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REVIEW ARTICLE

# Temporomandibular joint - An anatomical view

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## Abstract

Temporomandibular joint (TMJ) is one of the most intricate and complicated loading joints found in humans. TMJ is also called the mandibular joint; it is an ellipsoid variety of the left and right synovial joints which form a bicondylar articulation. The components of this joint are a fibrous capsule, a disk, synovial membrane, fluid, and tough adjacent ligaments. The mandible and the cranium are mechanically two different components; therefore, the appropriate term for this joint is the craniomandibular articulation. It is not possible to understand the accurate points of occlusion without a thorough knowledge of the biomechanics, physiology, and anatomy of TMJ. The primary necessity for successful occlusal treatment is steady and comfortable TMJ. This understanding of the TMJ is the foundation to diagnosis and treatment of almost everything a dentist does.

## Introduction

The part where the articulation of the temporal bone of the cranium and the mandible occurs is called the temporomandibular joint (TMJ), definitely one of the intricate joints in the body.[1] The articular disk is fibrous tissue that is present between the TMJ and acts as a buffer.[2] Mastication and speech are the main functions of the TMJ and are of at most interest to dentists, clinicians, and radiologists.[1] TMJ provides hinging movement in one plane, therefore known as ginglymoid joint and at the same time it provides gliding movements, which is known as arthrodial joint; therefore, it is known as ginglymoarthrodial joint [Figure 1].[3]

## Pecularity of TMJ

- Bilateral diarthrosis.
- Only joint in the human body that has a rigid end point due to closure of the teeth making occlusal contact.[3]
- The surface that articulates is covered by fibrous cartilage instead of hyaline cartilage.[4]
- Compared to other diarthrodial joints, TMJ develops the last ($7^{th}$ week indexed universal life [IUL]).[5]
- TMJ is formed from distinct blastema.[5]

## Development of TMJ

It develops from first pharyngeal arch, innervated by fifth cranial nerve, and develops from mesenchyme between the temporal and condylar blastemas.[6]

- $7^{th}$–$8^{th}$ weeks IUL - By this time the primary cancellous bone is first seen in the temporal mesenchyme and by $8^{th}$ week it is seen in ramal mesenchyme.
- $9^{th}$-week IUL - The rudimentary mandible is formed by intramembranous ossification.
- $10^{th}$-week IUL - The condylar cartilage is first seen.[5]
- First sign of lower TMJ space is seen when a cleft is formed between the condylar process and the temporal component [Figure 2].[5]
- $11^{th}$– $12^{th}$-week IUL - Another cleft forms the upper TMJ space [Figure 3].[5]
- TMJ disk is formed by condensation of the mesenchyme between the lower and upper TMJ spaces.
- $12^{th}$ week - The disk is connected to the upper part of the lateral pterygoid. The condylar process is attached to the lower part of the lateral pterygoid.
- $14^{th}$ week - Lower and upper TMJ spaces are fully formed. Meckel's cartilage plays no part in the development of TMJ.[7] TMJ disk develops separately from the tendon of the external pterygoid muscle.[8]

