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The Ear-Temporomandibular Joint Complex: A Narrative Review of Anatomical and Pathological Connections

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Abstract

Background: The ear and temporomandibular joint (TMJ) share common embryological origins. Disorders of the ear and TMJ frequently share the same aetiological origins.

Materials and methods: A PubMed literature search between 1970 and 2023 was performed to reveal anatomical and pathological connections between the ear and TMJ.

Results: Various anatomical communications exist between the ear and TMJ. Pathological processes that can affect both structures include infectious, inflammatory and neoplastic processes.

Conclusion: Otologists and dentists care for diseases in the ear and TMJ should recognize the possible anatomical and pathological connections between both areas.

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

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

Introduction

The temporomandibular joint (TMJ) lies directly Infront of the ear. Tissues of both structures have common sensory innervation from the auriculotemporal nerve [1]. They both receive arterial blood supply from the superficial temporal and maxillary arteries [2]. Several structures pass between both compartments [3]. Many pathological disorders, such as infectious and inflammatory processes, can traverse both areas [4]. Recently, much interest has surged in the reporting of otoneurologic symptoms in relation to dysfunction of the TMJ and related structures (Costen's syndrome) [5]. Also, surgery to the middle ear can have deleterious effect on TMJ structures [6]. Recent literature recommends that otologists should be familiar with temporomandibular disorder (TMD), as it is a common presentation to their practice [7]. On the other hand, the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) did not include otoneurological symptoms, despite including headache in the classification, as a subjective symptom.8 Hearing loss, blocked-ear sensation, subjective tinnitus, and vertigo are quite common symptoms in TMD patients (Costen's syndrome) [9]. This is true for both arthrogenous and myogenous subtypes of TMD [10]. Objective audiometric and vestibular function tests support the otological origin of these symptoms in patients with TMD [9,11,12]. Additionally, ear pain is one of the most common presentations of TMD [13]. The TMJ and middle ear share common embryologic origin from the first branchial arch, emphasizing the notion that the TMJ and ear might be considered as a unit [14]. From these perspectives, the author reviews the anatomical and pathological connections between both regions. This would serve as a road-map for both otologists and dentists caring for pathology in this area. As far as the author is aware, and after a PubMed literature search from 1970 till 2023, no study had comprehensively discussed this connection between the ear and the TMJ.

Embryological considerations

The development of the human TMJ and ear structures follows a synchronous process that progresses through various stages.

These developmental stages in the human embryo and fetus putatively mirror the evolutional scenario in the various living animals [15]. The human TMJ has evolved to be a robust, load-bearing joint [16]. Initially, the mandible and middle ear structures have a common ancestor, Meckel's cartilage, which is the cartilage of the first branchial arch [17]. Having three middle ear ossicles (malleus, incus and stapes) is a unique mammalian feature [18]. The posterior portion of Meckel's cartilage transforms into the malleus and incus [19]. The incudo-malleolar joint is considered analogous to the primary jaw joint that persists in fish [20]. Oral movements in the human fetus are essential for development of the secondary condylar cartilage that becomes responsible for synovial fluid production and formation of the disc to evolve into the two-compartment TMJ [21]. During the process of TMJ development, the masticatory and hearing organs separate by the development of the temporal bone [22]. Part of the sheath of the lateral pterygoid muscle persists in adults as the discomalleolarligament, while the proximal remnants of Meckel's cartilage persist in adults as the anterior malleolar and sphenomandibular ligaments (collectively termed the malleomandibular ligament) [23]. In hereditary disorders involving the TMJ, the external and middle ear are almost always severely affected. This is especially so in Treacher Collins syndrome and its variants [24]. A further embryological perspective is found in defects of development of the temporal bone, leading to the persistence of foramen of Huschke, which is associated with herniation of TMJ tissues into the external and middle ear [25].

