiropractor

History

- Spasm of masticatory muscles
- Arthritis
- Vitamin deficiency
- Endocrine disorder
Clinical Symptoms

- Acute muscle disorders
- Disc-interference disorders
- Inflammatory disorders
- Chronic mandibular hypomobilities
- Growth disorders

Symptoms can all be explained by comparing to the “norm”-- that is why understanding of anatomy/physiology/biomechanics is important
Cranial Bones

- Frontal
- Parietal
- Temporal
- Sphenoid
- Nasal
- Mandible
- Maxillae/zygomatic arch
- Occipital
Temporomandibular Joint (TMJ)

- Temporal bone
  - Roof of the joint
  - Making the superior joint space
  - Associated with external auditory meatus, parietal bone, occipital bone, sphenoid
- Mandible
  - Gives rise to the condyle
  - Fitting into the fossa of the temporal bone
  - Not directly associated with other cranial bones, but related due to muscular and ligament attachments
Joint Characteristics

- Some believe a two joint compartment with upper or superior compartment (allowing for gliding) and lower (where hinge motion occurs)
- Relationship with boney landmarks on skull
  - Coronoid process - anterior to condyle, attachment for temporalis
  - Post glenoid spine - attachment for posterior ligament
  - Articular eminence - subluxing
  - Maxillae - sinus, upper teeth
  - External auditory meatus - ear canal and ear drum
Condyle

- Shape-primarily convex superiorly
  - Medial/lateral measurement twice the anterior/posterior
    - Not pure hinge movement with opening
    - Rotation with translation forward
    - Medial pole-up/forward
    - Lateral pole-down/back
Attachments

- Collateral ligaments
  - Medial/lateral
  - Stabilizes medial/lateral joint
- Large lateral ligament
  - Temporomandibular or capsular ligament
  - Limits depression of condyle (for opening) and posterior movement
- Stylohyoid
  - Limits protrusion
  - A band of fibrous tissue connecting the tip of the styloid process of the temporal bone to the center of the hyoid bone
- Sphenomandibular ligament
  - A flat thin band of fibrous tissue extends downward from the sphenoid bone to the mandible
Ligaments

Henry Gray
Anatomy of the Human Body (1918)

Temporomandibular Ligament (Lateral)
Condyle

- Histologically
  - Covered with dense fibrous connective tissue and fibrocartilage - also on articular eminence and tubercle.
  - Trabecular bone underneath - superficial layer laid down parallel while deeper layer perpendicular

Weight bearing Joint

- Withstand shearing forces better
- Each condyle withstands 62.3 kg (monkey research) - other research 597 N in women and 847 N in men.
- Arthritis
- Joint affected by action of both TMJs
  - Balancing side or non-working often has more force on it than working side
  - Chew on diseased/sore side
Third Class Lever

- Weight bearing joint-Class III lever
- Example - tweezer

Research

- Dynamic structure - unilateral chewing or removal of teeth changed the content of glycosaminoglycans in the condyle and disc and caused thickening/hypertrophic layer on condylar cartilage

- Unilateral chewing - ipsilateral side moves shorter distance than contralateral side so ipsilateral side less loaded
Good Teeth Positioning

Poor Teeth Positioning
Disc

- Fibrocartilagenous material which is pliable and able to support, protect and lubricate the articulating bones
- Attaches firmly medial/lateral to condyle with anterior attachment to capsule and lateral pterygoid muscle

Posterior Disc

- Some believe posterior disc is separated by a fat pad into two parts - superior part being elastic with inferior part attaching to mandibular neck and inferior being non-elastic
Disc

- Characteristics
  - Bow-tie
  - Posterior portion thickest
  - Intermediate portion
    - Always in contact with condyle
    - Thinnest
    - Avascular
    - Aneural

Disc Location
Contents

- Consists of Type 1 collagen fibers in intermediate zone that run anterior/posterior and in ringlike fashion around periphery
- Increased tensile strength in center portion - more in anterior/posterior direction than medial/lateral
- Some elastin fibers with collagen fibers to restore form after loading
- Stiffer to compressive forces in center

Disc Dynamics

- More pliable with dynamic loading (chewing) versus static loading (clenching) due to fluid flow in and out of disc.
- Fluid flow for nutrition - especially avascular intermediate portion
- Fluid flow to help eliminate waste products.
Retrodiscal Tissue

- High capacity for energy dissipation during stress of joint
- Little to no function to pull disc backward with closing
- Pain sensitive structure - inflammation
Disc Attachments

- Attachments
  - Posterior ligament
    - Connects disc to posterior glenoid spine
    - so attachment to posterior skull
  - Elastic
  - Passive-tension tissue

Other Disc Attachments

- Lateral pterygoid - superior fibers - to superior/anterior portion
- Collaterals - disc to condyle
- Capsule - anterior/posterior only
- Does not attach to condyle directly
Normal Disc Movement-Left Joint

- Moves as unit with condyle
- Held in place on condyle by ligaments (collaterals and posterior)
- First 11 mm of opening, disc stationary, while condyle rotates
- >11 mm, disc and condyle translate forward
- Disc rotates backward by tension of posterior ligament
- Condyle always in contact with intermediate portion
- Opening door analogy

First 11 mm of opening, disc stationary, while condyle rotates
Capsule

- Highly vascular and innervated
- Fibers run temporal to mandible
- Strongest fibers lateral/inferior
- Less fibers superior/lateral medial - question if this instability contributes to anterior dislocation of disc
- Synovial membrane
  - Produces synovial fluid - small amounts of a clear, straw-colored viscous fluid. It is an infiltrate of the blood diffused out from the capillary network of the synovial membrane.
  - Lubrication and metabolic exchange for avascular joint tissue (disc)
- Temporomandibular ligament
Innervation