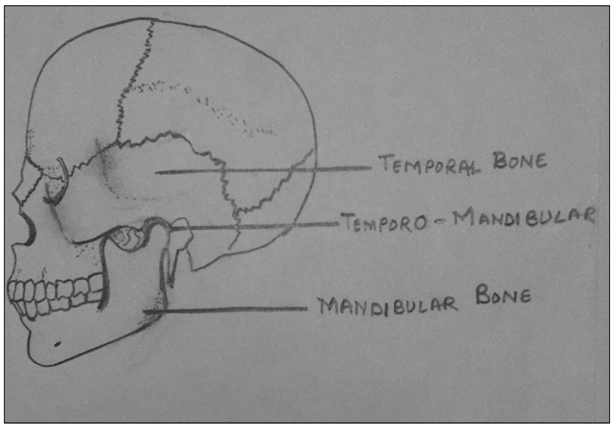


**Figure 1:** Introduction

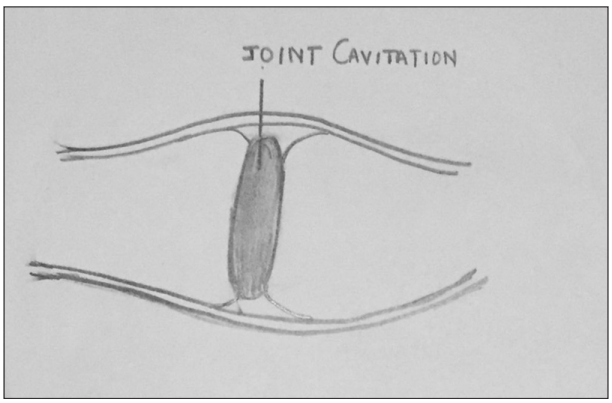


**Figure 2:** First sign of lower temporomandibular joint space is seen when a cleft is formed between the condylar process and the temporal component

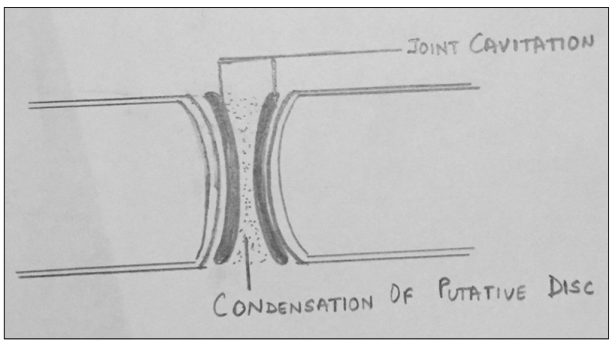


**Figure 3:** Another cleft forms the upper temporomandibular joint space

## Components[9]

1. Bony components
   - Glenoid fossa.
   - Mandibular condyle
   - Articular eminence
2. Ligaments
   A. Primary
      - Fibrous capsule
      - Lateral ligament
      - Collateral ligament

   B. Accessory
      - Sphenomandibular ligament
      - Stylomandibular ligament
3. Articular disk
4. Muscles.

## Bony Components

### Glenoid/mandibular/articular fossae

It is an elliptical concave depression, made up of squamous portion of temporal bone. They are bordered, in front, by the articular tubercles; behind they are separated from the external acoustic meatus by tympanic part of the bone. Posterior roof of the mandibular fossa is very thin and, therefore, cannot sustain heavy forces.[10]

### Mandibular condyle

This component has a tapered mandibular neck with an ovoid condylar process on it. It is 16–20 mm side to side and 9–10 mm from back to front.[1] There is upward projection from the posterosuperior part of the ramus, wherein upper end is expanded from side to side to form the head. The head is covered with fibrocartilage and articulates with temporal bone. From the front view, there are lateral and medial projections known as poles. The lateral pole is less prominent compared to medial pole.[3]

### Articular eminence

A convex bony prominence is present immediately anterior to the fossa known as articular eminence. The degree of convexity of the articular eminence is important, as the steepness of this surface dictates the pathway of the condyle when the mandible is positioned anteriorly, but it is also highly variable. It has a thick dense bone and can to tolerate heavy force unlike glenoid fossa.[3,9]

### Articular disck

The articular disk is one of the significant anatomic structures of the TMJ. It is located between the temporal bone and mandibular condyle; it is a biconcave fibrocartilaginous structure. It rotates on the condyle like a handle of a bucket which is attached to lateral and medial poles of the condyle. It helps the gliding and hinging actions between the mandibular articular and temporal bone.[2] The disk is firm, fibrous, and nearly oval plate with its long axis being transversely directed. It looks like a peaked cap that divides the joint into lower and upper compartments. The upper compartment allows the socket to slide up and down the

eminence. The lower compartment serves as a socket, in which the condyle rotates. The inferior surface of the disk is concave to fit in the mandibular condyle, whereas the superior surface is saddle shaped to fit into the cranial contour [Figure 4].

The disk is oval to round and thick all around its rim; it divides into an anterior band of 2 mm thick, a posterior band of 3 mm in thickness, and an intermediate band of 1 mm thickness which is thin in the center.

