ESSAY

THE EUSTACHIAN TUBE FUNCTION
And DYSFUNCTION

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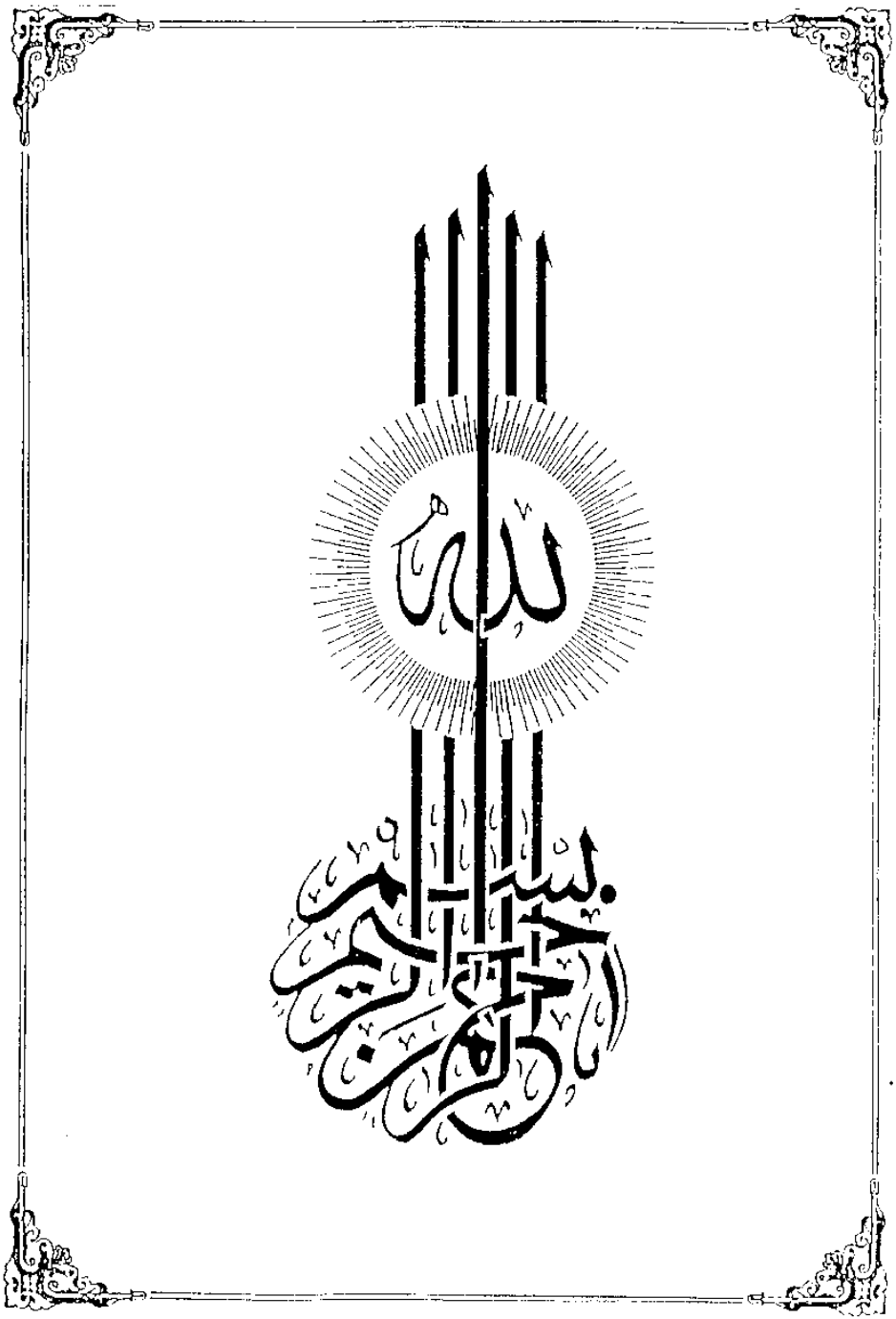

A I M

The aim of this essay is to review the literature discussing the eustachian tube function & dysfunction with the purpose of full appreciation of:

1. Anatomy of the eustachian tube.
2. Function of the eustachian tube and the different tests for its assessment.
3. Causes of the eustachian tube dysfunction:
   a) Abnormally patent eustachian tube
   b) Causes of eustachian tube obstruction
4. Sequelae of the eustachian tube dysfunction.