Anatomical considerations

The TMJ is a synovial articulation between the condyle of the mandible inferiorly, and the glenoid fossa of the squamous temporal bone and articular eminence from the zygomatic bone; superiorly [26]. Posterolaterally, the glenoid fossa presents the postglenoid process, which contributes to forming the upper wall of the external auditory meatus [27]. This represents the squamotympanic fissure, which continues medially as the petrotympanic fissure that forms the anterosuperior border of the petrous temporal bone and separates the TMJ from the middle ear [28,29]. Continuation between both compartments is provided by canaliculi in the petrotympanic fissure, which transmits the chorda tympani nerve, the discomalleolar and anterior malleolar ligaments, and the anterior tympanic artery [30]. It has been suggested that the extratemporal portion of the discomalleolar ligament would limit extreme anterior disc movement during wide mouth opening [31]. On the other hand, anterior disc displacement could cause increased tension on the dicsomalleolar and anterior malleolar ligaments, leading to a subtle movement of the malleus (in the order of microns), which would cause increased stiffness of the middle ear [11]. This movement of the malleus would be transmitted to the stapes, leading to altered polarization of inner ear hair cells, providing a plausible otologic cause for Costen's syndrome symptoms in anterior disc displacement [32].

Immediately medial to the glenoid fossa is the bony Eustachian tube [33]. Recent advances in otological endoscopy concluded that the bony Eustachian tube is indeed the protympanum [34]. Several links exist between the Eustachian tube and masticatory apparatus. Movement of the TMJ, such as during yawning and chewing helps to briefly open the Eustachian tube, which is necessary for its ventilatory function for the middle ear cleft [4]. Immediately above the bony Eustachian tube is the tensor tympani muscle, which via its connection to the malleus, causes tension on the tympanic membrane, via a reflex mechanism to loud sound [35]. On the other hand, baroreceptors in the middle ear and tympanic membrane can, via reflex mechanisms, delicately affect the ventilation of the middle ear, via actions on the Eustachian tube musculature [36]. In this regard, the tensor tympani muscle has been considered a (strange chewing muscle) [37]. Tension on tensor tympani, in conjunction with tension on masticatory muscles, have been hypothesized to play an essential role in the pathogenesis of otologic symptoms in patients with TMD [38,39]. Increased tone in these muscles, supplied by the mandibular nerve, appears to be centrally mediated, as revealed by brain imaging studies [40,41].

During mouth opening and closure, the condyle of the mandible exhibits both rotation and gliding movements [42]. In a normal TMJ, movement of the condyle-disc complex is a smooth, silent process [43]. This is due to the excellent lubrication system inside the TMJ [44]. However, disc abnormalities may lead to abnormal sounds in the joint which are transmitted to the inner ear. The sounds include clicking in reducing disc displacement or crepitus in degenerative joint disease [45,46]. Recently, joint vibration analysis (JVA) has been applied as a useful, simple tool to screen for sounds in the TMJ, as well as to categorize the sounds as click or crepitus, based on the vibration frequency of the sound in the disordered joint. Therefore, this tool bridges the gap between clinical findings and sophisticated TMJ imaging [47]. Elicited sounds from the disordered TMJ reach the neighboring cochlea by the recently described soft tissue conduction; a form of sound conduction different from air conduction and bone conduction [48]. Soft tissue conduction from the TMJ to the cochlea takes place along the vascularized retro discal tissue as well as the Eustachian tube [49,50]. Apart from the associated clinical complaints, the abnormal sounds have been described as a (noisy annoyance) [51].

Pathological considerations

The TMJ and ear are anatomically very close to each other. Therefore, pathology in one region can readily spread to the other region. Notable pathologies include sequelae of traumatic, infectious, inflammatory, and neoplastic processes. Traumatic events may be macrotrauma to the jaw region or microtrauma to the TMJ (bruxism) [52]. Motor vehicle accidents, assaults, sports injuries, and falls are the most common causes of TMJ and ear injuries, that are associated with fractures [53]. Fractures of the TMJ are frequently complicated by external ear canal fractures, soft tissue injuries, and tympanic membrane perforations [54].

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More seriously, are associated petrous temporal bone fractures, which may be complicated by facial nerve paralysis, sensorineural hearing loss, cerebrospinal fluid leak, and/or traumatic brain injury [55]. Apart from fracture, traumatic posterior or superior TMJ dislocations may damage the external ear canal [56].

