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Review Article

Analysis of Anatomical and Pathological Connections for The Ear-Temporomandibular Joint Combination

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Abstract

Background: The ear and the temporomandibular joint (TMJ) have similar embryological roots. TMJ disorders and ear disorders can have similar aetiological roots. Material and methods: To identify anatomical and clinical relationships between the ear and TMJ, a PubMed literature search was conducted between 1990 and 2024.

Results: Several anatomical channels connect the TMJ to the ear. Neoplastic, inflammatory, and viral pathological processes can impact both structures.

Conclusion: It is important for otologists and dentists who treat conditions of the ear and TMJ to acknowledge any potential anatomical or clinical linkages between these regions.

Keywords: Otoneurologic symptoms; External ear; Middle ear; Temporomandibular joint; Temporomandibular dysfunction

Abbreviations: JVA: Joint Vibration Analysis; RA: Rheumatoid Arthritis; TMJ: Temporomandibular Joint; TMD: Temporomandibular Disorder

Introduction

The joint right in front of the ear is called the temporomandibular joint (TMJ). The auriculotemporal nerve provides sensory innervation to the tissues of both structures [1]. The superficial temporal and maxillary arteries provide them with arterial blood [2]. Between the two compartments are several structures. Numerous disease conditions, including inflammatory and viral processes, can move between the two [3]. The identification of otoneurologic symptoms in connection with TMJ and associated structural dysfunction (Costen's syndrome) has garnered a lot of attention recently [4]. TMJ structures may also be negatively impacted by middle ear surgery [5]. According to recent research, otologists should be knowledgeable about temporomandibular dysfunction (TMD), as they frequently present it in their practice [6].

Because temporomandibular dysfunction (TMD) is a prevalent present in their practice, recent literature recommends that otologists become knowledgeable about it. However, although headache was classified as a subjective complaint, otoneurological symptoms were not included in the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) [7]. Symptoms of TMD patients include vertigo, perceived tinnitus, hearing loss, and clogged ears (Costen's syndrome). This is valid for TMD subtypes that are both myelogenous and arthrogenous [8,9]. TMD patients' ontological complaints are corroborated by objective testing of audiometric and vestibular function. Moreover, one of the most typical TMD presentations is ear discomfort [8,10,11]. Because of their shared embryologic ancestry from the first branchial arch, the TMJ and middle ear may be viewed as a single entity [12]. The author examines the anatomical and pathological relationships between the two regions from various angles.

For otologists and dentists treating pathology in this area, this would be a road map. To the best of the author's knowledge and based on a search of the PubMed literature from 1990 to 2024, no study has thoroughly examined the relationship between the ear and the TMJ.

Considering embryology

The synchronized process of development leading through several phases is how the human TMJ and ear structures grow. The phases of development observed in the human embryo and fetus are believed to reflect the evolutionary process observed in several living organisms [13]. Strong and capable of bearing weight, the human TMJ has developed over time. Initially, Meckel's cartilage, the cartilage of the first branchial arch, was the common progenitor of the mandible and middle ear structures [14]. Mammals are remarkable in that they have three middle ear ossicles: the malleus, incus, and stapes. The malleus and incus develop from the posterior part of Meckel's cartilage [15,16]. The major jaw joint that remains in fish is thought to be comparable to the incudo-malleolar joint [17]. The human fetus's oral motions are crucial for the development of the secondary condylar cartilage, which produces synovial fluid and forms the disc that eventually develops into the two compartment TMJ [18]. The growth of the temporal bone separates the masticatory and hearing organs during the TMJ process. Adults still have a portion of the lateral pterygoid muscle sheath, known as the disco malleolar ligament, and the anterior malleolar and sphenomandibular ligaments, together known as the malleomandibular ligament, which are the proximal vestiges of Meckel's cartilage [19].

The external and middle ears are nearly always badly damaged by inherited TMJ issues. In particular, this is true in Treacher variations on the Collins syndrome. An additional embryological viewpoint can be observed in the faults in the temporal bone's development, which result in the foramen of Huschke's persistence and the herniation of TMJ tissues into the external and middle ear [20].

