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Some Anatomical Studies on the Tympanic Cavity of the Goat (Capra Aegagrus Hircus) with Special Reference to Their Ossicles

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Abstract: The present study was applied on six heads cadavers and four dried skulls of goat. The examined specimens showed that, the tympanic cavity was consisted of 3 parts; epitympanic recess, tympanic cavity proper and hypotympanicum. The lateral wall of the tympanic cavity was oriented by tympanic membrane while the medial wall was supported by promontory, fenestra vestibule and fenestra cochlea. The bony structures of the middle ear were achieved by 3 ear ossicles; Malleus, incus and stapes. The former one was the longest and drum stick in shape and consisted of head and neck that carried rostral and lateral processes in addition to handle. The incus was short wide tooth-shaped and it consisted of body and two; long and short diverging roots. The stapes was the most medial one of ear ossicles and constricted from head, two crus and foot plate. Stapes structures were excavated internally forming the obturator foramen. Average measurements of length, width and diameter for each ossicle were applied. The results obtained were discussed with the literatures in the same scope. In conclusion, the anatomy of the structures within the middle ear of goat can help the surgeons for easy approaches in the cavity of the middle ear.

Key words: Tympanic cavity · Ear ossicles · Malleus · Incus · Stapes · Goat

INTRODUCTION

Despite the economic importance of goats in many countries as a source of meat production, goat's meat resembles about 47% of all meat produced in India [1] also goat's milk and cheese industry provides major income in Europe. In the present day, due to the wide spread of trans-canal endoscopic ear surgery in human specially in the middle ear, we found that, the goat is suitable as an experimental animal due to its advantageous size [2]. The middle ear is a notable organ; tympanic cavity and ossicular chain represent an extremely sound pressure wave receiver. The goats middle ear can give the surgeons an affordable experimental approach after confirming its comparison with the human middle ear structures to enhance surgeons' skills [3].

Although some researchers studied anatomical features of the middle ear [4] in ruminants, [5] in dog, [6] in buffalo, [7] in camel and cattle and [8] in domestic animals, as well as The auditory ossicles were studied by Arnautovice. and Osman [9] in camel and donkey but still there is no enough data about the anatomical features of goat tympanic cavity and their ear ossicles. Most of the previous works gave a data on the clinical significant of the middle ear and studded it in practically applied form [3]. Moreover, many authors tried to apply that among the domestic animals;] in sheep [10, 11] in pig [12], in sheep [13], in human and sheep [14, 15] and in pig [16].

MATERIALS AND METHODS

Six fresh goat heads were collected from Cairo slaughter -house in addition to four dried goat skulls from the department of veterinary anatomy, Cairo University. The tympanic cavity and its associated structures were studied bilaterally by removing of the tympanic bulla to show the auditory ossicles in situ. The auditory ossicles were removed from both sides of the dried skull by aid of an electric drill introduced through the external acoustic meatus. Careful examination of the specimens and the auditory ossicles was done by using magnifying lens. The measurements were applied by using the Vernier Caliber. The specimens were photographed by digital Olympus camera, 12 mega-pixels.

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RESULTS

Tympanic Cavity: The tympanic cavity of the goat is an irregular narrow where it excavated by laterally compressed space. The corresponding cavity is formed by three parts; epi-tympanic recess, tympanic cavity proper and hypotympanium. It contains mainly the structures of the middle ear as well as this cavity has two walls; lateral membranous and medial ossous. Epi-tympanic recess (epitympanicum) (Fig. 2/2) lodges dorsally to the tympanic membrane. It is bear shape space and consists of base and apex; its base measured about 1.14 cm while its apex was 0.62 cm in its transverse diameter. The tympanic cavity proper (mesotympanicum) (Fig. 2) considers the widest part of the current cavity where it measures about 1.35 cm in its transverse diameter. It contains the tympanic membrane, malleus and incus bones. The third part is the hypotympanicum (Fig. 2/1) is the narrowest part of the tympanic cavity where it measured about 0.52cm and lodges ventrally to the handle of the malleus and the tympanic membrane where it embedded in the bulla tympanica (Fig. 1/2).