INTRODUCTION

The eustachian tube (the anatomical tubal connection between the nasopharynx and the middle ear) was recognized as early as 580 B.C. Since that time studies and researches have been done about its anatomy, function, malfunction and how to assess, its important function and how to manage different causes and sequelae of its malfunction.

All otologists realised its important role in normal function of the middle ear, also its role in pathogmesis of different middle ear disease. With the advancement of ear surgery, good functioning eustachian tube is a pre-requiste for success of tympanoplastic operations.

ANATOMY OF THE EUSTACHIAN TUBE

The eustachian tube is named after Bartolomeus Eustachius "1520-74", who at one time held the chair of Anatomy at Rome. His book on the ear, Epistola de Auditus Organis, appeared in 1562 and is probably the earliest work to deal exclusively with the ear. The structure which is now known as the eustachian tube was known to the Greeks and mentioned by Aristotle, but Eustachius was one of the first to describe its structure, course and relations with accuracy. He divided it into bony and cartilagenous parts, but he did not hazard an opinion as to its function; he stated also that this passage could be of great use to doctors for the proper use of medicines.

The eustachian tube is about 3.75 cm long in the average adult. It is directed upwards, backwards and outwards from its lower opening in the lateral wall of the nasophargnx towards its upper opening in the anterior wall of the tympanic cavity. The lower opening lies behind and on a level with the posterior end of the inferior turbinate. The eustachian tube consists of an anteromedial fibrocartilagenous two thirds and posterolateral bony third "protympanum", Proctor 1967. The direction of the tube in the adult inclines superiorly at an angle of 30° - 40°, with the horizontal plane, thus the pharyngeal orifice is about 15 mm lower than the tympanic orifice. In the child the direction is more horizontal with perhaps a 10° superior angle.

From a sagittal plane through the pharyngeal orifice the tube passes laterally with an angle of 45°. The tube lies obliguely laterally and posteriorly and forms an angle of 130° - 140° with the sagittal plane of the nasal fossa. The bony and cartilagenous parts meet at an obtuse angle of 160° "Proctor 1967", this meeting is named the isthmus and is not the same in all types of eustachian tubes, it may be indistinct with a straight lumen or it may be spiral or narrow with marked angulation and this last type is easly obstructed.

The bony portion of the eustachian tube "Protympanum:"

It lies within the temporal bone and is a prolongation of the anterior portion of the tympanic cavity from its opening which is called the tympanic ostium of the eustachian tube; its height is 4.4 mm, and its width is 3.3 mm. The lumen of the bony canal is only about 2.0 mm. The tensor tympani muscle in its bony semi-canal forms the roof of the protympanum; the lateral wall is formed by the thin tympanic plate of the tympanic bone; the chorda tympani nerve passing through the canal of Huguier lateral to the protympanum. The medial wall is the thin bony carotid wall which usually has several perforations for the passage of carotico tympanic vessels. Sometimes the carotid wall may be dehiscent so that the carotid artery may actually bulge into the protympanum. The floor of the protympanum is

irregularly ridged by the junction between the tympanic, and petroeal portion of the temporal bone. The protympanum is 13-14 mm, long, 5 mm high and 2 mm wide.

The cartilagenous portion of eustachian tube:

It is about 25 mm, long and forms the lower two-thirds of the tube, when seen in cross-section, the cartilagenous part looks somewhat like a sphered's crook, the cartilage being confined to the upper and medial parts of the tube, the remainder being composed of a membrane.