Bruxism is a diurnal or nocturnal parafunctional activity, associated with clenching or grinding of the teeth. Awake bruxism occurs in response to stress or anxiety, while sleep bruxism is associated with micro-arousals and changes in the autonomic nervous system [57]. Bruxism has been postulated to cause TMJ microtrauma and/or masticatory muscle hyperactivity [58]. Regarding the TMJ, mechanical studies have revealed that bruxism causes abnormal loads on the TMJ disc, contributing to its deterioration [59]. TMJ microtrauma is associated with a low-grade inflammation in the joint. Various inflammatory molecules sensitize pain receptors, with the TMJ pain being referred to the ear via the auriculotemporal nerve [60]. Additionally, masticatory muscle hyperactivity may involve contraction of the tensor tympani muscle (causing stiffness of the middle ear system), and contraction of the medial pterygoid muscle (causing Eustachian tube dysfunction) [11,50]. These factors are putatively associated with sensation of ear fullness, hearing loss, tinnitus, and vertigo (Costen's syndrome) [61].

Otogenic septic arthritis of the TMJ is due to invasion of the joint space by microbes from a severe infection of the external or middle ear [62]. Malignant (necrotising) otitis externa is a severe infection of the external ear, that progresses to cause osteomyelitis of the temporal bone [63]. TMJ involvement, with osteomyelitis of the mandibular condyle, has been previously described in uncontrolled cases with malignant otitis externa [64]. Septic arthritis of the TMJ may also be a complication of acute otitis media, especially in young children with a partially developed temporal bone [65]. Early radiological features show joint effusion, which may later progress to abscess formation, then TMJ ankylosis [66]. Apart from acute infectious disorders, a recent study had confirmed a higher incidence of internal derangement of the TMJ in patients with chronic suppurative otitis media, compared to controls [67]. It was postulated by the author that the inflammatory process in the middle ear could spread to the TMJ through the canaliculi in the petrotympanic fissure. This would presumably alter the lubrication system in the TMJ, leading to disc displacement [67]. Furthermore, harvesting of the temporalis fascia, a common procedure in ear surgery, can alter the biomechanics of the TMJ, leading to internal derangement [6].

Osteoarthritis of the TMJ, associated with degenerative joint disease, is classified as a low-grade inflammatory condition of the joint [68]. On the other hand, rheumatoid arthritis (RA) of the TMJ is considered a high-grade inflammatory joint disorder [69]. RA affects 1 per cent of the population and it is considered as the prototype of joint inflammatory disorders [70]. Pathologically, the characteristic synovial pannus destroys the TMJ structures, and leads to long-term sequelae [71]. The incidence of clinical involvement of the TMJ in adult RA patients has been reported to vary from 1% to 20%, depending on the stage of the disease [72]. A recent study on patients with RA of the TMJ revealed an incidence of otalgia of 54.6 per cent; subjective hearing loss of 51.8 per cent; subjective tinnitus in 48.9 per cent; and vertigo in 64.5 per cent of patients. The incidence of these otologic symptoms was much higher in patients with RA of the TMJ than in control subjects (P=0.001) [73]. The same authors, in another study, reported that TMD patients presented to an otology clinic with Costen's syndrome symptoms, whereas they presented to the rheumatology clinic with degenerative joint disease and its sequelae [74]. Notably, the author reported that the incidence of otologic symptoms was higher in RA of the TMJ than in patients with TMD.73,74In a review of literature they concluded that ,in addition to the altered input from the inner ear to the brain stem, maladaptive plasticity in central nervous system pathways (neuroinflammation), plays an essential role in the maintenance of the otologic symptoms in patients with RA of the TMJ [75-78].

The sensory nerve supply to the TMJ and external ear comes from the auriculotemporal nerve. Additionally, the auriculotemporal nerve carries post ganglionic parasympathetic nerve fibers to the parotid gland [79] Nociceptive nerve fibers from the ear and TMJ converge onto the subnucleuscaudalis in the brain stem [80]. Referred otalgia is a common symptom of painful TMD [81]. Masticatory muscle entrapment of the auriculotemporal nerve is hypothesized to be an important cause of ear pain, temple headaches, and migraine [82,83]. Auriculotemporal neuralgia; either primary or secondary to trauma and surgery, causes severe, shock-like pain around the ear, condyle of the mandible and temporal region [84,85]. Frey syndrome (auriculotemporal syndrome) is most encountered after parotid gland surgery, that is characterized by gustatory sweating and flushing in the region of the ear and cheek. It is due to aberrant reinnervation of postganglionic parasympathetic neurons to nearby denervated sweat glands and cutaneous blood vessels [86].