Anatomical consideration

The TMJ is a synovial articulation that connects the articular eminence from the zygomatic bone to the glenoid fossa of the squamous temporal bone and the inferior mandibular condyle; above all [21]. The postglenoid process, which is presented by the glenoid fossa posterolaterally, aids in the formation of the external auditory meatus' upper wall [22]. This is the squamotympanic fissure, which forms the anterosuperior border of the petrotympanic fissure and extends medially [23].

divides the middle ear from the TMJ and is called the petrous temporal bone. Canaliculi in the petrotympanic fissure, which transport the anterior tympanic artery, the discomalleolar and anterior malleolar ligaments, and the chorda tympani nerve, maintain continuity between the two compartments [24]. Extreme anterior disc movement during broad mouth opening may be restricted by the extratemporal segment of the disco malleolar ligament, according to certain theories [25]. However, anterior disc displacement may result in a slight movement of the malleus (on the order of microns), which would enhance middle ear stiffness by putting more strain on the dicsomalleolar and anterior malleolar ligaments. This malleal movement would be conveyed to the stapes, resulting in altered inner ear hair cell polarization and a possible otologic explanation for the symptoms of anterior disc displacement associated with Costen's syndrome [26]. The bony Eustachian tube is located directly medial to the glenoid fossa. According to recent developments in otological endoscopy, the protympanum is the bony Eustachian tube [27]. There are multiple connections between the masticatory apparatus and the Eustachian tube. Yelling and chewing are two examples of TMJ movement that temporarily opens the Eustachian tube, essential to its ability to ventilate the middle ear cleft. The tensor tympani muscle, which is located directly above the bone Eustachian tube, contracts the tympanic membrane as a reaction to loud noises through its link to the malleus [28]. However, through reflex processes, middle ear baroreceptors and the tympanic membrane can gently influence middle ear ventilation by acting on the muscles of the Eustachian tube. The tensor tympani muscle has been referred to as a "strange chewing muscle" in this context [29].

Tension on the masticatory muscles and tensor tympani have been proposed to be crucial factors in the pathophysiology of otologic symptoms in patients with TMD [30]. Brain imaging investigations have shown that the mandibular nerve-supplied increased tone in these muscles appears to be centrally mediated [31,32]. Both rotation and gliding movements are seen in the mandibular condyle during mouth opening and closure. The condyle-disc complex moves in a normal TMJ in a smooth, quiet procedure. This is a result of the TMJ's superior lubricating system [33,34]. On the other hand, anomalies in the disc may cause unusual noises in the joint that travel to the inner ear. The noises produced by the degenerative joint disease include clicking while minimizing disc displacement or crepitus [35]. Joint vibration analysis, or JVA, is a practical and easy-to-use technique that has been used recently to identify noises in the temporomandibular joint (TMJ) and classify them as click or crepitus based on the frequency of vibration in the affected joint. As such, this instrument fills the gap between advanced TMJ imaging and clinical results. Via a process recently identified as "soft tissue conduction," which is distinct from "air conduction" and "bone conduction," noises expelled from the dysfunctioned TMJ reach the nearby cochlea [36,37]. Soft tissue conduction travels via the Eustachian tube and the vascularized retrodiscal tissue from the TMJ to the cochlea. In addition to the accompanying clinical symptoms, the unusual noises have been called (noisy irritation) [38,39].

Pathological factors to consider

Anatomically, the ear and TMJ are relatively near to one another.

Consequently, disease in one area might easily move to another area. The aftereffects of traumatic, infectious, inflammatory, and neoplastic processes are among the notable diseases. Traumatic incidents might involve microtrauma to the TMJ (bruxism) or macrotrauma to the jaw region. The most frequent causes of TMJ and ear injuries linked to fractures include motor vehicle accidents, assaults, sports injuries, and falls. Soft tissue injuries, tympanic membrane perforations, and external ear canal fractures usually exacerbate TMJ fractures [40,41]. Associated petrous temporal bone fractures are more dangerous and can get worse if you have a traumatic brain injury, facial nerve paralysis, sensorineural hearing loss, or a cerebrospinal fluid leak. In addition to breaking, acute dislocations of the posterior or superior TMJ might harm the external ear canal [42,43]. Bruxism is a parafunctional behavior that can occur during the day or night and is characterized by teeth clenching or grinding. While sleep bruxism is linked to autonomic nervous system abnormalities and micro-arousals, waking bruxism is a reaction to stress or worry. It has been suggested that bruxism can result in masticatory muscle excitation and/or TMJ microtrauma. Mechanical research on the TMJ has shown that bruxism places excessive strains on the disc, which exacerbates the TMJ's degradation [44,45]. There is a low-grade joint inflammation linked to TMJ microtrauma. Auriculotemporal nerve refers to TMJ discomfort to the ear. A variety of inflammatory chemicals intensify pain receptors. Furthermore, contraction of the medial pterygoid muscle, which results in Eustachian tube dysfunction, and contraction of the tensor tympani muscle, which causes middle ear stiffness, might be associated with masticatory muscular hyperactivity. These elements may be connected to vertigo, tinnitus, hearing loss, and ear fullness (Costen's syndrome) [46,47].