The lateral membranous wall of the tympanic cavity is oriented by the tympanic membrane (Fig. 2/4) that attached by the ring bone of the external acoustic meatus. The tympanic membrane of the goat is ovoid, semitransparent. It has a vertical diameter which measures about 0.83 cm. The peripheral circumference of the membrane is thick and attached to the ring bone of the external acoustic meatus while the central part of the corresponding membrane is attached via the lateral process and the handle of the malleus. The large lighter part of the membrane above the latter structures termed pars flaccida and the ventral irregular triangular concave surface called pars tensa. The inner surface of the tympanic membrane has prominent areas of the convexity called umbo-membrana tympani. The ossous medial wall of the tympanic cavity is formed by the promontory, fenestra vestibule and fenestra cochlea of the inner ear.

Auditory Ossicles: The auditory ossicles are three in number; malleus, incus and stapes that enclose to the tympanic cavity. The malleus (Fig. 2/5), (Fig. 3) in the goat is drum stick bone and considered the longest bone of ear ossicles where it measured about 0.93cm in its length. It consisted of head, neck and handle. The head of malleus (Fig. 3/1) is oval in shape and measured about 0.35 cm in its vertical diameter. It directed rostrodorsally to articulate by its caudomedial part that carry articulated facet (Fig. 3/6) with the body of incus forming malleoincudal joint (Fig. 6/1). The neck of malleus (Fig. 3/2) is thin, concave and measured about 0.21 cm in its thickness and carries two processes; the lateral (Fig. 3/3) and the rostral process (Fig. 3/4) that adhere to the tympanic membrane. The handle of the malleus (manubrium) (Fig. 3/5) is the longest part and measured about 0.74 cm long with a concave rostral border. It completely attached to the tympanic membrane (Fig. 2/4) and draws the center inwards towards the tympanic cavity.

The incus (Fig. 4) is wide short bone measured about 0.42 cm in its width and consists of the body and two diverging roots as molar teeth in shape. The body (Fig. 4/1) is cuboidal in shape and lies caudal to the head of the malleus in the tympanic cavity proper where it articulates via a saddle-shaped facet. The long root (Fig. 4/2) is about 0.36 cm in its length and emanates close to medial depression (Fig. 4/5) and descends caudoventrally to form an acute angle with the body. The short root (Fig. 4/3) is about 0.21 long it directs rostrodorsally to articulate by terminal facet (Fig. 4/6) with the body of the stapes forming incudostapedial joint (Fig. 6/2).

Fig. 1: A photograph showing left petrous part of the temporal bone.(1. External acoustic meatus, 2. Bulla tympanica, 3. Mastoid process, 4. Styloid process, 5. Muscular process)

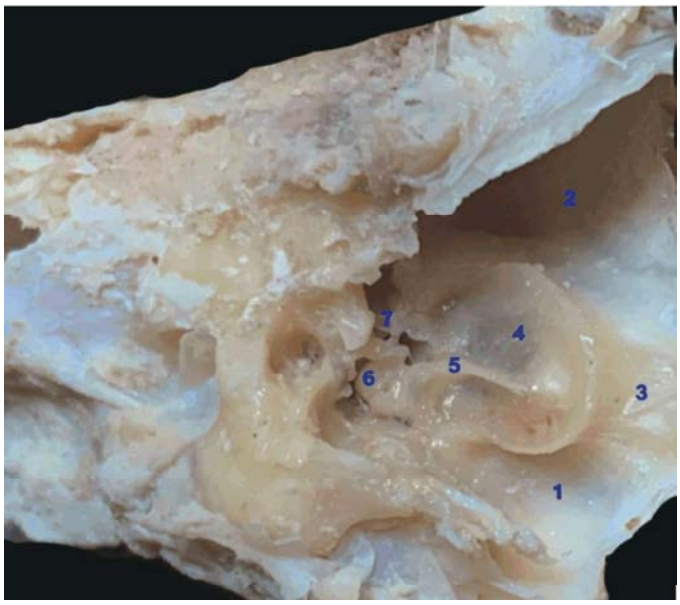

Fig. 2: A photograph showing right medial view of the intra tympanic cavity structures. (1. Hypotympanicum, 2. Epi-tympanic recess, 3. External acoustic meatus, 4. Tympanic membrane, 5. Malleus, 6. Incus, 7. Stapes)