The cartilagenous frame is made up of 2 unegual laminae which unite and form an arch with an inferior concavity, this arch is bridged by fibrous tissue. The lateral lamina becomes thinner, narrower and coils inwards as it extends from isthmus to the pharynx, while the medial lamina is narrower near the isthmus then becomes thicker "10-15 mm" at the pharyngeal end to form the eustachian cushion. Torus tubarius, this cushion circumscribes the posterior and superior aspect of the pharyngeal osteum "Proctor 1973".

A fibrous band anchors the cartilagenous tube firmly to the rough surface of the skull base superior tubal ligament, in the sulcus tubarius.

The cartilagenous tube is not a single segment but it is made up of 3 or 4 segments originating from 3-4 centres

of chondrification with 2-3 sliding joints in between, these joints permit the pharyngeal end to whip around with swallowing.

The membranous floor of the cartilagenous portion is very rich with elastic tissue which allows for wide expansion on swallowing "Proctor 1967".

At rest, the pharyngeal orifice is a vertical slit with the anterior and posterior lips in contact.

The posterior lip is mobile and forms variously shaped triangles according to the degree of opening.

Behind the posterior lip "Torus Tubarius" lies the fossa of Rosenmüller, this fossa has great surgical significance as a hidden site for carcinoma in the nasopharynx and it also may be the site for false passage during eustachian catheterization.

The pharyngeal opening of eustachian tube measures 8-9 mm in diameter in adult but it may be so small to 4-5 mm in small diameter. The position of the pharyngeal ostium varies greatly depending upon the age, constitution and stature. Its distance posterior to the inferior turbinate is between 4-12 mm, but its distance is about 10-13mm, postero-lateral to the nasal septum.

The pharyngeal opening can be visualized by trans-nasal endoscopy and transoral nasopharyngoscopy" Jauman et al., 1980".

Musculature of the eustachian tube and soft palate:

The muscles concerned with eustachian tube function can be divided into two groups:

a) Those muscles which by having an insertion into the walls of the tube exert a direct action.

b) Those muscles which by anatomical association assist or influence tubal opening.

The first group includes:

1. Tensor veli palatini muscle.
2. Levator veli palatini muscle.
3. Salpingopharyngeus muscle.
4. Tensor tympani muscle.

The second group includes:

1. The superior constrictor of the pharynx.
2. The sphincter of the nasopharyngeal isthmus, of which the palato-pharyngeus is a major contributor.

The tensor and levator palatini muscles include the eustachian tube between them, the first infront and the latter behind.

The tensor palatini and tensor tympani muscles are extrapharyngeal muscles have a common embryolagical origin and common nerve supply from a branch of the 5th eranial nerve, while the rest of the muscles are intrapharyngeal muscles and are innervated from the pharyngeal plexus of nerves formed by "ninth-tenth-eleventh cranial nerves".

Tensor veli palatini muscle "dilator tubae":

It originates from the scaphoid fossa at the root of the medial pterygoid plate, from the spine of sphenoid and from the lateral membranous part of the eustachian tube. It becomes tendinous and bends at right angle around the bursa of the hamulus and is continued inwards to be inserted partly into the posterior border of the hard palate and chiefly into the openeurosis of the soft palate above the other palatal muscles. The muscle is fan shaped with its base attached to the entire tength of antero-external wall of the cartilagenous tube.

Levator veli palatini muscle:

It has a double origin "Proctor 1973":

1. From the cranium: from that portion of the temporal bone directly infront of the carotid orifice, from the tubal apophysis of the tympanic bone and from the petrosa "anterior fibres".

2. From the cartilagenous tube: The muscle is fixed on its posterior third into the medial cartilagenous lamina. In its anterior 2/3 the muscle has no direct relation, with the tube. It is seperated from the elastic tubal wall by connective tissue in the middle 1/3 and by fatty tissue in the anterior third. The rounded belly of the muscle descends parallel to the tube and is inserted in a radiating manner into the dorsal surface of the soft palate below its pharyngeal orifice.