Owing to the proximity of the ear, TMJ, and parotid gland, a malignant tumour in any of these areas can spread to other areas. The determination of the anatomical origin of the tumor has important prognostic implications [87]. Cancer of the ear canal or middle ear cleft frequently presents as an aural polyp. The biopsy of the aural polyp must be a deep biopsy to avoid misdiagnosis [88]. The anterior spread of the tumour along the fissures of Santorini or foramen of Huschke results in involvement of the TMJ [89]. This would lead to trismus and mandibular deviation during mouth opening [90]. Notably, the report of glandular carcinomas in the ear merit search for a parotid primary or metastatic spread from a distant primary [91,92]. Malignant tumours of the parotid gland may involve the TMJ [93]. Furthermore, deep lobe malignant parotid tumours may present as TMD, resulting in delay in diagnosis [94].

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Conclusion

Otologists should have a broad understanding of the TMJ region, especially because TMD frequently presents with otologic complaints. On the other hand, TMJ disorder may be due to primary aetiology in the ear. The DC/TMD should include otologic symptoms in the classification of disorders of the masticatory system.

References

1. Ruiz M, Porta-Etessam J, Garcia-Ptacek S, De la Cruz C, Cuadrado M L, et al. (2016) Auriculotemporal neuralgia: Eight new cases report. Pain Med 17(9): 1744-1748.
2. Cuccia AM, Caradonna C, Caradonna D, Anastasi G, Milardi D, et al. (2013) The arterial blood supply of the temporomandibular joint: an anatomical study and clinical implications. Imaging Sci Dent 43(1): 37-44.
3. Ottria L, Lauritano D, Guzzo F, Gargari M, Barlattani A (2018) Anatomic relationship between temporomandibular joint and middle ear. J BiolRegHomeost Ag 32(2 Suppl): 209-212.
4. Bernkopf E, Cristalli G, De Vincentiis GC, Bernkopf G, Capriotti V (2022) Temporomandibular joint and otitis media: A narrative review of implications in etiopathogenesis and treatment. Medicina (Kaunas) 58(12): 1806.
5. Effat KG (2021) A minireview of the anatomical and pathological factors pertaining to Costen's syndrome symptoms. CRANIO p. 1-5.
6. Effat KG (2022) A clinical study on the incidence of internal derangement of the temporomandibular joint following harvesting of temporalis fascia. CRANIO p. 1-8.
7. Lu E, Crowder HR, Tummala N, Goodman JF, Abbott J, et al. (2021) Temporomandibular disorder treatment algorithm for otolaryngologists 42(6): 103155.
8. Schiffman E, Ohrbach R, Truelove E, Look J, Anderson G, et al. (2014) Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for clinical and research applications: Recommendations of the international RDC/TMD Consortium Network and Orofacial Pain Special Interest Group. J Oral Facial Pain Headache 28(1): 6-27.
9. Effat KG (2016) Otological symptoms and audiometric findings in patients with temporomandibular disorders: Costen's syndrome revisited. J Laryngol Otol 130(12): 1137-1141.
10. Effat KG (2021) A comparative clinical study of arthrogenous versus myogenous temporomandibular disorder in patients presenting with Costen's syndrome. CRANIO 39(5): 433-439.
11. Riga M, Xenellis J, Peraki E, Ferekidou E, Korres S (2010) Aural symptoms in patients with temporomandibular joint disorders: multiple frequency tympanometry provides objective evidence of changes in middle ear impedance. OtolNeurotol 31(9): 1359-1364.
