Anatomy of the Eustachian Tube

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KEYWORDS

• Eustachian tube cartilage • Rüdinger safety canal • Auxiliary gap • Ostmann fat pad • Tubal supensory ligaments • Tensor veli palatini muscle • Medial pterygoid muscle • Salpingopharyngeal muscle

KEY POINTS

- The opening of the eustachian tube, provided by the contraction of the tensor veli palatini muscle, is limited to Rüdinger safety canal.
- The contraction of the tensor veli palatini muscle is almost completely isometric; it depends on hypomochlia, which modulate the muscular force vectors.
- Due to their fibromuscular interconnections on both sides of the Weber-Liel fascia, tensor veli palatini muscle and medial pterygoid muscle form a functional unit.

The eustachian tube consists of 2 different portions: an osseous posterolateral and a fibrocartilaginous anteromedial portion. The osseous portion is grossly formed by the petrous part of the temporal bone, the flexible fibrocartilaginous portion by the tubal cartilage, and its surrounding tissue. The active eustachian tube function is located in the fibrocartilaginous portion. This portion is connected to the skull base by suspensory ligaments.

SPATIAL ORIENTATION

The longitudinal axis of the tube forms an angle with the mediosagittal plane as well as with the horizontal plane.[1] The angle between the longitudinal axis of the cartilaginous part of the eustachian tube and the mediosagittal plane in adults is about 45° on average. In infants, it is only about 10°.[2] The average angle between the Frankfurt horizontal plane (orbitomeatal plane) and the tubal longitudinal axis in adults is about 35°.[1]

LENGTH

The total length of the eustachian tube ranges between 31 and 44 cm[3,4] in adults. Its length in newborns measures only about one-half of the adult's.[5] The length of the

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osseous part is about one-third; the length of the fibrocartilaginous part is about two-thirds of its total length. There is no sharp borderline between the osseous and the fibrocartilaginous portion for the cartilage extends into the roof of the osseous part.[6] The tubal cartilage ends posterolaterally to the isthmus, which is the narrowest point in the tubal lumen. According to Zöllner,[4] the distance between the pharyngeal orifice and the isthmus measures 24 to 28 mm. Rüdinger[7] observed a fibrocartilaginous mass connecting the bone and the hyaline cartilage; this is the reason why there is a difference between the length of the cartilage, which is about 31.2 mm, and the fibrocartilaginous portion of the eustachian tube, which is about 26 mm. Pahnke even observed cartilage reaching the tympanic orifice of the tube.[1]

COMPARTMENTS

On a frontal 2-dimensional view, **Fig. 1** depicts the main structures contributing to the functional eustachian tube anatomy.

The fibrocartilaginous portion of the eustachian tube is almost completely surrounded by the tubal cartilage and by the tensor veli palatini muscle.[8] Both structures form the cartilaginous and the muscular wall of the eustachian tube.[7]

Cartilage

With respect to the eustachian tube function, the cartilage is a very important structure, because it forms the luminal frame of the tube.[8] Looking at the cross-section of the eustachian tube cartilage, its shape resembles a shepherd's crook,[9] consisting of a dome with a short lateral lamina and a long medial lamina. The lateral lamina has a mean height of 1.8 mm at its largest extension, and the medial lamina has a mean maximum height of 5.1 mm. This maximum height of both laminae can be found at about 6.6 mm behind the pharyngeal orifice. The size and shape of the lateral lamina are much more constant than that of the medial lamina. By means of MRI studies of the eustachian tube, Oshima and colleagues[8] could demonstrate a wide individual variety especially of the medial lamina. They concluded that this could have potential implications for eustachian tube surgery. Pahnke[10] also described this variety, which he found in an anatomic specimen. In about 25% of his specimen, the lower end of the medial lamina formed a hook around the lower portion of the eustachian tube lumen. The thickness of the medial and lateral lamina in the middle portion is approximately equal. In comparison to the medial lamina, the lateral lamina, however, becomes thinner toward both orifices.[10]

According to Bluestone,[9] the elasticity of the tubal cartilage is comparable to that of the pinna and the nasal cartilage. This elasticity, which is higher in adults than in infants,[11] is crucial for the reset forces after the contraction of tensor veli palatini muscle.

Lumen

Fig. 2 is a copy of an original illustration by Rüdinger.[7] It shows his cross-sectional view of the tubal lumen. Rüdinger distinguishes between 2 zones of the tubal lumen:

- A cranial half-cylindrical space, which today is called the "Rüdinger safety canal." This space is situated between the lateral and the medial lamina of the cartilage and is filled with mucus or air. Its diameter is about 0.5 mm, and it is found in about 85% of the adults. Most probably this space is always open.[10] The safety canal probably warrants pressure equalization and ventilation function of the eustachian tube.[12]
- Under the safety canal, there is a gap that is mainly surrounded by the muscular or membranous wall of the eustachian tube and partly by the medial lamina of the