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# The Auriculotemporal Nerve and TMJ region: anatomy and function

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**Abstract.** The studies on the auriculotemporal nerve in humans are limited. However, we considered crucial to investigate the topographic relation between the auriculotemporal nerve and the TMJ region that can explain some of the symptoms in TMDs. The results derived from our experience in the anatomic dissection on 16 adult cadaveric heads were compared with what literature describes from 1971 to 2023. The results confirm the existence of a particular anatomic position of the ATN within the infratemporal fossa in direct contact with the lateral pterygoid muscle and the TMJ capsular region. Therefore, there is evidence of a potential entrapment mechanism involving the ATN caused by an internal derangement of TMJ or a spastic condition of the lateral pterygoid muscle. Through a detailed anatomical description of the ATN the present study aims to offer an explanation to the main sensory and otological symptoms that patients with TMJ disorders often complaint, from facial pain and paresthesias to external ear pruritus.

**Keywords:** auriculotemporal nerve, TMJ, pterygoid muscle.

## 1. INTRODUCTION

The auriculotemporal nerve (ATN) origins within the infratemporal fossa and it is in direct contact with the TMJ capsular region and the lateral pterygoid muscle. For these reasons we suggest the involvement of the ATN in a potential entrapment mechanism. The ATN anatomy has been described in textbooks and paper as a nerve that origins form a single root that splits into two segments surrounding the middle meningeal artery (MMA) before reuniting, such as a 'button hole' (Wilson 1857; Chung 1995; Netter 1997; Sinnatamby

1999; Gosling et al. 2002; Snell 2004). After reuniting the ATN runs 1) posteriorly to the the lateral pterygoid muscle and between the sphenomandibular ligament and neck of the mandible, 2) laterally to the temporomandibular joint and then 3) splitting into the auricular and temporal components. The straight interaction of the ATN with the Temporomandibular Joint (TMJ) suggest the involvement of the nerve with some TMJ pathologies, such as potential entrapment mechanism. Given the close relationship with the aforementioned anatomical structures, it is crucial to define the precise origin and precise course of the nerve. Although that, many anatomy texts frequently provide stereotyped descriptions and neglect pertinent features of the auriculotemporal nerve; moreover, the existent anatomical descriptions are not representative of all individual and ethnic variables (Toni et al. 2003, 2005). By that, the aim of the present report was to give a detailed description of the anatomy and functions of this nerve in order to attribute an etiology to the main neurosensory and otological symptoms associated with TMJ disorders.

## 2. MATERIAL AND METHODS

Sixteen adult cadaveric heads (32 sides) were dissected. On each side, the TMJ region was approached laterally. A preauricular incision was extended to the superior aspect of the temporal region; the skin, subcutaneous tissue, and muscle were reflected. It was performed an osteotomy of mandibular ramus from the mandibular angle to the sigmoid notch to expose the infratemporal fossa and identify the exit of the third branch of the trigeminal nerve at the level of the middle cranial fossa (foramen ovale) [3, 16]. The mandibular nerve was followed from its origin to the medial aspect of TMJ capsule. The auriculotemporal nerve was identified at its point of origin off the mandibular nerve and was observed along his course. The results derived from our experience in the anatomic dissection of the mandibular nerve were compared with what literature describes. This paper includes experimentations on human cadavers approved by the local Ethics Committee (prot. n. 33/2020 approved on 30 July 2020).

## 3. RESULTS

### *3.1 Descriptive anatomy*

The ATN arises in the infratemporal fossa from the posterior trunk of the mandibular nerve (V3), which is the third division of the trigeminal nerve (CN V). The mandibular nerve exits the middle cranial fossa through the foramen ovale and splits up into two divisions, the anterior and posterior trunk. The posterior trunk comprises the lingual, inferior alveolar and auriculotemporal nerve. Although many variations have been described about the formation and the configuration of the auriculotemporal nerve, in most specimens analyzed in the entire literature two are the anatomical patterns that occur most frequently. The first one is the ATN with two roots that envelope the middle meningeal artery, the second one is the ATN with a single root. Other patterns are three-, four-,and five-roots variants, but they are beyond our aim. Fernandes et al. (7) describe a case in which the ATN arises as a single root and then it divides into two segments that travel around the middle meningeal artery to rejoin again on the opposite side of this vessel. We had a doubt in deciding which category it belongs to, and because its relative high frequency we have thought it belongs to the first pattern. We infer there is no clear distinction about the pattern with two roots and the pattern with one root that splits up into two segments to become again a single trunk. A review of the literature revealed that the study by Baumel presents the most complete quantitative data on the ATN. We compared our findings with those of Baumel and observed no differences in the results regarding variations. ATN roots are usually long (15 mm) and when they converge they form a short trunk (6mm) that divides into a spray of branches which abruptly diverge (Fig 1). Moreover, roots length and trunk length are inversely correlated [1]. The principal named branches are: the superficial temporal ramus, communicating rami with the facial nerve, nerves to the external acoustic meatus, the anterior auricular nerve, parotid branches, articular branches to TMJ, and communicating branches with otic ganglion [1].

