INTRODUCTION

The temporomandibular joint is closely related anatomically to the external acoustic meatus and clinical conditions of the joint may produce symptoms of pain that must be distinguished from those directly associated with the ear. The temporomandibular (craniomandibular) joint (TMJ) is a synovial joint. It is formed by the mandibular (glenoid) fossa articulating with the mandibular condyle ***(Scott et al., 2008).***

The temporomandibular joint (TMJ) is one of the most frequently used joints of the human body. It is used when speaking, chewing, yawning, swallowing and other activities during the day and even in sleep. The frequency of movement is assessed as approximately 1500–2000 times a day ***(Magee, 2002).***

The etiology of temporomandibular disorders (TMDs) is multidimensional. Biomechanical, neuromuscular, biopsychosocial and neurobiological factors may contribute to the disorder ***(Suvinen et al., 2005).***

These factors are classified as predisposing (structural, metabolic and/or psychologic conditions), initiating (e.g. trauma or repetitive adverse loading of the masticatory system) and aggravating (parafunction, hormonal, or psychosocial factors) to emphasize their role in the progression of TMD ***(Koray et al., 2009).***

Temporomandibular dysfunction (TMD) is defined as a group of conditions characterized by pain or dysfunction in the temporomandibular joint (TMJ) and masticatory muscles, restrictive, jaw movements and TMJ sound. Temporomandibular joint signs and symptoms may be correlated with patient's general health, head posture, chewing efficiency complete denture and occlusal conditions. It may by more intensive in elderly patients ***(Hotta et al., 2008).***

The patients with temporomandibular disorders may also complain of aural symptoms such as otalgia, tinnitus, vertigo and impaired hearing ***(DeFelacio, 2008).***

Different terms have since been introduced, such as "TMJ pain syndrome" by Schwartz and "myofascial pain and dysfunction syndrome" (MPD) by Laskin. In more recent reports, the terms "craniocervical-mandibular syndrome," "temporomandibular disorders" (TMD), and "craniomandibular disorders" were coined to describe this condition ***(Tuz et al., 2003).***

These terms indicate that various complaints in adjacent anatomic structures, such as the ear, mandible, face, head, and neck, can be associated with TMD. The ear is supplied by many innervations, including the trigeminal (V), facial (VII), glossopharyngeal (IX), and vagus (X) nerves, as well as the autonomic nerves. The TMJ is innervated by V and VII, and

cranial nerves with communicating branches (such as chorda tympani) that pass very close to ear structures ***(Tuz et al., 2003).***

Several pathophysiological mechanisms have been proposed in the literature to explain the aural symptoms reported by TMD patients. These are spasms in the masticatory muscles associated with a dysfunction of the tensor tympani and tensor palatinus muscles, dysfunction of the auditory tube, interference in the petrotympanic fissure and tension in the anterior malleolar ligament through spheno-mandibular ligament ***(Gurel et al., 2010).***

AIM OF THE WORK

It's a prospective study about the aural complaints such as otalgia, tinnitus, vertigo and aural fullness in patients with temporomandibular disorder.

EMBRYONIC DEVELOPMENT OF THE TEMPOROMANDIBULAR JOINT

Upper and lower jaw bones as well as temporal bones derive from the mesenchyme developing from neural crest cells during the fourth week of embryonic development. Out of this mesenchyme, pharyngeal arches develop in the head and neck area and they participate in facial development. After 4-5 weeks of development, the stomodeum is surrounded by an even numbered mandibular process (ventral part of the first pharyngeal arch), even numbered maxillary process (dorsal part of the first pharyngeal arch), and by a frontal process from above ***(Sadler, 2010).***