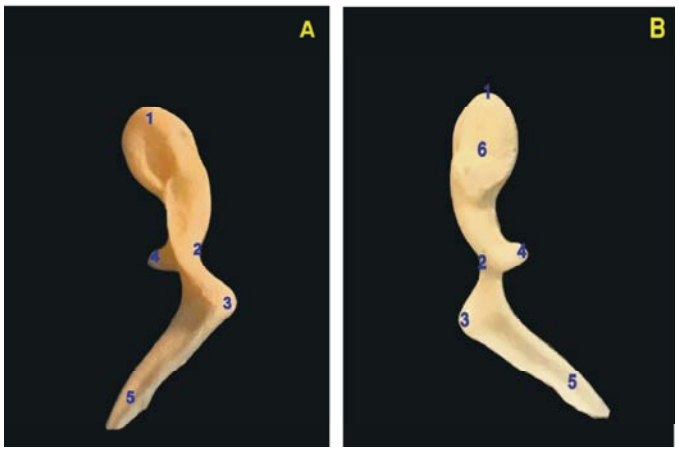

Fig. 3: A photograph showing A) lateral view, B) medial view of malleus bone. (1. Head, 2. Neck, 3. Lateral process, 4. Rostral process, 5. handle, 6. malleolar articular facet)

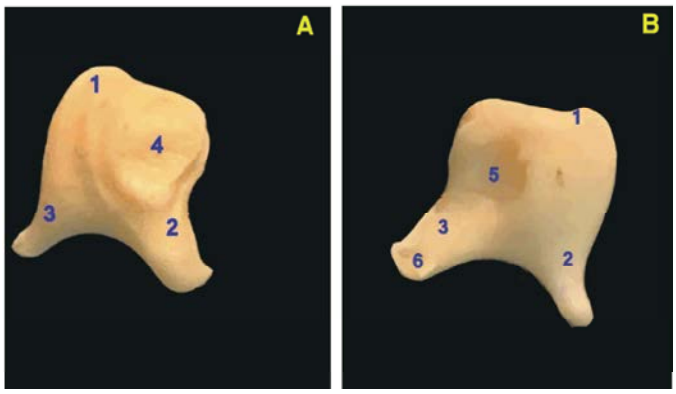

Fig. 4: A photograph showing A) lateral view, B) medial view of incus bone. (1. body, 2. long root, 3. short root, 4. incudal articular facet, 5. medial depression, 6. articular facet for stapes)

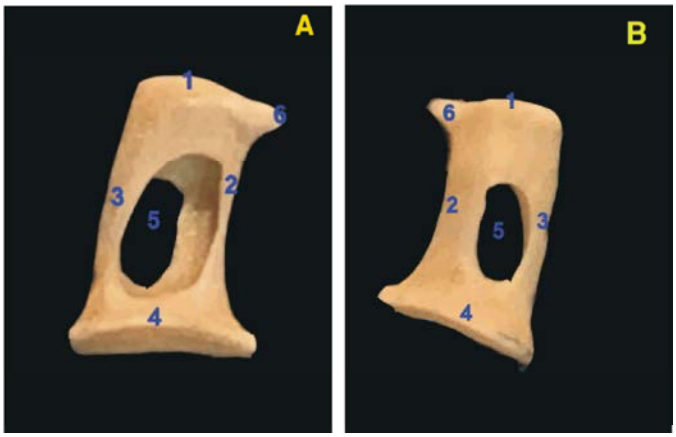

Fig. 5: A photograph showing A) lateral view, B) medial view of stapes bone. (1. head, 2. caudal crus, 3. rostral crus, 4. foot plate, 5. obturator foramen, 6. muscular process)

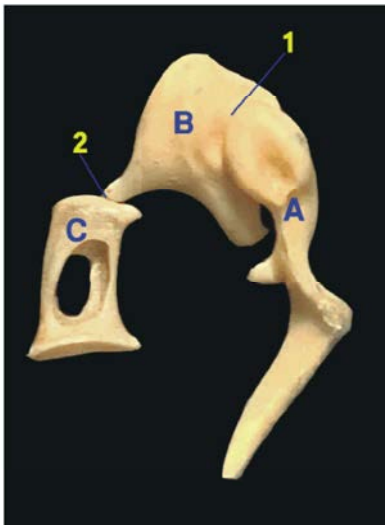

Fig. 6: A photograph showing the articulation of ear ossicles. (A. malleus, B. incus, C .stapes; 1. malleoincudal joint, 2. incudostapedial)

