

A study of the discomalleolar ligament in the adult human

T. Rowicki^{1, 2}, J. Zakrzewska^{1, 3}

¹Department of Anatomy, Center of Biostructure Research, The Medical University of Warsaw, Poland

²Department of Otolaryngology, Division of Stomatology, The Medical University of Warsaw, Poland

³Department of Electrophysiology, Institute of Cardiology, Warsaw, Poland

[Received 23 September 2005; Revised 9 February 2006; Accepted 9 February 2006]

The discomalleolar ligament (Pinto's ligament) is not described in the anatomy textbooks but was demonstrated by Pinto and others. This is a ligamentous structure connecting the malleus in the tympanic cavity and the articular disc and capsule of the temporomandibular joint. This anatomical relationship between the middle ear and the temporomandibular joint is supposed to be one of the explanations for the aural symptoms associated with temporomandibular joint dysfunction.

The objectives of our study were to determine: (1) the frequency of occurrence and morphology of the discomalleolar ligament, (2) its attachments, (3) the morphology of Pinto's ligament in endoscopic visualisation, and (4) whether tension applied to the discomalleolar ligament could elicit movement of the malleus. Fourteen adult human temporomandibular joint and tympanic cavity specimens were examined with the use of an endoscope and then by gross dissection with the superior approach and with the use of the operating microscope.

Endoscopic visualisation showed in four cases a band of tissue in the upper temporomandibular joint compartment, known as Pinto's ligament. The dissections exposed a discomalleolar ligament in 11 specimens. We were able to identify two main types of this ligament on the basis of its shape. The discomalleolar ligament was either triangular in shape, as in the first group of seven specimens, or longitudinal in shape, as in the second group of four specimens. We observed that tension applied to the discomalleolar ligament resulted in movement of the malleus in three specimens.

Key words: Pinto's ligament, anterior malleolar ligament, petrotympanic fissure, Meckel's cartilage, temporomandibular joint

INTRODUCTION

The discomalleolar ligament, also known as the mandibular-malleolar ligament or the "tiny" Pinto ligament, is a structure that is not described in the classical textbooks of anatomy [4, 12, 19]. Nevertheless, the term "Pinto's ligament" is used in textbooks of arthroscopic surgery of the temporomandibular joint [3, 14, 20]. This structure was initially referred to by Rees [17], while its first detailed description originates

from Pinto [16], whose discovery reflected the anatomical and ontogenic relationship between the middle ear and the temporomandibular joint. Pinto found a ligamentous structure of fibroelastic tissue connecting the neck and anterior process of the malleus through the petrotympanic fissure to the medioposterosuperior part of the temporomandibular joint capsule, the articular disc and the sphenomandibular ligament [16]. Since then many have attempted to

Address for correspondence: T. Rowicki, Department of Anatomy, Center of Biostructure Research, The Medical University of Warsaw, Chałubińskiego 5, 02-004 Warsaw, Poland, tel: 668 202 598 (GSM), fax: +48 22 629 52 83, e-mail: tomekrowicki@tlen.pl

explain how the presence of this structural relationship may be associated with aural symptoms such as otalgia, hearing loss, tinnitus, vertigo and a stuffy sensation in cases of temporomandibular joint dysfunction [2, 5, 9, 12, 14]. There has been much controversy not only about the morphology of this ligament and its clinical importance but also about its factual existence [8, 10, 11, 13, 18]. Some investigators have analysed the fibrous connections between the middle ear and the temporomandibular joint structures during foetal development [7, 15, 18] (Fig. 1).

In the study of Vazquez et al. [22] a tract of fibrous tissue was found arising from the mesenchyme and located cranial and lateral to Meckel's cartilage. This tract stretched dorsally from the posterior area of the temporomandibular joint disc to the middle ear through the most lateral aspect of the tympanosquamosal fissure. This tract of fibrous tissue, which later gives rise to the discomalleolar ligament, was attached to the area of continuity of Meckel's cartilage with the malleus. Transformation of Meckel's cartilage into the sphenomandibular ligament, the anterior ligament of the malleus and the malleus, with the exception of its anterior process, determines their continuity through the tympanosquamosal fissure and explains the connection between the dis-