### *3.2 Topographic anatomy*

The roots of the ATN run postero-inferiorly beneath the infratemporal surface of the great wing of the sphenoid bone. They lie on the lateral surface of the spine of the sphenoid bone, in the plane between the posterior fasciculi of the tensor veli palatini muscle and the lateral pterygoid muscle. The trunk formed by the joining of the roots is in direct contact with the medial aspect of the capsular region of the TMJ. According to Schimdt's study, the horizontal distance between the nerve and the condyle was 0 mm in all cases at the posterior border of lateral pterygoid muscle. Moreover, Loughner sug-

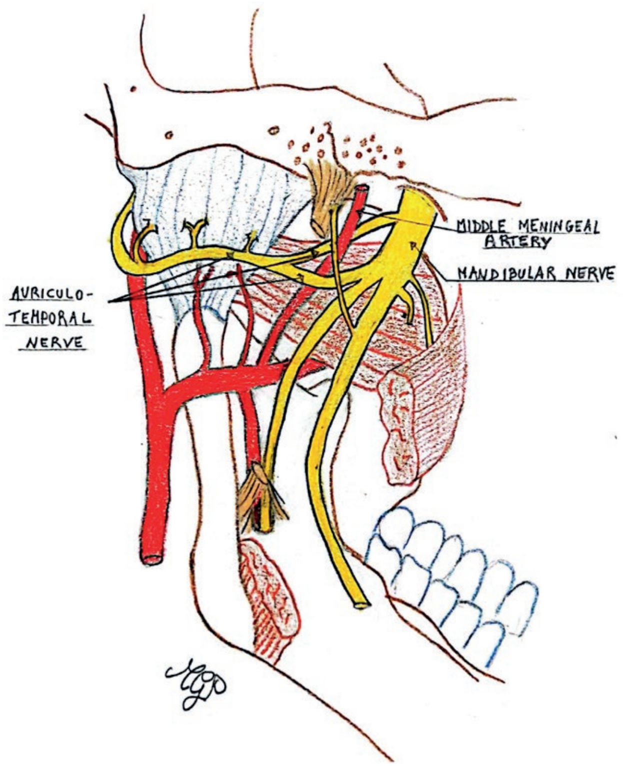


**Figure 1.** The antero-medial disk displacement. (FO: disk displacement; I: inferior alveolar nerve; AT: auricolo-temporal nerve; D: articular disk).

gested that ATN runs between fibers of the lower belly of the lateral pterygoid muscle (13). The nerve enters the parotid fascia, and then the retro-mandibular process of the parotid gland, and breaks up into smaller terminal branches. The terminal branches are mostly in line with the posterior border of the mandible above the bifurcation of the external carotid into the maxillary and superficial temporal arteries, regardless of the length of the trunk. The cluster of branches is divided into three sagittal levels by two arteries. The superficial temporal artery separates the lateral and intermediate levels; the deep auricular artery separates the intermediate and deep levels (1).

### *3.3 Terminal branches and related functions*

The superficial temporal ramus is the largest terminal branch; it runs laterally and typically supplies fine twigs to the TMJ, passing posterior to it. Getting more superficial, it turns superiorly lying postero-medial to the superficial temporal artery, then diverges into anterior and posterior divisions. The posterior division rises in front of the ear and sometimes splits up into several twigs supplying the anterior part of the external ear above the intertragal notch (1). The divisions ramify to the skin of the temporal region. It carries only general somatic afferent fibers (sensory fibers).