In the mandibular process, Meckel's cartilage is formed. The tympanic and mandibular process of Meckel's cartilage is completely developed in the 16^{th} week of embryonic development. The thickened posterior ending of the tympanic cartilage is the primordial cartilage called the malleus. Malleus is in direct contact with the primordial cartilage called the incus by means of a flat articulation plane. From the 8th until the 16th week of development, the primordial cartilages function as the primary temporomandibular or malleoincudal joint; auditory ossicles develop from the latter. This joint can perform only simple rotation or buccal movements, which appear in the 8th week of development. All these movements are important for the development of condylar cartilage. Later, the malleus is separated

from Meckel's cartilage and ossified to become the middle ear ossicle ***(Bontemps et al., 2001).***

Meckel's cartilage is important for the topographic organization and differentiation of the facial structures during embryonic and fetal development. The mandibular primary growth center starts developing from the 12th week in the mandibular process of Meckel's cartilage. It has a morphogenetic role in lower jaw development because it marks the beginning of the intramembranous ossification of the mandible. The volume of Meckel's cartilage decreases after the 18th week and later it disappears during mandibular ossification. Meckel's cartilage is replaced by the body of the mandible and secondary condylar cartilage. A characteristic of mandibular development is bone derivation from the mesenchyme by intramembranous ossification laterally from Meckel's cartilage, while the development of carrot-shaped condylar cartilage is placed posteriorly ***(Lee et al., 2001).***

TMJ development takes place mostly between the 7th and 20th week of intrauterine life and a particularly sensitive period is morphogenesis between the 7^{th} and 11th week. A particular feature of TMJ development compared to other joints in the human body is mutual approximation of the initial condylar and temporal base (blastema). There are three stages in TMJ development: blastemic stage (7th-8th week; development of the condyles, articular fossa, articular disk and capsule), cavitation

stage (9^{th}-11^{th} week; beginning of lower joint space development and condylar chondrogenesis), and maturation stage (after the 12^{th} week) ***(Badel et al., 2011).***

The tiny eminences on the ascending ramus of the mandible are the bases of the condylar and the coronoid processes. In the 9th week, chondrogenesis begins from the mesenchyme cells, laterally from Meckel's cartilage, in the middle of the condylar blastema. In the 10th week, the condylar head and the entire conical condyle are apically surrounded by the lower jaw body, which is ossified intramembraneously. Enchondral ossification of the condylar cartilage in the anterior part begins in the 17th week and after the 20th week the cartilaginous form of the condyle is present only on the surface ***(Avery, 2001).***

The existence of temporal bone is visible from the 8th and 9th week. It is situated above the most distal part of Meckel's cartilage and above the base of the malleus and incus auditory ossicles. During the 8^{th} week, the zygomatic process of the temporal bone is ossified. In the 10th week, there is medial thickening of the disk with mildly pronounced concave contours.

In the period of the 11th and 12th week, the articular fossa can be concave, convex or completely flat. The articular fossa spreads cranially from the condyle in anterior direction and from

the 12th week it has a concave shape. The extension of the articular eminence and postglenoid process appears after the 26th week ***(Avery, 2001).***

After the 7th week, mesenchymal thickening is visible, positioned craniolaterally from the future condyle, out of which the articular disk develops. Due to the forming of articular spaces, the articular disk is thinner in the middle section, which later creates a characteristic biconcave shape. From the 12th week, it is in its permanent position between the temporal bone and the condyle. Its cartilaginous structure is clearly visible between the 15th and 20th week ***(Badel et al., 2011).***

The mesenchymal development of the articular capsule starts in the 8th week and stretches from the squamous part of the temporal bone towards the articular disk and the condyle. In the 11th week, the capsule is positioned between the zygomatic arch of the temporal bone and the condyle and it is attached to the outer portion of the articular disk ***(Avery, 2000).***

The upper and lower articular spaces develop from several cracks in the thickened mesenchyme, from which the condyle, the articular disk and the capsule develop. Lower articular space starts developing earlier but slower than the upper one, in the 9th week, and follows the condylar base shape. The upper articular space starts forming in the 11th week

between the zygomatic process of the temporal bone and the articular disk. It grows laterally and anteriorly between the 12th and 16th week of development ***(Badel et al., 2011).***