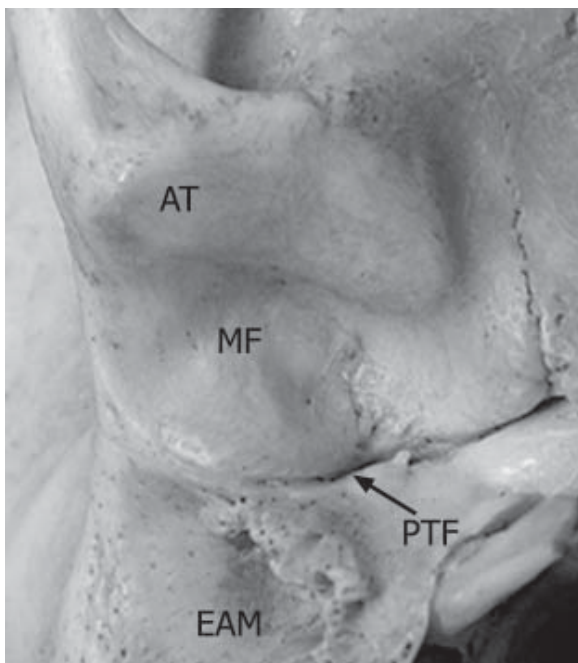


Figure 1. An inferior view of the mandibular fossa (MF) and petrotympanic fissure (PTF). The discomalleolar ligament is passing through the patent petrotympanic fissure — connection between the tympanic cavity and mandibular fossa of the temporal bone. AT — articular tubercle; EAM — external acoustic meatus.

comalleolar ligament and the anterior ligament of the malleus. These observations were convergent with those reported by others [12, 15, 18, 21].

Since the clinical implications of the above-mentioned observations may seem somewhat indistinct, we decided to reconsider the evidence for an anatomical structural relationship between the middle ear and the temporomandibular joint. The objectives of our study on adult cadavers were to investigate:

- the frequency of occurrence and morphology of the discomalleolar ligament;
- its attachments;
- the morphology of Pinto's ligament in endoscopic visualisation;
- whether tension applied to the discomalleolar ligament could elicit movement of the malleus.

MATERIAL AND METHODS

The study was conducted on 14 intact block specimens of the temporomandibular joint and tympanic cavity obtained from the Department of Anatomy of the Medical University of Warsaw. Ten specimens were embalmed in formalin, four being additionally decalcified in 5% nitric acid. Before dissection was performed an endoscopic visualisation of the temporomandibular joint was carried out. An endoscope of 2 mm in diameter and with an angle of view of 0° was inserted into the posterior recess of the upper joint compartment from the lateral aspect in order to observe Pinto's ligament. The second step was dissection performed with the use of an operating microscope from a superior approach through the middle cranial fossa. The floor of the middle cranial fossa, the tegmen tympani, were carefully removed to expose the articular disc, the petrotympanic fissure, the auditory ossicles, the tympanic membrane, the chorda tympani nerve, and the ligamentous structures associated with the anterior process of the malleus. The ligamentous continuity between the malleus and the area of the temporomandibular joint was examined with particular attention. As the last step, in the specimens in which the discomalleolar ligament was present we pulled it gently forward with tweezers at the level of its attachment to the articular disc.

RESULTS

On endoscopic visualisation of the temporomandibular joint we were able to identify a structure known as Pinto's ligament in four cases. A band of thickened but rather flaccid tissue was observed in the postero-medial aspect of the upper joint compartment (Fig. 2).

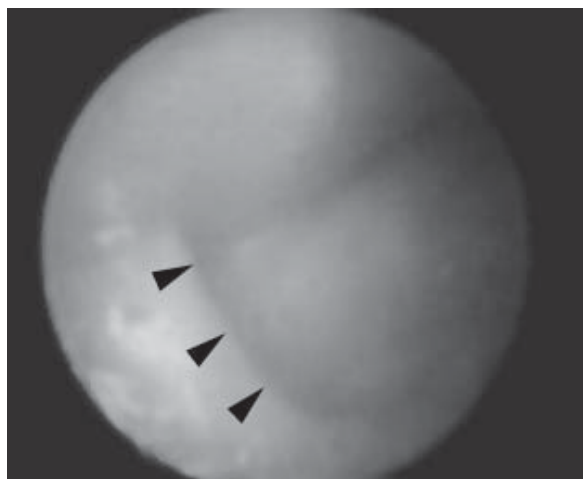


Figure 2. An endoscopic photograph of the upper temporomandibular joint compartment. A band of tissue known as Pinto's ligament was found (arrowheads).