- Cranial Nerve V (trigeminal)
  - Mandibular branch - made up of posterior deep temporal, masseteric, and auriculotemporal nerves
  - Innervates temporalis, masseter, medial, lateral pterygoid, digastric, mylohyoid, tensor tympani, tensor veli palatini muscles
  - Both sensory and motor
  - Travels through foramen rotundum and ovale

Innervation

- Pain fibers - Type IV (from auriculotemporal branch)
  - Mechanoreceptors I, II, III in nerve endings
    - Postural and kinesthetic perception, reflexive activity and inhibition of pain
    - May act abnormally with response to dysfunction (swelling, capsule tightness, condyle positioning) - causing abnormal muscle firing
Cranial nerves
Vascular Supply

- Superficial temporal artery --- posterior
- Middle meningeal artery --- anterior
- Internal max.artery ---- inferior
- Deep auricular
- Anterior tympanic
- Ascending pharyngeal arteries

Muscles-Temporalis

- Origin - temporal fossa, superior to zygomatic arch
- Insertion - coronoid process of mandible
- Anterior, middle and posterior fibers
Temporals

- Elevation of mandible
- Posterior fibers - retraction, and deviation to same side
- Postural muscle
- Large muscle - 53% of total mass of elevators
- Keeps jaw shut during everyday activities
Temporals

- Referral pattern - temple, along eyebrow, behind the eye or upper teeth
- Perpetual clencher

Muscles-Masseter

- Origin - zygomatic arch
- Insertion - mandibular angle and ramus
  - Sling with medial pterygoid
  - Together make up 57% of cross section of elevators - power chewer
Masseter

- Synergist with temporalis for elevation but also retrudes jaw, lateral deviation to same side
- Chewing - first muscle to activate, especially with front teeth
Masseter

- Referral pattern - lower jaw, molar teeth and gum, maxilla, lower portion of mandible, temple eyebrow and to ear (externally)
- “Sinusitis”

Muscles - Medial Pterygoid

- Origin-inner surface of lateral pterygoid plate (under lateral pterygoid)
- Insertion-ramus of mandible by the angle
Medial Pterygoid

- Elevation, protrusion and lateral deviation to opposite side
- Close relationship with lateral pterygoid

Medial Pterygoid - Internal Palpation
Medial Pterygoid

- Referral pattern - posterior mandible, mouth, below and behind TMJ including ear (internally) - not teeth
- Stiffness in ear due to tensor veli palatini muscle unable to push medial pterygoid out of the way to dilate the Eustachian tube
- Swallowing difficult as restriction in protrusion of jaw
Muscles-Lateral Pterygoid

- Origin - lateral pterygoid plate of sphenoid
- Insertion - condylar neck, ramus of mandible and disc

Lateral Pterygoid

- Elevation, protrusion, lateral deviation to opposite side (also initial opening)
Lateral Pterygoid

- Referral pattern - zygomatic arch, TMJ
- Major myofascial source of pain
- Cause disc and jaw to be unable to return to normal resting position
- Malocclusion of teeth
Overview of Jaw Muscle Action

• Elevation - temporalis, masseter, medial pterygoid, superior division of lateral pterygoid

• Depression - digastric, mylohyoid, geniohyoid, and inferior portion of lateral pterygoid (initiates movement)

• Lateral deviation - ipsilateral posterior temporalis, contralateral medial pterygoid and inferior portion of the lateral pterygoid

• Protraction - medial pterygoid, supranyoid, inferior portion of lateral pterygoid

• Retraction - posterior and middle temporalis, digastric and masseters

Muscles - Digastric

• Origin - mastoid notch (posterior); symphysis of mandible (anterior)

• Insertion - join by a common tendon to the hyoid bone
Digastrics

- Depression and retrusion of jaw
- Less forceful movement - assisted with long lever arm and gravity
- Active with swallowing and coughing

Digastrics

- Referral pattern - behind mandible towards back of ear, lower incisors
- Rarely in spasm due to forward head posture (stretch weakness - Kendall)
Cervical Spine/Muscles

- Form stable base for TMJ to work on
- Upper cervical relationship
- Poor posture - condyle rotates backward - change of biomechanics
- Referral pattern from cervical spine

Thesis - Masticatory Muscle Activity with Varying Head Postures

- Purpose: Compare the muscle activity of bilateral temporalis and masseters (masticatory muscles) with head in natural, forward and retracted postures, with chewing.

- Results: Did show a difference in masticatory muscle activity of the TMJ in varying head postures. More activity was seen in forward and retracted head postures when compared to natural head postures in asymptomatic females. However, differences were not statistically significant.
Posture and TMJ Position

Chin retraction could cause TMJ posterior positioning, changing the biomechanics of the joint.

Mandibular Movement

- Mandibular movement
  - Maximum opening (incisor to incisor) - norm 40 mm - rotation and translation of condyle
  - Protrusion/retraction – norm 6-10 mm - just translation of condyle
  - Lateral deviations - norm is 10 mm - look for symmetry - rotation of ipsilateral condyle with translation of contralateral condyle
Rest Position

Opening - First 10mm
Full Opening - 40mm

Normal Opening and Symmetry
Aging

- Flattened condyle
- Osteoporosis of the condyle bone
- Thickening of the fibrous covering of the condyle
- Thinning of the cartilagenous zone of condyle
- Thinning of the disc
- Fibrotic synovial folds
- Thickening of the blood vessel walls
- Decrease in the number of nerves

Age Changes Cause:

- Decrease in the synovial fluid formation
- Impairment of motion due to decrease in the disc and capsule extensibility
- Decrease the resilience during mastication due to cartilage changes into collagenous element
- Dysfunction in older people
Where do we fit in?

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