Two communicating rami with the facial nerve are usually present (22). Both rami pass postero-laterally and connect with the facial nerve near to the posterior border of the mandible. They join the temporofacial division of the facial nerve and were observed to supply the upper muscles of facial expression, i.e. frontalis, orbicularis oculi and zygomaticus major. According to Namking's study (14), these fibers convey proprioceptive impulses from orbicularis oculi. This finding has special significance, since it has not been clearly established which nerve carries the proprioceptive impulses from the muscles of facial expression. It is believed that proprioception is conveyed via the same cutaneous nerves (i.e. branches of the trigeminal nerve) which innervate the skin over the muscles of facial expression and form multiple communications with the branches of the facial nerve (12). Normally, blinking occurs every six seconds and proprioception from the orbicularis oculi should therefore be important for its precise action (14). It is possible that these fibers provide proprioceptive impulses from these muscles to the trigeminal nuclei of the brainstem. Knowledge about that may be of special importance for ophthalmic, oral and maxillofacial surgeons, as lesions of communicating rami with the facial nerve may compromise proprioceptive feedback and therefore the function of orbicularis oculi.

The anterior auricular nerve at first courses laterally, then turns posteriorly and runs deep to the superficial temporal artery. It pierces the interval between the tragus and crus of the helix and supplies the skin above and below its point of entry (1). It carries only sensory fibers.

Nerves to the external acoustic meatus: deep level of the terminal spray is represented by two branches, the superior and inferior nerves to the external acoustic meatus that form neuro-vascular bundles with branches of the deep auricular artery (1). The posteromedial region of the TMJ capsule receives two to four fine branches from the superior nerve. At the level of osseocartilaginous junction of the external acoustic canal, both nerves enter. The superior nerve enters the canal by the lateral extent of the squamotympanic fissure in the bony incisure directly behind the postglenoid tubercle.

The inferior nerve pierces the antero-inferior part of the canal. Each of them gives off a medially directed ramus membranae tympani which basically supply skin of the osseous segment of the acoustic canal and the outer surface of the tympanic membrane. The lateral twigs of each nerve connect to the superficial temporal ramus and anterior auricular nerve to supply the skin lining the cartilaginous portion of the auditory canal. Typically, the nerve supplies the anterior and superior walls of the meatus, whereas the auricular branches of the vagus, facial, and glossopharyngeal nerves innervate the postero-inferior half of the canal (1).

The parotid rami are numerous terminal branches that provide secretomotor innervation for the parotid gland; they may also carry sensory fibers from the capsule of the gland and perhaps to myoepithelial cells and smooth muscle of the parotid gland. Parotid rami arise in two ways: as independent terminal branches or as collaterals of the major branches such as the superficial temporal ramus and the communicating rami with the facial nerve (1).

The articular rami to the posteromedial portion of the TMJ capsule originate from the superior nerve of the external acoustic meatus; the posterolateral part of the capsule is supplied by rami from the superficial temporal ramus (1).

The vascular rami carry vascular sensory fibers from the vessels. Communication between the peri-arterial nerve plexuses of the maxillary, middle meningeal, superficial temporal and accessory meningeal arteries with the ATN have been found.

Communicating rami with otic ganglion: the otic ganglion is commonly considered to contain cell bodies of postganglionic parasympathetic, secretomotor fibers for the parotid gland, but also parasympathetic vasodilator fibers for the glandular vessels and motor fibers for myoepithelial cells and smooth muscle of the duct system of the gland. The otic ganglion receives preganglionic fibers from the glossopharyngeal nerve via the tympanic plexus and the small superficial petrosal nerve. The auriculotemporal nerve, which connects to the otic ganglion through a communicating branch, carries postganglionic parasympathetic secretomotor and sympathetic vasomotor fibers for the parotid gland. In summary, the general visceral efferent fibers of the glossopharyngeal nerve (CN IX), that originate in the inferior salivatory nucleus, provides parasympathetic innervation of the parotid gland via the otic ganglion**.**

## 4. DISCUSSION

The present study aimed to emphasize the existence of topographic relations in the infratemporal fossa for mechanical influence upon the ATN. The peripheral nervous system may be injured in different ways such as nerve entrapment, especially if the nerve runs in anatomical districts where nearby anatomical structures can compress it (20).