The dissections exposed a ligamentous continuity between the articular disc of the temporomandibular joint and the malleus or the anterior malleolar ligament in the tympanic cavity in 11 specimens. This included specimens with endoscopically confirmed Pinto's ligament in the upper joint compartment. According to the morphology of the discomalleolar ligament, we were able to distinguish two groups in the material examined.

The first group embraced seven specimens. The discomalleolar ligament under investigation was present as a band of connective tissue which was flat and triangular in shape, lying in an almost horizontal plane. The base of this triangle was continuous with the posteromedial part of the articular disc and capsule. Posteriorly this ligament passed through the petrotympanic fissure laterally to the anterior malleolar ligament, which within the fissure becomes continuous with the sphenomandibular ligament [1, 15], and laterally to the chorda tympani nerve. In the tympanic cavity the discomalleolar ligament ran in close proximity to the lateral aspect of the anterior malleolar ligament. The anterior malleolar ligament in each case was attached to the anterior aspect of the neck of the malleus and the anterior process of the malleus. In five cases the attachment of the discomalleolar ligament was to the anterior aspect of the neck of the malleus and the anterior process of the malleus, together with the anterior malleolar ligament (Fig. 3). In two cases, however, the discomalleolar ligament did not reach the malleus and inserted into the lateral aspect of the anterior malleolar ligament (Fig. 4). The chorda tympani nerve

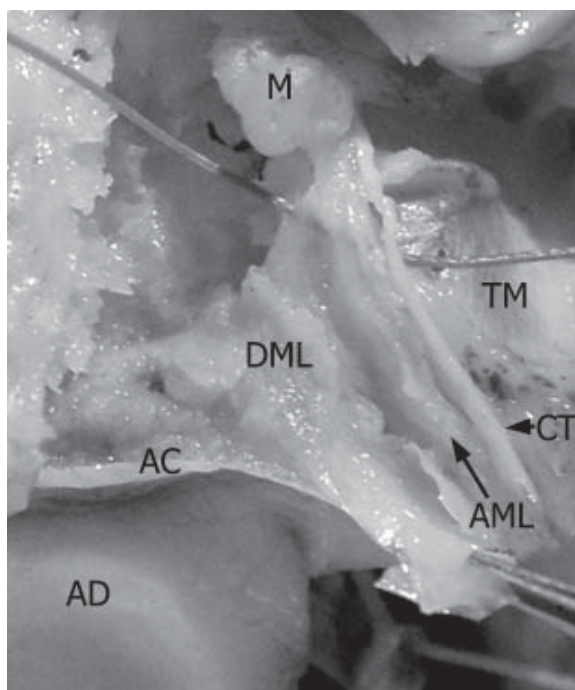


Figure 3. A superior view of the dissected area, right side. Discomalleolar ligament (DML) present as a flat triangular band of connective tissue attached in the tympanic cavity to the malleus (M) together with the anterior malleolar ligament (AML). TM — tympanic membrane; CT — chorda tympani nerve; AC — articular capsule; AD — articular disc.