12. Monzani D, Guidetti G, Chiarini L, Setti G (2003) Combined effect of vestibular and craniomandibular disorders on postural behavior. Acta Otorhinolaryngol Ital 23(1): 4-9.
13. Ely JW, Hansen MR, Clark EC (2008) Diagnosis of ear pain. Am Fam Physician 77(5): 621-628.
14. Nakanishi T, Iwai-Liao Y (1990) Comparative histological contributions to the development of the ear-ossicular joints and the temporomandibular joint in the mouse. Okajimas Folia Anat Jpn 67(5): 381-391.
15. Anthwal N, Joshi L, Tucker AS (2013) Evolution of the mammalian middle ear and jaw: adaptations and novel structures. J Anat 222(1): 147-160.
16. Fazaeli S, Ghazanfari S, Everts V, Smit TH, Koolstra JH (2016) The contribution of collagen fibers to the mechanical compressive properties of the temporomandibular joint disc. Osteoarthritis Cartilage 24(7): 1292-1301.
17. Badel T, Savić-Pavičin I, Zadravec D, Marotti M, Krolo I, et al. (2011) Temporomandibular joint development and functional disorders related to clinical otologic symptomatology. ActaClin Croat 50(1): 51-60.
18. Ugarteburu M, Withnell RH, Cardoso L, Carriero A, Richter CP (2022) Mammalian middle ear mechanics: A review. Front Bioeng Biotechnol 10: 983510.
19. Anthwal N, Thompson H (2016) The development of the mammalian outer and middle ear. J Anat 228(2): 217-232.
20. Svandova E, Anthwal N, Tucker A S, Matalova E (2020) Diverse fate of an enigmatic structure: 200 years of Meckel's cartilage. Front Cell Dev Biol 8: 821.
21. Parada C, Chai Y (2015) Mandible and tongue development. Curr Top Dev Biol 115: 31-58.
22. Keith DA (1982) Development of the human temporomandibular joint. Br J Oral Maxillofac Surg 20(3): 217-224.
23. Mérida-Velasco JR, Rodriguez-Vázquez JF, Mérida-Velasco JA, Sánchez-Montesinos I, Espin-Ferra J, et al. (1999) Development of the human temporomandibular joint. Anat Rec 255(1): 20-33.
24. Chang CC, Steinbacher DM (2012) Treacher Collins syndrome. SeminPlast Surg 26(2): 83-90.
25. Choi JW, Nahm HJ, Shin JE, Kim CH (2019) Temporomandibular joint herniation into the middle ear: A rare cause of mastication-induced tinnitus. Radiol Case Rep 15(2): 125-127.
26. Alomar X, Medrano J, Cabratosa J, Clavero J R, Lorenti M, et al. (2007) Anatomy of the temporomandibular joint. Seminars Ultrasound CT MRI 28(3): 170-183.
27. Bender ME, Lipin RB, Goudy SL (2018) Development of the pediatric temporomandibular joint. Oral Maxillofac Surg Clin 30(1): 1-9.
28. Bag AK, Gaddikeri S, Singhal A, Hardin S, Tran BD, et al. (2014) Imaging of the temporomandibular joint: An update. World J Radiol 6(8): 567-582.
29. Anagnostopoulou S, Venieratos D, Antonopoulou M (2008) Temporomandibular joint and correlated fissures: anatomical and clinical consideration. CRANIO 26(2): 88-95.
30. Monteiro JCC, Ennes JP, Zorzatto JR (2011) Ossification of the petrotympanic fissure: morphological analysis and clinical implications. CRANIO 29(4): 284-290.
31. Mérida-Velasco JR, De la Cuadra-Blanco C, Kreilinger JJP, Mérida-Velasco JA (2012) Histological study of the extratympanic portion of the discomalleolar ligament in adult humans: a functional hypothesis. J Anat 220(1): 86-91.
32. Norena AJ (2015) Revisiting the cochlear and central mechanisms of tinnitus and therapeutic approaches. AudiolNeurotol 20(Suppl 1): 53-59.
33. Shah OA, Elluru RG (2013) Eustachian tube anatomy and physiology. In Kountakis SE (eds): Encyclopedia of Otolaryngology, Head and Neck Surgery; Springer, Berlin, Heidelberg pp. 828-831.
34. Tarabichi M, Poe DS (2016) The Eustachian tube redefined (Editorial). Otolaryngol Clin N Am 49(5): 7-10.