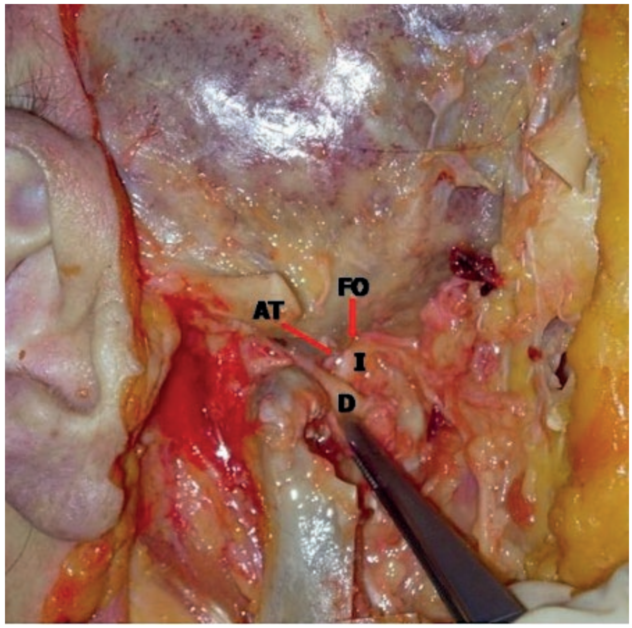


**Figure 2:** In this figure, the ATN is represented with two roots converging in a single trunk. I, the undersigned, Maria Grazia Poerio, being the creator of the figure 2, hereby give permission to have my artwork submitted with this article.

One of the sites that has the potential of compressing the nerves is the infratemporal fossa, a space behind the maxilla that contains several structures, including the lateral pterygoid muscle (21); these specific anatomical regions are also referred to as "points of entrapment." (21).

Entrapment process occurs when a peripheral nerve is caught and subjected to persistent mechanical trauma that triggers irritation and inflammation by means of compression, rubbing, traction or friction (9, 30,31,32). At the level of the roof of the infratemporal fossa, the mandibular nerve exits the middle cranial fossa through the foramen ovale and then immediately bifurcates, in close association with the lateral pterygoid muscle, into two divisions that originate terminal branches. The anterior division contains the anterior deep temporal, posterior deep temporal, and masseteric nerves and travels between the roof of the infratemporal fossa and the LPM. The posterior division contains the lingual, inferior alveolar, and auriculotemporal nerves and descends medial to the LPM. Of these, the auriculotemporal nerve is at greatest risk for entrapment (18, 23, 24, 25, 27).

Because of its close anatomic relation with the lateral pterygoid muscle and the TMJ capsular region described above, it was speculated that a spastic condition of the lateral pterygoid muscle or other local changes in this muscle such as myositis or myofibrositis and an internal derangement of the TMJ, such as an anteromedial disk displacement (Fig. 2), could cause nerve compression or impingement. (13, 9).

The outstanding feature of this condition is pain, probably related to focal ischemia effecting the local nervi nervorum, followed by paresthesias, hypesthesias, and dysthesias (13, 9). During jaw movements, symptoms are local sharp, shooting pains within the cutaneous preauricular area over the condyle often spreading upward into the temple or along the zygomatic arch, sometimes in conjunction with a burning sensation in the anterior half of the external ear (9). Other symptoms are otalgia, characterized by absence of aural pathology that radiates to the auricle or the temple, and itching of the external auditory meatus (ear pruritus). Therefore, sensory disturbances affect the TMJ-ear region as well as the temporal region. Furthermore, secretomotor fibers innervating the parotid gland also may be compressed and this compression could result in ipsilateral impairment of salivation (20).

Moreover, through its communicating branch, the ATN is strictly related to the facial nerve. For this reason, ATN entrapment could lead to discomfort and impaired functions in the muscles that control facial expression because of this anatomical connection.

These findings could offer an explanation to the sensory and otological disturbances that patients with TMJ disorders often complaint (26, 28,29).

## 5. CONCLUSIONS

The anatomical study of the ATN is pivotal since it opens the door to attributing the right etiological meaning to the symptoms reported by patients with TMJ disorders so as to direct the clinician towards the correct diagnosis and treatment. In addition, our contribution aims to underline the importance of sensory disturbances of TMJ region in order to not overlook them as etiological factors in analyzing cases. We suggest that knowledge about the topographic relationship between the TMJ and the ATN and the existence of an entrapment mechanism involving the ATN may be of special interest for otolaryngologist and oral and maxillo facial surgeons as well as for dentists.

## ETHICAL APPROVAL

This paper includes experimentations on human cadavers approved by the local Ethics Committee (prot. n. 33/2020 approved on 30 July 2020).

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