Some of the anterior fibres of the tubal origin are inserted into the posterior edge of the hard palate constituting the salpingopalatinus muscle, while others descend on the lateral wall of the pharynx covered by mucous membrane beneath the salpingopharyngeal fold. They make up the salpingopharyngeal muscle.

<u>The Tensor tympani muscle:</u>

It originates from:

1. The wall of the osseus canal through which the muscle passes.

2. The top of cartilagenous part of eustachian tube "posterior fibres".

3. Adjacent portions of greater wing of sphenoid adjacent to the carotid canal.

The fibres converge in a feather like manner to the tendon which begins within the muscle about the middle of the canal. The muscle is contained in the bony canal above the protympanum from which it is separated by the septum canalis musculatubaris. The rounded tendon leaves the canal at the rostrum cochleari "processus cochleariformis" extends in a direction almost perpendicular on the muscle belly across the tympanic cavity to be inserted into the inner margin of the handle of malleus just below the short process. Sometimes the anterior portion of the tensor tympani is connected with the tensor veli palatini either directly or by tendinous tissue.

The Salpingopharyngeal muscle:

It originates from the inferior aspect of the torus tubarius and sometimes also from the floor of the tube. Its inferior portion is divided into 2 heads one of which is inserted into the superior horn of the thyroid cartilage and the other into the posterior wall of the pharynx.

The superior pharyngeal constrictor:

The muscle arises successively from above downwards from the posterior border of the lower part of the medial pterygoid plate, the hamular process, the pterygomandibular raphe, the posterior one-fifth of the mylobyoid ridge of the mandible and from the musculature of the tongue and the

adjacent mucous membrane. The fibers pass backwards to be inserted into the pharyngeal tubercle and into the median pharyngeal raphe. The upper border of the muscle is free and forms the lower boundary of the sinus of Morgagni.

The superior fibres curve below the levator veli palatini and the eustachian tube, so that contraction of the superior constrictor muscle also assists in elevation of the eustachian tube during swallowing.

The Palatopharyngeus muscle:

This muscle arises from the pharyngeal aponeurosis and from the posterior border of the thyroid cartilage. This origin is commonly described as the insertion of the muscle. The muscle fibres pass almost vertically upwards to the palate in the palatopharyngeal fold. As the muscle passes forwards to the palate it divides into 2 strands. One strand passes anteriorly and laterally to the levator palati and is inserted into the anterior part of the superior surface of the palatal aponeurosis and the posterior edge of the hard palate. This strand lies above the musculus uvulae. The other more inferior strand passes medial to the levator and blends with its fellow of the opposite side in the middle line. In the palate this strand lies below the musculus uvulae.

How does the eustachian tube open?

The answer of this question is not well estabiiehed and is not definite uptil now, but we shall present the different opinions and views offered in this respect, Mc Myn "1940" belived that the tensor palati was the prime mover in opening the tube, and he coneidered that the other muscles are supporting and act synergistically. The view that the tensor palati is the only muscle involved in opening the tube was put forward by Rich "1920" and this view is supported by Mabeth "1960" on phylogentic evidence in whalee and porpoisee, which have well developed levator palati muscle that appears to be the sole mechanism of opening the tube in these animalis Holborow in 1962 proposed that the tube opens by the tensor muscle without any help of the levator palati muscle.

Proctor in 1973 proposed that with every swallowing the tensor palati muscle certainly, the levator muscle probably open the tube.

The levator opens the phargngeal orifice by lifiting the cartilage upwards by pulling on the fibrous wall of the cartilagenous tube. This action opens the inferior or pharyngeal third of the fibrocartilagenous tubal lumen. The upper 2/3 of the tube is opened by the action of tensor palati muscle. The posterior portion of the tensor muscle is attached to the entire length of the hook "cartilagenous