Introduction

The anatomy of Prussak’s space (Ps) was described in 1867 by Alexander Prussak when he published his studies on the anatomy of the human tympanic membrane. As most of other middle ear (ME) spaces, studying and dealing with this space as a separate compartment based mainly on the concept of the studying of various mucosal folds (MFs) attached to the ossicular chain with its ligaments and the tendons of the tensor tympani (*) and stapled muscle (**) along with the chorda tympani nerve (CTN). This concept and studies were pioneered by Helmholzt, 1868; von Troeltsch, 1881; Hammar, 1902; Politzer, 1909; Balance and Green, 1919; Sobotta, 1920; Lowndes Yates, 1938; Maisonne and Coudane, 1950.2

Another concept closely related to the mucosal folds (MFs) and ME compartmental studies was introduced by Chatellier and Lemoin in 1946, which is the epitympanic diaphragm made up of various membranous ligaments and folds (MFs), which, together with the malleus(M) and the incus (I), formed the floor of the epitympanic compartment and the theory of routes and pathways of tympanic ventilation.3

The problem with these mucosal folds, and the concepts based on them, is that they are easily seen in the living and in fresh temporal bones (TBS) and they disappear or disintegrate rapidly if the TBS are permitted to dry, frozen or immersed in fixative solutions and disintegrate in disease processes involving ME or are often considered as residues of inflammation or as adhesions.2 This problem together with the difficulty in documenting the ventilation pathways have led to the vague nature of this area and many conflicts about it the most prominent among them is the conflicting conclusions of the work of Proctor,4,4 and Palva and11-12. The idea of utilizing different techniques in investigating ME compartmental anatomy and physiology has emerged.1-14

We aimed by our work to present the anatomical data obtained due to the incorporation of endoscopes as an untraditional method in its studying.

Methods and Materials

Anatomy and variations were studied in 55 Fresh frozen TBS. To the best of our knowledge, all TBS came from adult cadavers. There were 31 right TBS and 24 left. All TBS were dissected by the same approach and all were studied utilizing an operating microscope and otoendoscopes with 0°, 30° and 70° angles and 2.7 and 3 mm diameters. The photos were processed digitally by Photoshit® digital computer photo-system (Photoshit, USA).

Anatomy and Ventilation

As posteriorly when the annulus (AF) leaves the sulcus tympanicus (STy) its outer fibers insert on the posterior tympanic spine (PTSy) or extend in the stria membrana tympanici posticus (SMTYP) to the short process of the malleus (MSP), while its inner fibers insert on the cranial part of the prepyramidal or posteriorly placed prismatic spine (PPRSy) or radiate out, forming the supporting structure for the posterior malleal fold (PMF) and attaching on the postero-medial aspect of the upper third of the malleal handle (MH).2,4 Between the posterior malleal fold (PMF) and the tympanic membrane (TM) lies the posterior pouch of von Troelt (vTP). The posterior lip of the posterior malleal fold (PMF) then represents the posterior wall.2,4 The lateral aspect is represented by the pars flaccid (PF) of the tympanic membrane (TM).2,14

Beneath the attic floor (AT) and in the upper mesotympanum there are three compartments: the inferior incudal space (IIS) and the anterior (vTA) and posterior (vTP) pouches of von Troelt.2 The inferior incudal space (IIS) extends from the inferior surface of the incus (I) laterally to the posterior malleal fold (PMF) and is limited medially by the medial incudal fold (MiF) and anteriorly by the interossicular fold (IF) which lies between the long crus of the incus (ILP) and the upper two thirds of the malleal handle (MH). Between the posterior malleal fold (PMF) and the pars tensa (PT) and pars flaccid (PF) of the tympanic membrane (TM) lies the posterior pouch of von Troelt (vTP). The chorda tympani nerve (CTN) lies in the free margin of the posterior malleal fold (PMF), although it may cross the posterior tympanum in a few cases. The shallow anterior pouch of von Troelt (vTA) lies between that portion of the drumhead (TM) anterior to the malleal handle (MH) and the anterior malleal fold (AMF) which draping the anterior malleal ligament (AML).