*Thick anterior band*

It continues into the loose fibroelastic connective tissue. It is avascular and innervated. Also known as anterior foot extension.[2]

*Thick posterior band*

It is attached to the back of the condyle with an inelastic band of collagen fibers which prevents the disk from rotating too far forward. It is highly vascular and richly innervated. Also known as pis vasculosa.[2]

The retrodiscal is present in the intra-articular part which is behind the disk and condyle. When the disk and condyle are in centric relation, they are seated more anteriorly. As the condyle translates anteriorly, the volume of retrodiscal tissue increases immediately. It is compressed and folded in the space of the joint when the jaw closes; once the jaw opens, the condyle moves forward and downward. The retrodiscal tissue is best seen in the open-mouth position.[2]

## Histology of Articular Surfaces

The articular surfaces are made of four different layers or zones.

- Articular zone - collagen type I fibers aligned parallel to the articular surface in saggital and transverse directions. Due to this fibrous connective tissue layer, it is less prone to the effect of breakdown over time and aging.
- Proliferative zone - Mostly cellular, it has regenerative and differentiation activity throughout life.
- Cartilaginous zone - Collagen type II fibers in random orientation offer substantial resistance against lateral and compressive forces, but they become thinner with age.
- Calcified zone - Deepest zone consists of chondrocytes, chondroblast, and osteoblast. This is the best site for remodeling activity as bone growth takes palce.[3,4]

## Ligament

Ligaments have a significant role in protecting the structures. They do not take part actively into function of the joint but act as passive restrictive devices to hamper border movements.

### Primary ligaments (functional ligaments)

*Collateral (discal) ligaments*

The collateral ligaments join the medial and the lateral margins of the articular disk to the condylar poles. They are also known as *discal ligaments*, and there are two types: The medial edge of the disk to the medial pole of the condyle is attached by the medial discal ligament and the lateral edge of the disk to the lateral pole of the condyle is attached by the lateral discal ligament. Their role is to restrict the discal movements; they permit the condyle to move passively with the disk as it glides posteriorly and anteriorly. They cause the hinging movement of the TMJ, which occurs between the articular disk and the condyle. The discal ligaments are innervated and have a vascular supply. Their innervations give an idea regarding joint movement and position. Pressure on these ligaments causes pain.[3]

*The fibrous capsular ligament*

The whole TMJ is enclosed by the capsular ligament. Superior to the temporal bone, the fibers of the capsular ligament are attached. Inferiorly, they are attached to the condylar neck.[3]

### Temporomandibular/lateral ligament [Figure 5]

The lateral aspect of the capsular ligament is toughened by firm fibers, which forms the lateral ligament or the TM ligament. It has two parts, an inner horizontal portion (IHP) and an outer oblique portion. The outer portion extends from the

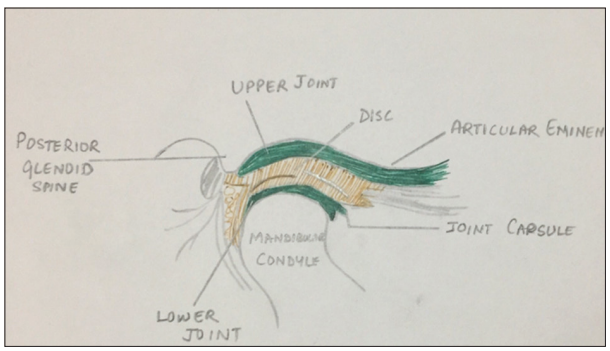


**Figure 4:** The articular disk

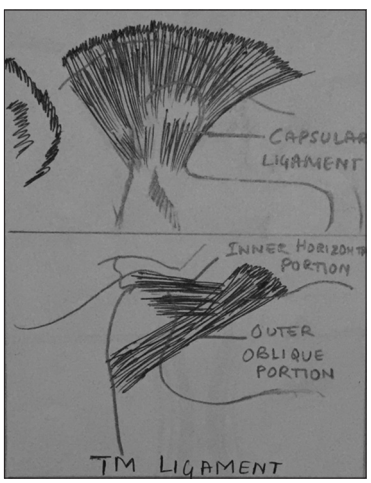


**Figure 5:** Capsular ligament (lateral view), which extends anteriorly to include the articular eminence and encompass the entire articular surface of the joint. Temporomandibular ligament (lateral view), there are two distinct parts: The outer oblique portion (OOP) and the inner horizontal portion (IHP). The OOP limits normal rotational opening movement; the IHP limits posterior movement of the condyle and disk