The stapes (Fig. 5) is the shortest excavated and most medial one of the three ear ossicles where it measures about 0.48 cm in its length. It constructed from head, two crura and foot plate. The head (Fig. 5/1) is thin flate and shows a dorsal depression for articulation with long root of the incus and the caudomedial muscular process (Fig. 5/6). The rostral crus (Fig. 5/1) is curved concave and longer than the caudal one and measured about 0.25 cm. The caudal crus (Fig. 5/2) is curved convex and measures about 0.18 cm in its length. They connected at their ends by flattened foot plate (Fig. 5/4). The head, the two crura and the foot plate of the stapes are surrounded internally by an oval obturator foramen (Fig. 5/5).

DISCUSSION

In the present study, the anatomical structure of the middle ear was composed of tympanic cavity which included the epitympanicum, mesotympanicum and hypotympanicum. These results are similar to that stated by Ragab & Osman [6] in buffalo and Nitovski *et al*. [17] in cattle and pig. While König and Liebich [8] in domestic mammals described that the middle ear was consisted of tympanic cavity, auditory ossicles and auditory tube, the former comprised the epitympanicum, mesotympanicum and hypotympanicum. On the other hand, Pracy *et al*. [12] in pig classified the middle ear into Eustachian tube, tympanic cavity and air cell system within the tympanic bulla.

According to the shape of tympanic cavity and their wall, our study revealed that the shape of current cavity was an irregular narrow, compressed laterally space and has two walls; lateral membranous and medial ossous. On the other hand [6] in buffalo mentioned that this cavity was a biconvex lens with dorsomedial and ventrolateral faces. A result was disagreed with that declared by Pracy *et al*. [12] in pig who said that it was looks like a biconcaved lens with six walls; roof, anterior, posterior, lateral, medial and floor. However, Ragab & Osman [6] in buffalo reported dorsal, ventral, lateral and medial walls.

Concerning to the shape of the tympanic membrane of the goat was ovoid, semitransparent. This statement was similar to that cited by Ragab & Osman [6] in buffalo and König and Liebich [8] in domestic mammals. On the other hand, Kurtu *et al.* [18] in rabbit found it was a tear shaped like.

Our study mentioned that the auditory ossicles of the goat were three in number; malleus, incus and stapes that enclose to the tympanic cavity. These results come in contact with the available literatures. While Kurtu *et al.* [18] in rabbit added that there was one tiny bone that termed the lenticular process as a continuity of the long root of incus.

The malleus bone of the goat was a drum stick bone and considered the longest bone of ear ossicle. It consisted of head, neck and handle and its neck had lateral and rostral processes that adhere to the tympanic membrane. While Arnautovice and Osman [9] in camel and donkey, Ragab & Osman [6] in buffalo, Booker [7] in camel and cattle, Arnautovice and Osman [9] in camel cited that it consisted of head, neck and handle with medial, lateral and rostral processes. On the other hand, [16] in pig found only two parts of malleus; head and handle.

The incus bone of the goat was wide short bone. It consisted of the body and two; long and short diverging roots as molar teeth in shape. These statements were simulated to that defined by Kurtu *et al.* [18] in rabbit and Arnautovice and. Osman [9] in camel.

Concerning to the stapes bone of the examined specimens was the shortest excavated and most medial one of the three ear ossicles. It constructed from head, two crura and foot plate that surrounded internally by an oval obturator foramen. We added that the rostral crus was curved and longer than the caudal one. These results were similar to that stated by Arnautovice and Osman [9] in Camel and Cat. On the other hand, Arnautovice and Osman [9] in camel and donkey, Ragab & Osman [6] in deer and Gurr *et al*. [16] in pig mentioned that the two roots are equal in length.

CONCLUSION

In conclusion, the anatomy of the tympanic cavity and features of the ear ossicles in goat were studied to give the surgeons an experimental model for easy surgical approaches in the cavity of the middle ear. Further studies are needed upon trans-canal endoscopic ear study to emphasis the similarity and dissimilarity of the tympanic cavity of goats to humans.

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