Microsurgical Anatomy of Stapedius Muscle: Anatomy Revisited, Redefined with Potential Impact in Surgeries

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Received: 7 September 2018 / Accepted: 3 October 2018 / Published online: 9 October 2018
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Abstract Stapedius muscle even though being the smallest skeletal muscle in human body, it has a major role in otology. As many of the distinguished books in otology missed to explain much about stapedius muscle, and also considering the need for the anatomy based visit to this small muscle we felt it was important to have a exercise like this. In the dissection hall of our institution we dissected 32 cadaveric temporal bones and delineated stapedius muscle as a part of PG teaching programme to have a clear idea of the anatomy of stapedius muscle, its origin, attachment, extension, size (all dimensions). Length of the stapedius muscle varied between 9 and 11 mm. Stapedial tendon measured about 2 mm. The muscle had a classical sickle shape with tendon looking like the handle of the sickle. It has a bulky belly with a maximum breadth of 2–3 mm. It was found to be medial to midportion of vertical limb of facial nerve. All of our temporal bones measured size varied from 9 to 11 mm in length excluding stapedial tendon. Stapedial tendon measured almost 2 mm. Muscle is classical sickle shaped with tendon acting like the handle of the sickle. It has a bulky tummy which forms the maximum breadth of 1–3 mm. Why to have a clear idea about the anatomy of stapedius muscle is that, unless the anatomy is clear there is chance of confusing the muscle with that of facial nerve while doing facial nerve grafting and also while drilling for facial nerve decompression in experienced hands may get confused and decompress the muscle. Stapedius muscle said to be the smallest muscle in the body, but its not as small as its been described. Detailed

awareness of the anatomy of stapedius muscle is needed so as to avoid confusion while facial nerve grafting and while drilling.

Keywords Stapedius muscle · Revisit to anatomy · Redefining stapedius muscle · Relationship of stapedius muscle to facial nerve

Introduction

Stapedius muscle is termed to be the smallest skeletal muscle in human body, which has a major role in otology. Stapedius muscle is one of the intratympanic muscles for the regulation of sound. The origin of the stapedius muscle is from the fasciculi of the posterior belly of digastric muscle, which is inserted in the mastoid groove, then the fasciculi passes through stylomastoid foramen and approaches the neck of stapes to form the stapedius muscle, and it gives fibres to the tympanic cavity [1–3]. It develops from the second brachial arch and is innervated by the branch from the vertical segment of the Facial nerve, that is Nerve to Stapedius. It is supplied by stapedial branch of Posterior Auricular artery. The stapedius and tensor tympani muscles contract together in a reflex synchronised manner to dampen the amplitude of high intensity, low frequency sound and prevent excessive movement of the stapes [4–6]. Therefore stapedius reflex is important for protection against hazardous levels of noise and for improving the speech perception, in the presence of background noise. Paralysis of the stapedius muscle causes hyperacusis, the patients will perceive normal sounds abnormally louder [2, 4, 5]. A study by Roudriguez-Vazquez et al. showed that stapedius muscle was formed by 2 anlagen, one for tendon which is derived from the internal

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segment of the interhyale—a condensation of mesenchyme which gives rise to Riecherts cartilage, the cranial end of which forms the stapedial tendon and another separate anlage forms the belly of the muscle [7]. Surgical anatomy of the stapedius muscle is important in many otologic surgeries especially in case of stapes surgeries, as the tendon needs cut. A study by Elovikor et al. suggested saving stapedius

muscle [8]. Many of the standard books in otology do not give a detailed explanation about origin and microanatomy of stapedius muscle. Considering the importance of the muscle during stapes surgery we undertook this study to revisit and redefine the microanatomy of stapedius muscle by dissecting 32 cadavers.

Fig. 1 Thread measuring the entire length of the muscle. Thread measuring the belly of the muscle

Fig. 2 Muscle dissected and removed in toto

Objectives

To revisit the anatomy of smallest muscle in the body and clearly define the microanatomy of stapedius muscle.

To convey a clear concept of anatomy of stapedius muscle and its relation to facial nerve during facial nerve surgeries.