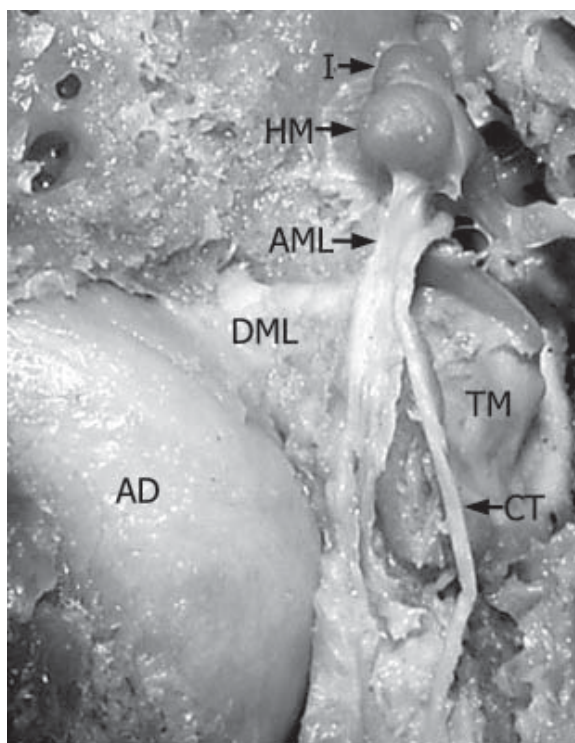


Figure 4. As in Figure 3 the discomalleolar ligament (DML) is triangular in shape but in the tympanic cavity it does not reach the malleus directly and is attached to the lateral aspect of the anterior malleolar ligament (AML). HM — head of malleus; I — incus; TM — tympanic membrane; CT — chorda tympani nerve; AD — articular disc.

running anteriorly to the petrotympanic fissure always lay medially and superiorly to the discomalleolar ligament and the anterior malleolar ligament.

The second group, smaller in number, consisted of four specimens. In these instances most of the fibres arising from the posteromedial aspect of the articular disc and capsule did not reach the malleus or its anterior ligament but were mainly attached to the walls of the petrotympanic fissure (Fig. 5A). However, an elongated discomalleolar ligament was also observed, attached, together with the anterior malleolar ligament, to the anterior aspect of the neck of the malleus and the anterior process of the malleus. It stretched forward adjacent to the anterior ligament of the malleus. Just beneath the petrotympanic fissure a thin bundle of fibres turned laterally and attached to the posteromedial part of the articular disc and capsule (Fig. 5B). Likewise in the first group the course of the chorda tympani nerve was medial and superior to both the ligaments.

Our attempts to move the malleus by pulling the discomalleolar ligament forward at the level of the temporomandibular joint resulted in a slight movement of the malleus and the tympanic membrane in three cases only. These specimens were from the first group. In the remainder no movement of the malleus was noticed.

DISCUSSION

Our investigation confirmed that there is an evident link between the temporomandibular joint and the tympanic cavity. In some specimens this ligamentous connection was undoubted, whereas only a few cases lacked this relationship. In the literature there are varying opinions concerning the morphogenesis and role of this ligament.

The embryological development of the discomalleolar ligament is closely connected with that of Meckel's cartilage. In the study of Coleman [7] a definitive discomalleolar ligament was observed in foetuses, which connected the articular disc to the malleus and Meckel's cartilage. His histological evidence also showed some fibres of the discomalleolar ligament becoming attached to the walls of the petrotympanic fissure in the foetus, which confirmed his findings in adult specimens. His observations in the adult did not demonstrate a direct ligamentous connection between the disc and the malleus, but retrodiscal fibres were continuous with the origin of the anterior malleolar ligament and did attach the articular disc and capsule to the walls of the petrotympanic fissure. Rees [17] supposed that the retrodiscal fibres are the upper stratum of the bilaminar zone of the articular disc