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35. Edmonson A, Iwanaga J, Olewnik L, Dumont AS, Tubbs RS (2022) The function of the tensor tympani muscle: a comprehensive review of the literature. Anat Cell Biol 55(2): 113-117.

36. Sakata T, Esaki Y, Yamano T, Sueta N, Nakagawa T, et al. (2009) Air pressure-sensing ability of the middle ear- Investigations of sensing regions and appropriate measurement conditions. AurisNasus Larynx 36(4): 393-399.

37. Ramírez L M, Ballesteros L E, Sandoval GP (2007) Tensor tympani muscle: strange chewing muscle. Med Oral Patol Oral Cir Bucal 12(2): E96-E100.

38. Kierner A C, Mayer R, Kirschhofer KV (2002) Do the tensor tympani and tensor veli palatini muscles of man form a functional unit? A histochemical investigation of their putative connections. Hearing Res 165(1-2): 48-52.

39. Maulina T, Amhamed M, Whittle T, Gal J, Akhter R, et al. (2018) The effects of experimental temporalis muscle pain on jaw muscle electromyographic activity during jaw movements and relationships with some psychological variables. J Oral Facial Pain Headache 32(1): 29-39.

40. He S, Li F, Gu T, Ma H, Li X, et al. (2018) Reduced corticostriatal connectivity in temporomandibular disorders. Human Brain Mapp 39(6): 2563-2572.

41. Zhang J, Li X, Jin Z, Liang M, Ma X (2018) Spontaneous brain activity and connectivity in female patients with temporomandibular joint synovitis pain: a pilot functional magnetic resonance imaging study. Oral Surg Oral Med Oral Pathol Oral Radiol 126(4): 363-374.

42. Ferrario VF, Sforza C, Lovecchio N, Mian F (2005) Quantification of translational and gliding components in human temporomandibular joint during mouth opening. Arch Oral Biol 50(5): 507-515.

43. Gallo LM (2005) Modeling of the temporomandibular joint function using MRI and jaw-tracking technologies- mechanics. Cells Tissues Organs 180(1): 54-68.

44. Tanaka E, Detamore M S, Tanimoto K, Kawai N (2008) Lubrication of the temporomandibular joint. Ann Biomed Eng 36(1): 14-29.

45. Leader JK, Boston JR, Rudy TE, Greco CM, Zaki HS (2003) Relation of jaw sounds and kinematics visualized and quantified using 3-D computer animation. Med Eng Phys 25(3): 191-200.

46. Tanaka E, Detamore MS, Mercuri LG (2008) Degenerative disorders of the temporomandibular joint: etiology, diagnosis, and treatment. J Dent Res 87(4): 296-307.

47. Radke J, Sutter BA (2022) Sensitivities and specificity of joint vibration analysis (JVA): A Review. Adv Dent Tech p. 59-65.

48. Sohmer H (2017) Soft tissue conduction: Review, mechanisms, and implications. Trends Hear 21: 2331216517734087.

49. Mérida-Velasco JR, Rodriguez JF, De la Caudra C, Peces MD, Mérida JA, et al. (2007) The posterior segment of the temporomandibular joint capsule and its anatomic relationship. J Oral Maxillofac Surg 65(1): 30-33.

50. Boedts MJO (2018) The pharyngeal recess/Eustachian tube complex forms an acoustic passageway. Med Hypotheses 121: 112-122.

51. Naeige M, TeVeldhuis AH, TeVeldhuis EC, Visscher CM, Lobbezoo F (2013) Disc displacement within the human temporomandibular joint: a systematic review of a 'noisy annoyance'. J Oral Rehabil 40(2): 139-158.

52. List T, Jensen RH (2017) Temporomandibular disorders: Old ideas and new concepts. Cephalagia 37(7): 692-704.

53. Suhas S, Ramdas S, Lingam PP, Kumar HRN, Sasidharan A, et al. (2017) Assessment of the temporomandibular joint dysfunction in condylar fracture of the mandible using the Helkimo index. Indian J Plast Surg 50(2): 207-212.

54. Reghunadhan P, Upasi AP, Rai KK, Shikha N, Vakil S (2022) A spectrum of auditory canal injuries ensuing from direct or indirect trauma to the temporomandibular joint: A 2-year prospective study. J Cranio-Maxillofac Surg 50(10): 765-770.