The articular spaces are disproportionate until the 26th week. The secondary TMJ is fully developed after the 14th week of intrauterine growth, anteriorly from the otic capsule, and after the 16th week it assumes the primary joint function. The ossified parts of the primary joint (malleus and incus) become part of the middle ear. Only two other rudimentary otomandibular ligaments remain to be developed, without functional significance. The disco-malleolar ligament connects the anterior malleolar ligaments and ends in the posterior threads of the articular disk. The malleo-mandibular ligament is a remainder of Meckel's cartilage and it goes through the tympanosquamous fissure ***(Badel et al., 2011).***

ANATOMY OF THE TEMPROMANDIBULAR JOINT

The temporomandibular joint (TMJ) is the site of articulation between the mandible and the skull, specifically the area about the articular eminence of the temporal bone. This bilateral joint functions to open and close the jaws and to approximate the teeth of the opposing arches during mastication. The articulation consists of parts of the mandible and temporal bones, which are covered by dense, fibrous connective tissue and are surrounded by several ligaments. The TMJ is operated by four bilateral muscles of mastication assisted by accessory muscles that manipulate the lower jaw in mastication, swallowing, and phonation ***(Katzberg et al., 1993).***

Relations of the temporomandibular joint

- Anteriorly: the mandibular notch and the masseterie nerve and artery.
- Posteriorly: the tympanic plate of the external auditory meatus and the glenoid process of the parotid gland. The great strength of the lateral temporomandibular ligament prevents the head of the mandibule from passing backword and fracturing the tympanic plate when a severe blow falls on the chin
- Laterally: the parotid gland, fascia, and skin.
- Medially: the maxillary artery and vein and the auriculotemporal nerve.

(Richard et al., 2013)

The temporomandibular joint is a bilateral diarthrodial joint, of a modified hing type, between the articular eminence of the temporal bone and the condyles of the mandibule ***(Koslin, 2000)***.

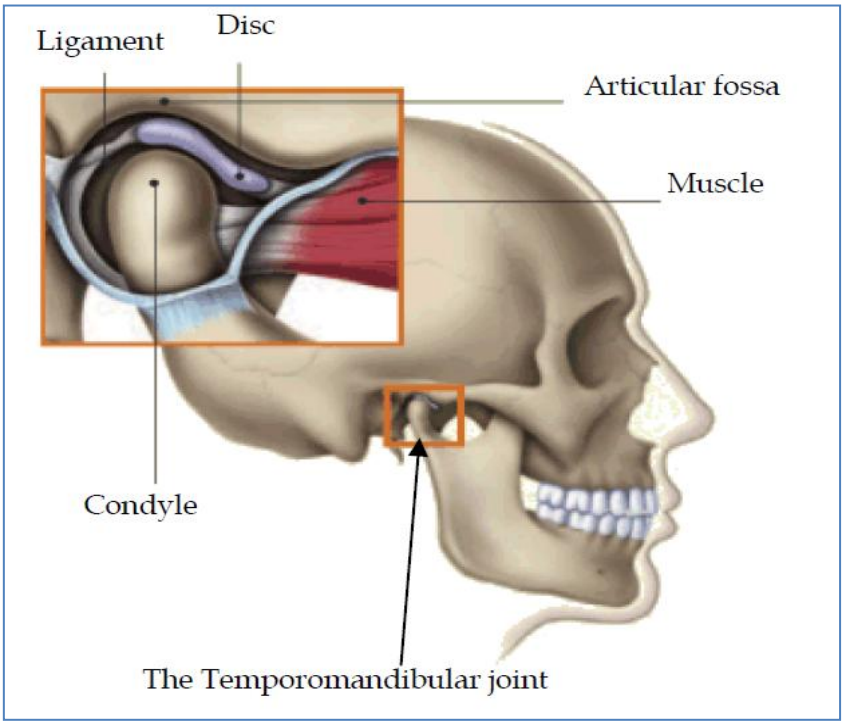


Fig. (1): The Temporomandibular joint quoted from ***(Tarun and Shirish, 2012).***

Components of Tempromandibular Joint:

The bony structures consist of the articular fossa; the articular eminence, which is an anterior protuberance continuous with the fossa and the condylar process of the mandible that rests within the fossa. The articular surfaces of the condyle and the fossa are covered with cartilage. The disc divides the joint cavity into two compartments superior and inferior. The two compartments of the

joint are filled with synovial fluid which provides lubrication and nutrition to the joint structures. The bones are held together with ligaments. Ligaments completely surround the TMJ forming the joint capsule ***(Tarun and Shirish, 2012).***

1) Mandibular Condyle (condylar head and neck):

The TMJ is composed of the condyle of the mandible articulating against the glenoid fossa and articular eminence of the temporal bone with an interposed disc the mandibular condyle is the moving component of the articulation, while the fossa-eminence remains stationary relative to the cranium. The TMJ is surrounded by a capsule, which encloses the intraarticular environment and attaches to the disc near the condylar head ***(Zhang and Athanasiou, 2011).***

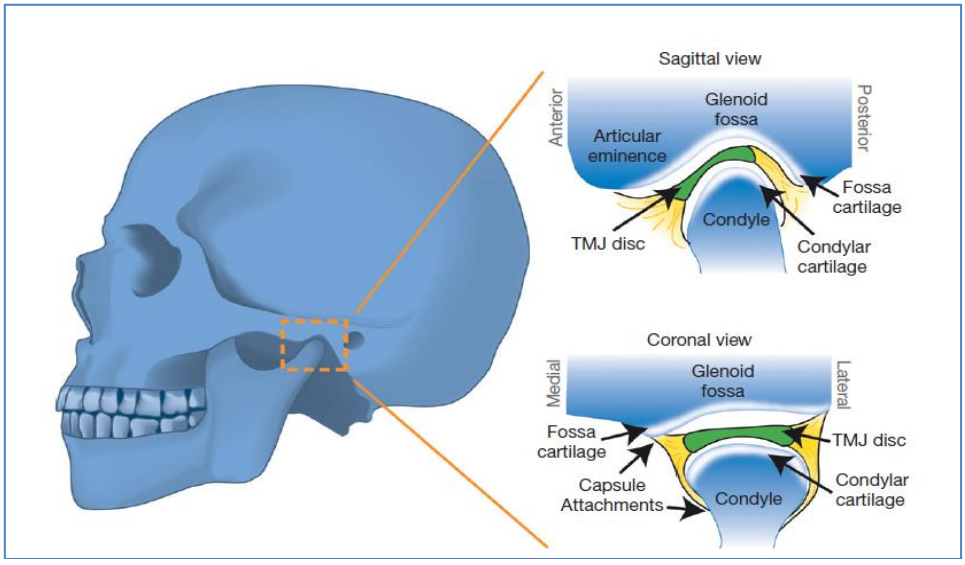


Fig. (2): Location and anatomy of the temporomandibular joint (TMJ) in the sagittal and coronal planes quoted from ***(Zhang and Athanasiou, 2011).***

The length of the mandibular condyle varies from 13-25 mm, and its width is 10 mm approximately in adults. Each condyle has a cylindrical to elipitical shape. The long axis has a mediolateral orientation perpendicular to a plane through the mandibular ramus. The angle formed from this intersecting long axis at the front of the greater occipital foramen is 145^{o} to 160^{o} ***(Koslin, 2000)***.

2) Glenoid fossa:

The glenoid fossa is the concave portion of the temporal part of the joint. The concavity runs anteroposteriorly and mediolaterally. The mediolateral axis of the fossa is aligned with the same axis of the condylar head. The glenoid fossa is located anteriorly to the tympanic plate on the squamous portion of the temporal bone. The medial and lateral outline of the fossa consists of an elevated ridge of bone. The postglenoid process (the lateral ridge) is designed to protect the fossa from superiorly directed trauma of the condyle ***(Koslin, 2000).***

3) Articular eminence:

The site of TMJ articulation on the temporal bone is on the inferior surface of the zygomatic process. The specific location is situated on the posterior slope of the articular eminence. The term “articular eminence, ” as it applies here, replaced the term “articular tubercle” by those specializing in

the study of the temporomandibular articulation. ***(Hiatt et al., 2010).***

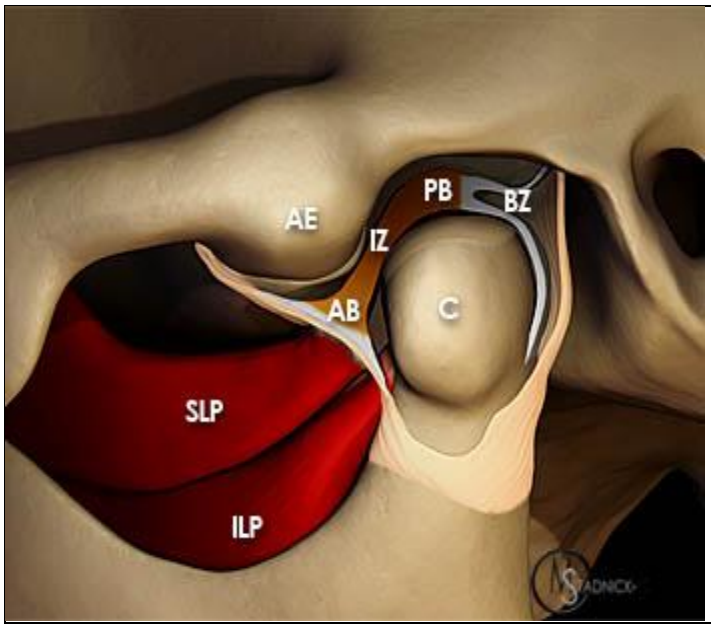
The articular eminence is defined as the strongly convex bony elevation on the root of the zygomatic process representing the anterior-most boundary of the articular or mandibular fossa (also referred to as the glenoid fossa). The articular tubercle is the bony "knob" on the lateral aspect of the articular eminence, where the fibrous capsule and the temporomandibular ligament attach. It would appear in the dried skull that, lying immediately anterior to the external auditory meatus, the mandibular condyle articulates within the mandibular fossa between the bony articular eminence and the postglenoid process. However, close observation of the mandibular (glenoid) fossa reveals a rather thin bony roof separating it from the middle cranial fossa. This fact, coupled with the knowledge of the biconcave anatomy of the disc, simply does not support the conclusion that the roof of the mandibular fossa can function as the stress-bearing articulation. Indeed, radiographic evidence indicates that the TMJ articulation occurs against the slope of the articular eminence ***(Baltali and Keller, 2008).***

4) Articular Disc:

The articular disc is a compact, dense, and fibrous connective tissue plate that is oval and contoured to fit between the mandibular condyle and the articular eminence of the temporal bone, the inferior surface of the disc is concavely

contoured to fit the convex condyle of the mandible. Superiorly, its surface is concavoconvex. The convex portion conforms to the concave mandibular fossa posteriorly, whereas anteriorly, the disc becomes concave to fit the convex posterior aspect of the articular eminence ***(Hiatt et al., 2010).***

The disc is thickest at its periphery and thinnest at the stress-bearing area of the joint. Peripherally, the disc becomes less dense as it merges into the surrounding capsule Posteriorly.the disc is attached to a highly vascular connective tissue known as the retrodiscal tissue. Occasionally, the disc (especially of older individuals) becomes perforated at its center, where it is thinnest ***(Zhang et al., 2009).***



Articula eminence of the temporal bone (AE) and the mandibular condyle (C) with the mouth closed. The articular disc demonstrates a thicker anterior band (AB) and posterior band (PB) separated by a thinner intermediate zone (IZ). The bilaminar zone (BZ) and the superior (SLP) and inferior (ILP) bellies of the lateral pterygoid muscle are also indicated.

Fig. (3): A 3D graphic lateral view of the temporomandibular joint with the capsule partially removed, quoted from ***(Zhang et al., 2009).***