Microbes from a serious external or middle ear infection infiltrate the joint area, resulting in otogenic septic arthritis of the TMJ [48]. Otitis externa was malignant (necrotizing) and is a significant external ear infection that develops into temporal bone osteomyelitis. Osteomyelitis of the mandibular condyle associated with TMJ involvement has been previously reported in uncontrolled cases of malignant otitis externa [49]. Acute otitis media can also result in septic arthritis of the TMJ, particularly in young children with a partly formed temporal bone [50]. Early radiological characteristics reveal joint effusion, which may develop into an abscess and ultimately TMJ ankylosis [51]. In addition to acute viral diseases, a recent study found that individuals with chronic suppurative otitis media had a greater frequency of internal TMJ derangement as compared to controls [52]. The author hypothesized that through the canaliculi in the petrotympanic fissure, the inflammatory process in the middle ear could travel to the TMJ. This would likely cause disc displacement by changing the TMJ's lubricating system. Moreover, internal derangement may result from harvesting the temporalis fascia, a common technique in ear surgery, which changes the TMJ's biomechanics [5,52]. TMJ osteoarthritis, which is linked to degenerative joint disease, is categorized as a low-grade inflammatory joint disease [53]. Rheumatoid arthritis (RA) on the other hand, high-grade inflammatory joint disorders include TMJ [54].

One percent of people have RA, which is thought to be the prototype for joint inflammatory illnesses [55]. Long-term consequences result from the pathological destruction of TMJ structures caused by the distinctive synovial pannus. Depending on the stage of the disease, adult RA patients have reported a 1% to 20% incidence of clinical involvement of the TMJ [56]. A new research investigation on patients with RA of the TMJ found that 51.6% of patients experienced otalgia, 51.8% reported subjective hearing loss, 48.9% reported subjective tinnitus, and vertigo was common. in 64.5% of cases. When comparing those suffering from RA of the TMJ to control subjects, the rate of these otologic complaints was significantly higher (P=0.001) [57]. In a different study, the same authors noted that TMD patients showed up with symptoms of Costen's syndrome at an otology clinic, although they presented to the degenerative joint disease and its consequences clinic in rheumatology [58].

The auriculotemporal nerve supplies the sensory nerves that supply the TMJ and external ear. In addition, postganglionic parasympathetic neurons are carried by the auriculotemporal nerve, nerve cells that supply the parotid gland. The subnucleus caudalis in the brain stem is where nociceptive nerve fibers from the ear and TMJ converge [59]. Recurrent otalgia is a prevalent sign of excruciating TMD. It is believed that auriculotemporal nerve masticatory muscle entrapment has a significant role in the development of migraine, ear pain, and temple headaches [60,61]. Most cases of Frey syndrome, also known as auriculotemporal syndrome, occur following parotid gland surgery. This condition is characterized by gustatory perspiration and flushing in the area between the cheek and ear. The cause is abnormal reinnervation of postganglionic parasympathetic neurons to the cutaneous blood vessels and adjacent denervated sweat glands [62]. A malignant tumor in any of these regions has the potential to spread to other places due to the proximity of the ear, TMJ, and parotid gland. The tumor's anatomical origin has been identified, with significant consequences on prognosis. Aural polyps are a common symptom of middle ear cleft or ear canal cancer. To prevent a false positive, the aural polyp biopsy needs to be done deeply [63]. The TMJ is involved when the tumor spreads anteriorly along the Santorini fissures or the Huschke foramen [64]. Trismus and mandibular deformity might result from this during mouth agape [65]. A parotid primary or metastatic spread from a distant primary should be looked for in light of the noteworthy reports of glandular carcinomas in the ear [66]. Cancerous tumors of the TMJ may be affected by the parotid gland. Moreover, TMD may be the presenting symptom of deep lobe malignant parotid tumors, delaying diagnosis [67].

Conclusion

Otologists ought to be well-versed in the TMJ area, particularly as otologic problems are oftentimes the first signs of TMD. Conversely, a main ear etiology could be the cause of TMJ problems. Otologic symptoms should be included by the DC/TMD in their classification of masticatory system abnormalities.

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Conflict of Interest

No conflict of interest.

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