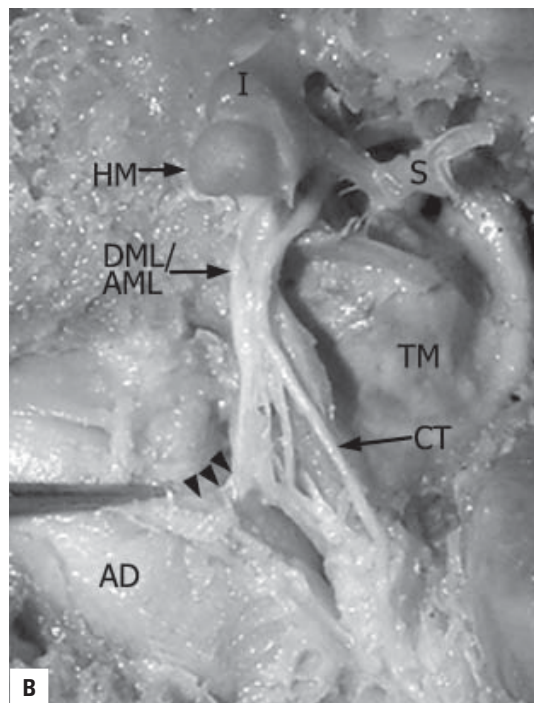
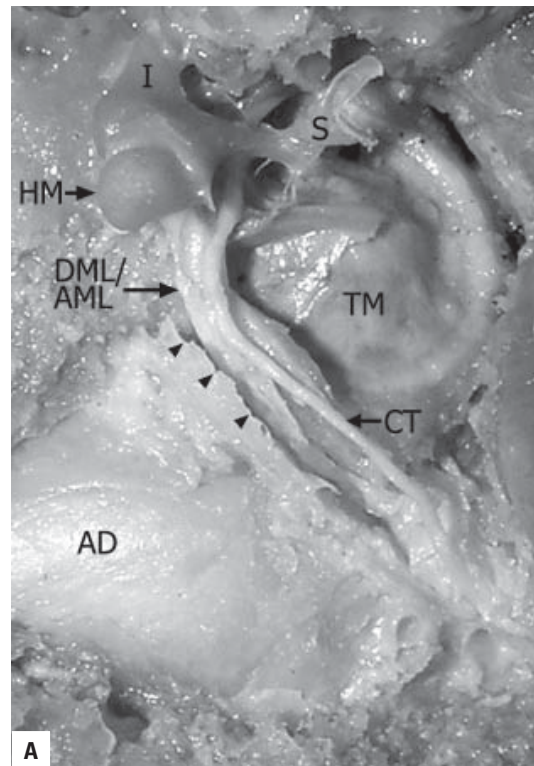


Figure 5. Note that most of the fibres (arrowheads) arising from the posteromedial aspect of the articular disc and capsule do not reach the malleus. The discomalleolar ligament is contiguous with the anterior malleolar ligament (DML/AML) (A). When these fibres were elevated with tweezers a bundle of fibres (arrowheads) was observed detaching from the DML/AML and joining the articular disc and capsule just beneath the petrotympanic fissure (B); HM — head of malleus; I — incus; S — stapes; TM — tympanic membrane; CT — chorda tympani nerve; AD — articular disc.

and that they represent the “discomalleolar band of foetal life” which connects the tendon of lateral pterygoid muscle to the malleus through the squamotympanic suture. A similar concept of the origin of the discomalleolar ligament was presented by Ögütçen-Toller [15]. According to him, the discomalleolar ligament derived from the fibrous attachment of the lateral pterygoid muscle to the future malleus and this muscle was no longer in direct attachment to it after ten weeks of the foetal life. Burch [6], in contrast, did not find any continuation of the temporomandibular joint capsular fibres into the petrotympanic and squamotympanic fissures.

In the light of these statements, it would be possible to recognise the ligamentous connection between the temporomandibular joint and the tympanic cavity observed in our study as a remnant of the foetal discomalleolar ligament. The hypothesis has been made that the discomalleolar ligament is unnecessary after cavitation of the temporomandibular joint is completed and should diminish and disappear [10]. This could well explain the variations in morphology of the ligament observed in our study.

The matter of mobility of the discomalleolar ligament is of special importance. It was postulated by Loughner et al. [11] that abnormal tension on the ligaments that attach the malleus to the mandible or the retrodiscal tissues of the temporomandibular joint might result in disturbances of the articulations of the malleus-incus-stapes unit. In their study on adult cadavers they did not note movement of the malleus when tension was applied to the discomalleolar ligament. This agreed with the observations of others [7, 10, 11]. Notwithstanding, one should bear in mind Pinto's observations that movement of the capsule or disc of the temporomandibular joint seemingly caused his “tiny ligament”, the chain of auditory ossicles, and the tympanic membrane to move [16]. In our study we were able to move the malleus by pulling the discomalleolar ligament in three cases only. Such a confusing observation may be explained from the embryological point of view. It may result from the observed fact that the fibres of the discomalleolar ligament can be attached to the walls of the petrotympanic fissure to a varying degree. Furthermore, the method of eliciting movement of the malleus by pulling forward the ligaments attached to it with the petrotympanic fissure open superiorly, which was used in our study and in those of others [7, 10, 11, 16], does not reflect the real anatomical relationships of these structures. We assume that, in view of its possible clinical importance, this matter should be investigated further.