outer surface of the articular tubercle and zygomatic process posteroinferiorly to the outer surface of the condylar neck. The IHP extends from the outer surface of the articular tubercle and zygomatic process posteriorly and horizontally to the lateral pole of the condyle and posterior part of the articular disk. The oblique portion of the TM ligament prevents unnecessary falling of the condyle, therefore restraining the amount of opening of the mouth. This portion of the ligament also influences the normal opening movement of the mandible.[3]

#### Minor ligaments

- The sphenomandibular ligament
- The stylomandibular ligament.

## Blood Supply

- Lateral aspect - Superficial temporal artery
- Deep and posterior aspect of retrodiscal capsule - Deep auricular, posterior auricular, and masseteric artery. Vascular supply to the lateral pterygoid muscle also supplies the condylar head by numerous nutrient foramina vessels
    - Veins
    - Maxillary vein
    - Pterygoid venous plexus.[9]

## Nerve Supply

- Mandibular nerve innervates the TMJ. Three branches from this nerve send terminals to the joint capsule.
- Auriculotemporal nerve à posterior, medial, and lateral parts of the joint.
- Posterior deep temporal à anterior part of the joint.
- Masseteric nerve.[9]

#### Biomechanics of the TMJ

The TMJ is an tremendously intricate joint. The fact that there are two TMJs connected to the same bone (the mandible) further complicates the function of the entire masticatory system. Although each joint can simultaneously carry out different functions, they can never act without influencing the other. A sound understanding of the biomechanics of the TMJ is essential and basic to the study of function and dysfunction in the masticatory system.

The TMJ is a compound joint. Its function and structure can be divided into two different systems:

- One joint system comprises the tissues that surround the inferior synovial cavity (i.e., the articular disk and the condyle). Since the disk and the condyle are tightly attached by the medial and lateral discal ligaments, the only physiologic movement that can take place involving these surfaces is a rotation of the disk on the articular surface of the condyle. The disk and its attachment to the condyle are called the condyle–disk complex; this causes rotational movement in the TMJ.
- The second system is when the surface of the mandibular fossa is functioning against the condyle–disk complex. As the disk and the articular fossa are not firmly attached, free sliding movement occurs in between superior cavity surfaces. This occurs when the mandible is moved forward (translation). Translation occurs in the superior joint cavity between the mandibular fossa and the superior surface of the articular disk.[3]

For the opposite movements of the mandible, different muscles are essential. The abductors (jaw openers) and adductors (jaw closers) are muscles of mastication. The temporalis, masseter, and medial pterygoid muscles are adductors, while the lateral pterygoid muscles are the primary abductors of the jaw. The muscles that cause protrusive are also causes alternatively side to side jaw movements.[1,9]

#### Lubrication of the joint

There are two sources from where the synovial fluid comes: First from plasma by dialysis and second by secretion from Type A and B synoviocytes which is not >0.05 ml. Nevertheless, contrast radiography studies have predicted that the upper compartment has the capacity of roughly 1.2 ml of fluid without any pressure created, while the lower can hold up to 0.5 ml.[11]

#### Teeth and occlusion

The mode by which the teeth fit in together may influence the TMJ. Highest support to the joint and the muscle is provided by a steady occlusion with excellent tooth contact, whereas poor occlusion can cause the muscles to break down and eventually cause impairment to the joint. Unsteadiness of the occlusion can amplify the force on the joint, causing destruction and deterioration.[1]

## Conclusion

It is not possible to understand the minute points of occlusion without a proper knowledge of the biomechanics, anatomy, and physiology of TMJ. The primary requisite for successful occlusal treatment is stable TMJ. Only if we have good knowledge of the normal and healthy TMJ functions that we will be able to analyze what is wrong when it isn't functioning comfortably. This knowledge of TMJ is a foundation on which diagnosis and treatment planning are based.

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