55. Green L, Wang J, Li C, Tully D, Woliansky J, Gumm K, et al. (2022) Management of petrous temporal bone fractures: a 5-year experience from an Australian major trauma center. Aust J Otolaryngol 5: 27.

56. Jolly SS, Rattan V, Rai S, Verma U (2020) Traumatic posterior dislocation of bilateral mandible condyles into external auditory canal treated with midline mandibulotomy. A rare case report and review of literature. J Maxillofac Oral Surg 19(4): 642-646.

57. Lavigne GJ, Khowry S, Abe S, Yamaguchi T, Raphael K (2008) Bruxism physiology and pathology: an overview for clinicians. J Oral Rehabil 35(7): 476-494.

58. Buescher JJ (2007) Temporomandibular joint disorders. Am Fam Physician 76(10): 1477-1482.

59. Commisso MS, Martínez-Reina J, Mayo J (2014) A study of the temporomandibular joint during bruxism. Int J Oral Sci 6(2): 116-123.

60. Ernberg M (2017) The role of molecular pain biomarkers in temporomandibular joint internal derangement. J Oral Rehabil 44(6): 481-491.

61. Magalhâes BG, de Melo Freitas JL, de Silva Barbosa AC, Gueiros MCSN, Gomes SGF, et al. (2018) Temporomandibular disorder: otologic implications and its relationship to sleep bruxism. Braz J Otorhinolaryngol 84(5): 614-619.

62. Kim B, Choi HW, Kim JY, Park KH, Huh JK (2019) Differential diagnosis and treatment of septic arthritis in the temporomandibular joint: A case report and literature review. J Oral Med Pain 44: 127-132.

63. Handzel O, Halperin D (2003) Necrotizing (malignant) external otitis. Am Fam Physician 68(2): 309-312.

64. Mardinger O, Rosen D, Minkow B, Tulzinisky Z, Ophir D, et al. (2003) Temporomandibular joint involvement in malignant external otitis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 96(4): 398-403.

65. Al-Khalisy HM, Nikiforov I, Mansoora Q, Goldman J, Cheriyath P (2015) Septic arthritis in the temporomandibular joint. N Am J Med Sci 7(10): 480-482.

66. Luscan R, Belhous K, Simon F, Boddaert N, Couloigner V, et al. (2016) TMJ arthritis is a frequent complication of otomastoiditis. J Craniomaxillofac Surg 44(12): 1984-1987.

67. Effat KG (2022) Temporomandibular disorder: A previously unreported complication of chronic suppurative otitis media. CRANIO p. 1-6.

68. Chung MK, Wang S, Alshanquiti I, Hu J, Ro JY (2023) The degeneration-pain relationship in the temporomandibular joint: current understandings and rodent models. Front Pain Res (Lausanne) 4: 1038808.

69. Sodhi A, Naik S, Pai A, Anuradha A (2015) Rheumatoid arthritis affecting temporomandibular joint. ContempClin Dent 6(1): 124-127.

70. Bracco P, Debernardi C, Piancino MG, Cirigliano MF, Salvetti G, et al. (2010) Evaluation of the stomatognathic system in patients with rheumatoid arthritis according to the research diagnostic criteria for temporomandibular disorders. CRANIO 28(3): 181-186.

71. Ueno T, Kagawa T, Kanou M, Ishida N, Fujii T, et al. (2003) Pathology of the temporomandibular joint of patients with rheumatoid arthritis-case reports of secondary amyloidosis and macrophage populations. J Cranio-Maxilofac Surg 31(4): 252-256.

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72. Ringold S, Tzaribachev N, Cron RQ (2012) Management of temporomandibular joint arthritis in adult rheumatology practices: a survey of adult rheumatologists. Pediatr Rheumatol 10(1): 26.

73. Effat KG, Berty A (2023) Otological symptoms in patients with rheumatoid arthritis of the temporomandibular joint. CRANIO p. 1-8.

74. Effat KG, Berty A (2019) A comparative clinical study of temporomandibular disorder patients in the otolaryngology clinic versus a rheumatology clinic. CRANIO 37(5): 329-334.