REFERENCES

1. Alkofide EA, Clark E, el-Bermani W, Kronman JH, Mehta N (1997) The incidence and nature of fibrous continuity between the sphenomandibular ligament and the anterior malleolar ligament of the middle ear. *J Orofac Pain*, 11: 7–14.
2. Ash CM, Pinto OF (1991) The TMJ and the middle ear: structural and functional correlates for aural symptoms associated with temporomandibular joint dysfunction. *Int J Prosthodont*, 4: 51–57.
3. Bell Welden E (1985) Clinical management of temporomandibular disorders. *Year Book Med Publ Chicago*.
4. Bochenek A, Reicher M (1997) *Anatomia człowieka*. 11th Ed. Wydawnictwo Lekarskie PZWL, Warszawa.
5. Brookes GB, Maw AR, Coleman MJ (1980) “Costen's syndrome” — correlation or coincidence: a review of 45 patients with temporomandibular joint dysfunction, otalgia and other aural symptoms. *Clin Otolaryngol*, 5: 23–36.
6. Burch JG (1966) The cranial attachment of the sphenomandibular (tympanomandibular) *Anat Rec*, 156: 433–438.
7. Coleman RD (1970) Temporomandibular joint: relation of the retrodiscal zone to Meckel's cartilage and lateral pterygoid muscle. *J Dent Res*, 158: 13–22.
8. Furstman L (1963) The early development of the human temporomandibular joint. *Am J Orthodont*, 19: 672–682.
9. Ioannides CA, Hoogland GA (1983) The discomalleolar ligament: a possible cause of subjective hearing loss in patients with temporomandibular joint dysfunction. *J Maxillofac Surg*, 11: 227–230.
10. Komori E, Sugisaki M, Tanabe H, Katoh S (1986) The discomalleolar ligament in the adult human. *J Craniomandibular Pract*, 4: 299–305.
11. Loughner BA, Larkin LH, Mahan PE (1989) Discomalleolar and anterior malleolar ligament: possible causes of middle ear damage during temporomandibular joint surgery. *Oral Surg Oral Med Oral Pathol*, 68: 14–22.
12. Morgan DH, House LR, Hall WP, Vamvas SJ (1982) *Diseases of the temporomandibular apparatus. A multidisciplinary approach*. Mosby Company St. Louis Toronto.
13. Morgan DH, Goode RL, Christiansen RL, Tiner LW (1995) The TMJ-ear connection. *Cranio*, 13: 42–43.
14. Nuelle GD (1996) The temporomandibular joint: anatomy and treatment. In: McGinty J ed. *Operative arthroscopy*. Lippincott — Raven Publishers, Philadelphia.
15. Ögütçen-Toller M (1995) The morphogenesis of the human discomalleolar and sphenomandibular ligaments. *J Craniomaxillofac Surg*, 23: 42–46.
16. Pinto OF (1962) A new structure related to the temporomandibular joint and middle ear. *J Prosthet Dent*, 12: 95–103.
17. Rees LA (1954) The structure and function of the mandibular joint. *Br Dent J*, 96: 125–133.
18. Smeele LE (1988) Ontogeny of relationship of human middle ear and temporomandibular (squamomandibular) joint. I. Morphology and ontogeny in man. *Acta Anat*, 131: 338–341.
19. Standring S (2005) *Gray's anatomy. The anatomical basis of clinical practice*. 39th Ed. Elsevier, Edinburgh.
20. Tarro AW (1993) *TMJ arthroscopy: A diagnostic and surgical atlas*. J.B. Lippincott Company, Philadelphia.
21. Vazquez JFR, Velasco JRM, Collado JJ (1992) Development of human sphenomandibular ligament. *Anat Rec*, 233: 453–460.
22. Vazquez JFR, Velasco JRM, Collado JJ (1993) Relationships between the temporomandibular joint and the middle ear in human fetuses. *J Dent Res*, 72: 62–66.