Materials and Methods

In this observational study we dissected 32 cadaveric temporal bones and delineated stapedius muscle right from its origin to insertion to have a clear idea of the anatomy of stapedius muscle, its origin, attachment, extension, size (all dimensions). We used Zeiss microscope, stapedotomy instruments and microdrill and the entire stapedius muscle was dissected in all 32 cadaveric bones. Complete exposure of the muscle was done after anteriorly transpositioning the facial nerve. A cut thread was used to measure the entire length of the muscle.

Observations

Length of the stapedius muscle varied between 9 and 11 mm. Stapedial tendon measured about 2 mm. The muscle had a classical sickle shape with tendon looking like the handle of the sickle. It has a bulky belly with a maximum breadth of 2–3 mm. It was found to be medial to midportion of vertical limb of facial nerve. It extends from the posterior part of the neck of the stapes and runs from superior to inferior direction. The stapedial tendon was

attached to posterior aspect of neck stapes and distal lower most part of the muscle was about 3 mm above the stylo-mastoid foramen. To expose the middle one-third which is the belly of the muscle and lower one-third which is posteromedial to vertical segment facial nerve, the nerve needs to be dissected and transpositioned anterolaterally. Stapedius tendon was present in all temporal bones.

Discussion

In most of the literatures the stapedius muscle is explained as the smallest skeletal muscle in the human body. Its purpose is to stabilise the smallest bone in the body.

In our study comprising of 32 cadaveric temporal bones, the muscle was not as small as it is described in many of

Fig. 4 Muscle is being delineated and dissected. Facial nerve is getting dissected and lifted up to expose the muscle below

Fig. 3 Entire length of stapedius muscle is seen marked by a red thread from stapedial tendon to lower end of muscle (3 mm above stylomastoid foramen)

Fig. 5 Facial nerve after delineation is placed back to show the anatomical relationship

Fig. 6 Image showing complete canal wall down mastoidectomy. Exposed tympanic, second genu and vertical segment of facial nerve. Pyramid is drilled to expose the anterior most part of the muscle to begin with, anterior to its bulky tummy. Vertical portion not dissected yet

the text books. In literature, it has been shown to be small. In our study the length of the stapedius muscle varied between 9 and 11 mm. Stapedial tendon measured about 2 mm (as shown in Fig. 1). The muscle had a classical sickle shape with tendon looking like the handle of the sickle (Fig. 2). It has a bulky belly with a maximum breadth of 2–3 mm (Fig. 1). It was found to be medial to midportion of vertical limb of facial nerve. It extends from the posterior part of the neck of the stapes and runs from superior to inferior direction as shown in the picture. The stapedius muscle can be divided to upper one-third being anteriomedial, middle one-third forming the belly which is medial to facial nerve and lower one-third being posteromedial to vertical segment of facial nerve.

In our study the stapedial tendon was attached to posterior aspect of neck stapes and distal lower most part of the muscle was about 3 mm above the stylomastoid foramen. The main bulk, belly of muscle was in a hollow conical area medial to the vertical limb facial nerve as described above (Fig. 3). In literature some authors suggest that the tendon arises from the head and posterior crura of stapes. However In our study it was attached to posterior aspect of neck of stapes in all 32 temporal bones. For exposure of stapedius muscle facial nerve needs to be delineated, lifted and anterolaterally trans positioned (Fig. 3). Muscle can be divided as upper one-third, middle one-third and lower one-third. However to expose upper third the pyramid has to be drilled out with 2 mm diamond burr, facial nerve need not be transpositioned. To expose the middle one-third which is the belly of the muscle and lower one-third which is postero medial to vertical segment facial nerve, the nerve needs to be dissected and transpositioned anterolaterally (Figs. 4, 5, 6). Dalmia et al. described 2 cases where stapedius tendon was found absent in stapes surgery [1]. However in our series stapedius

tendon was present as described. A clear anatomy of stapedius muscle is mandatory to avoid confusion of the muscle with facial nerve during facial nerve surgeries like grafting or decompression. This knowledge of microanatomy during surgery is all the more important for beginners.

Conclusion

Stapedius muscle is not as small as described in literature. A good knowledge of microanatomy of stapedius muscle and its relation to facial nerve is mandatory both during stapes surgery and facial nerve surgery like decompression and nerve grafting.

Compliance with Ethical Standards

Conflict of interest The author declares that they have no conflict of interest.

Ethical Standards Ethical committee clearance taken from the respective university.

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