75. SüB P, Rothe T, Hoffmann A, Schlachetzki JCM, Winkler J (2020) The joint-brain axis: insights from rheumatoid arthritis on the crosstalk between chronic peripheral inflammation and the brain. Front Immunol 11: 612104.

76. Chung SW, Kim MJ, Ahn J-C, Suh M-W, Rhee C-K, et al. (2012) Inflammation of temporomandibular joint increases neural activity in rat vestibular nucleus. Neurosci Lett 528(2): 126-130.

77. Mennink LM, Aalbers MW, Van Dijk P, Van Dijk JMC (2022) The Role of inflammation in tinnitus: a systematic review and meta-analysis. J Clin Med 11(4): 1000.

78. Sun Y, Koyama Y, Shimada S (2022) Inflammation from peripheral organs to the brain: how does systemic inflammation cause neuroinflammation? Front Aging Neurosci 14: 903455.

79. Komarnitki I, Andrzejczak-Sobocińska A, Tomczyk J, Deszczyńska K, Ciszek B (2012) Clinical anatomy of the auriculotemporal nerve in the area of the infratemporal fossa. Folia Morphol (Warsz) 71(3): 187-193.

80. Sessle BJ (2011) Peripheral and central mechanisms of orofacial inflammatory pain. Int Rev Neurobiol 97: 179-206.

81. Sessle BJ, Hu JW, Amano N, Zhong G (1986) Convergence of cutaneous, tooth pulp, visceral, neck and muscle afferents onto nociceptive and non-nociceptive neurons in trigeminal subnucleuscaudalis (medullary dorsal horn) and its implications for referred pain. Pain 27(2): 219-235.

82. Sanniec K, Borsting E, Amirlak B (2016) Decompression-evulsion of the auriculotemporal nerve for treatment of migraines and chronic headaches. Plast Reconstr Surg Glob Open 4(4): e678.

83. Karl HW, Trescot AM (2019) Nerve entrapment headaches at the temple: zygomaticotemporal and/or auriculotemporal nerve? Pain Physician 22(1): E15-E36.

84. Kosminsky M, Do Nascimento MG (2015) Primary auriculotemporal neuralgia: case report. Rev Dor. Sáo Paulo 16(4): 312-315.

85. Effat KG (2014) Post-traumatic auriculotemporal neuralgia: A previously unreported complication of endaural incision. Egypt J Otolaryngol 30: 180-181.

86. Motz KM, Kim YJ (2016) Auriculotemporal syndrome (Frey syndrome). Otolaryngol Clin North Am 49(2): 501-509.

87. Allanson BM, Low T-H, Clark JR, Gupta R (2018) Squamous cell carcinoma of the external auditory canal and temporal bone: An update. Head Neck Pathol 12(3): 407-418.

88. Hu XD, Wu TT, Zhou SH (2015) Squamous cell carcinoma of the middle ear: report of three cases. Int J Clin Exp Med 8(2): 2979-2984.

89. Lovin BD, Gidley PW (2019) Squamous cell carcinoma of the temporal bone: A current review. Laryngoscope Investig Otolaryngol 4(6): 684-692.

90. Abboud WA, Hassin-Baer S, Alon EE, Gluck I, Dobriyan A, et al. (2020) Restricted mouth opening in head and neck cancer: Etiology, prevention, and treatment. JCO Oncol Pract 16(10): 643-653.

91. Effat KG (2002) Malignant ear polyps: A report of 3 cases and review of literature. Kasr El Aini Med J 8(2): 83-94.

92. Ingelaere PP, Simpson RH, Garth RJ (1997) Metastatic renal cell carcinoma presenting as an aural polyp. J Laryngol Otol 111(11): 1066-1068.

93. Klasser GD, Epstein JB, Utsman R, Yao M, Nguyen PH (2009) Parotid gland squamous cell carcinoma involving the temporomandibular joint. J Am Dent Assoc 140(8): 992-999.

94. Miyamoto H, Matsuura H, Wilson DF, Goss AN (2000) Malignancy of the parotid gland with primary symptoms of a temporomandibular disorder. J Orofac Pain 14(2): 140-146.

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