The posterior pouch of von Troelt (vTP) is the main route of ventilation,14 and as this is the most important section of the mesotympanum, so in most subjects, ventilation of Ps occurs through the communication with the mesotympanum.2,12-14 Lateral and posterior in the attic (AT) the floor of the superior incudal space (SIS) is formed by the lateral malleal fold (LMF) and by the lateral incudal fold (LIF), which extends posteriorly to the posterior incudal ligament (PIL). The entrance into Ps is usually located between the lateral malleal fold (LMF) and the lateral incudal (LIF) folds to form Ps.2 (including anatomical abbreviations key to all figures)

Ps aeration and communication pathways with other spaces were the most remarkable variable has been noticed regarding the Ps anatomy. Therefore, they were used to classify the Ps in the study specimens and also due to their proclaimed role in the ME pathophysiology. Four types of Ps could be distinct:

- **1st**: was the most common (39 TBS) (71%). The space aerated solely retrogradically via the posterior pouch of von Troeltch (vTP).
- **2nd**: (1 TBS) (2%) aerated via the anterior pouch of von Troeltch (vTA) only.
- **3rd**: (1 TBS) (2%) aerated only through a special superior mucosal pathway in the lateral malleal fold (LMF), mainly posteriorly between it and the lateral incudal fold (LIF).
- **4th**: (14 TBS) (25%) aerated through combined or multiple (1 specimen) pathways of the above types.

All types were lined by mucosa in all specimens.

Anatomy and Ventilation

Ps lies between the notch of Rivinus (NR), the anterior and posterior tympanic spines (A and PTyS) and the short process of the malleus (MSP).1 The medial and inferior aspects of Ps are formed, respectively, by the neck (MN) and the short process of the malleus (MSP).1,2 The neck of Rivinus is limited superiorly and anteriorly by the lateral malleal fold (LMF) which arises from the junction of the malleus head (MHe) and neck (MN) and radiates out to insert on the entire bony rim of the notch of Rivinus (NR) and medial wall of the scutum (Sc), thus forming a firm roof for Ps and the floor of the lateral malleal space (LMS),2.7,14 The space is limited laterally, and to some degree inferiorly, by the terminal flaring out of the annulus fibrosus (AF) as it leaves the anterior tympanic spine (ATyS). As anteriorly when the annulus (AF) leaves the sulcus tympanicus (STy) it attach in part to the anterior tympanic spine (ATyS) then continues on as the stria membra tympanica anticus (SMTyA) to the short process (MSP), to radiate out to help form the floor of Ps, to interdigitate with fibres of the lateral malleal fold (LMF), and to attach to the bony rim of the notch of Rivinus (NR).

Some authors2,9,11-14 describe the anterior aspect of Ps being bounded by very thin membranous fold among the tympanic membrane (TM) and the anterior malleal ligament fold (AMF) inserted laterally onto the tympanic membrane (TM) and medially onto the neck (MN) and long process (MLP) of the malleus. Posteriorly, on leaving the posterior tympanic spine (PTyS), fibres of the annulus (AF) and at the malleal neck (MN), forming Ps posterior floor.

Results

- **Space boundaries** were fixed in all specimens and were the same structures as was shown in the reviewed published literature:
  - Medially: neck (MN) of the malleus.
  - Inferiorly: short process of the malleus (MSP).
  - Superiorly (roof): lateral malleal fold (LMF) till notch of Rivinus (NR).
  - Anteriorly: terminal flaring out of the annulus (AF) as it leaves the anterior tympanic spine (ATyS).
  - Posteriorly: fibers of the annulus (AF) as it leave the posterior tympanic spine (PTyS) to end at the malleal neck with posterior pouch of von Troeltch (vTP) lies between the posterior malleal fold (PMF) and the tympanic membrane (TM).
  - Lateral: Strapnell’s membrane (PF).
  - Chorda tympani nerve (CTN) was lying s in the free margin of the posterior malleal fold (PMF) in all of the study specimens.

- **Space position and orientation in relation to surroundings**:
  - Ps had a fixed position in all our specimens and was usually a 3D sagittal space located laterally and superficially to the tympanum (in inferior position to the epitympanum and superior position to the mesotympanum).

- **Ps Size** depended mainly on the level of the neck of the malleus (MN).

Ps has different types depending on its ventilation and communication routes. A better understanding of the differences between these types might explain the development and progress between of the space pathological conditions such as isolated infections and dysventilation, in addition to the related retraction pockets and cholesteatomas. Endoscopes could be a significant tool to provide further information about the ME folds and spaces anatomy and potential aeration mechanisms.

Conclusions

References