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AUDITORY OSSICLES IN THE RUMINANTS: COMPARATIVE MORPHOLOGICAL ANALYSIS WITH THE ANALOGUES FORMATIONS OF HORSE

OSSICINI DELL'UDITO NEI RUMINANTI: ANALISI MORFOLOGICA COMPARATIVA CON LE CORRISPONDENTI FORMAZIONI DELL'EQUINO

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PAROLE CHIAVE:
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KEY WORDS:
middle ear, auditory ossicles, ruminants.

Riassunto

La ricerca descrive, dal punto di vista topografico e morfologico, gli ossicini dell'udito nei Ruminanti e confronta i dati ottenuti con quelli, riportati in letteratura, per gli Equidi.

I risultati dimostrano che la catena degli ossicini nei Ruminanti ha la stessa topografia descritta per gli Equidi, mentre sostanziali differenze emergono dal confronto dell'analisi morfologica dei singoli ossicini. In particolare queste riguardano la testa ed i tre processi del martello, la lunghezza dei processi dell'incudine, la forma della staffa e la topografia dei suoi processi.

Summary

The research describes the topography and morphology of the Ruminants auditory ossicles of the middle ear and compares them with data reported by literature on Equides.

The results prove that, in Ruminants, the topography of the ossicles chain is the same as in Equides, while the morphology of the individual ossicle shows substantial differences. These differences are, in particular, about the head and the 3 processes of malleus, the length of the processes of incus, the shape of the stapes and the topography of its processes.

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Introduction

The chain of auditory ossicles of the middle ear has a fundamental role in the transmission of sound, and therefore in animal behaviour. The different auditive ability of the various species is also due to morphological diversity of the auditory ossicles, of their articulations, and of the associated ligaments and muscles. These differences have already been investigated by many authors (1-7). Aim of the present study is to give a detailed morphological and topographical description of the chian of auditory ossicles in Ruminants and to compare our results with the data reported in literature on Equides.

Materials and methods

The heads of 8 bovines, aging between 8 months and 7 years, and of 8 sheep aging between 4 and 8 years have been taken from the public slaughter-house. The parietal regions have been isolated from both sides of each head. The disarticulation of the temporal bone, with particular attentions to its petrous part, has allowed to reach the middle ear (Fig. 1). The tensor tympani and stapedius muscles have been highlighted and the exact topography of the individual ossicles of the chain has been observed. After excising the muscles, the individual ossicles have been separated and boiled to eliminate the organic parts in excess and to allow a more detailed investigation of their morphology.

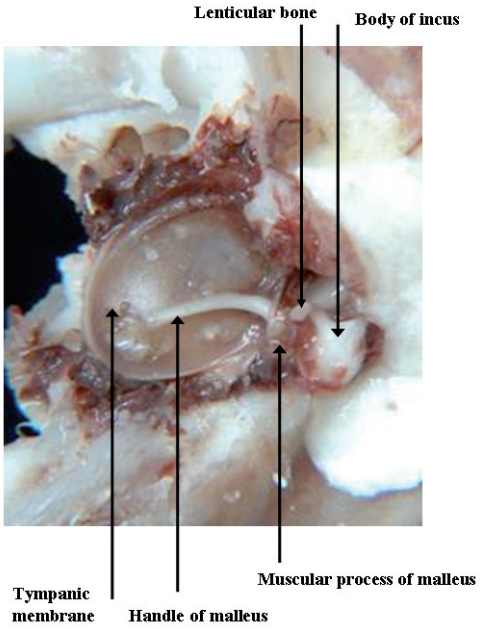

Figure 1: Lateral wall of bovine middle ear: medial view.

Results

The tympanic cavity was lateral-laterally crossed by the auditory ossicles that were in order: the malleus, the incus, and the stapes (fig. 2-4), like normally in the other species.

The malleus, also in Ruminants, was characterized by an handle, a neck and an head (fig. 3-4). The handle was inserted in the medial side of the tympanic membrane in that it determined, with ventro-dorsal direction, an impression: the malleolar strip (stria mallearis). This malleolar strip ended dorsally in the malleolar prominence (prominentia mallearis) that was determined by the lateral process of the neck. The neck followed dorsally the handle and it was thin, flattened and slightly curved medially. The head followed the neck and was oriented in rostro-medial direction. It was almost totally located in the epitympanic recess. The head was elongate and had triangular section, so it was flattened in the caudal side, where it showed two articular surfaces for the body for the incus. The malleus had 3 processes: lateral, muscular and rostral. The lateral process was cone-shaped and it was located in the junction point of handle and neck. This process was in contact with the tympanic membrane, where it defined the malleolar prominence. The rostral process was near the head it was "thorn of rose" shaped (fig. 4).

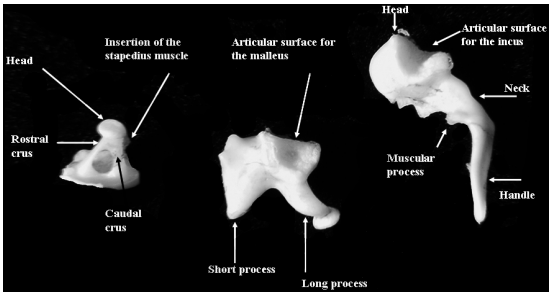

Figure 2:
Horse: auditory ossicles. From the right malleus, incus, stapes.

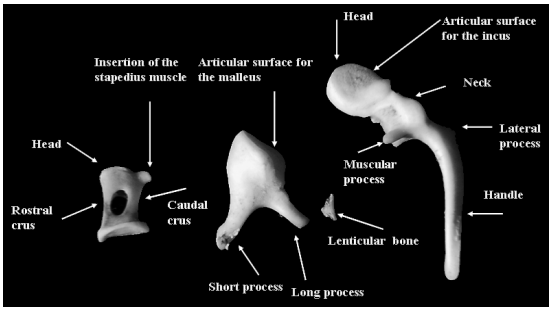

Figure 3:
Bovine: auditory ossicles. From the right malleus, incus, stapes.

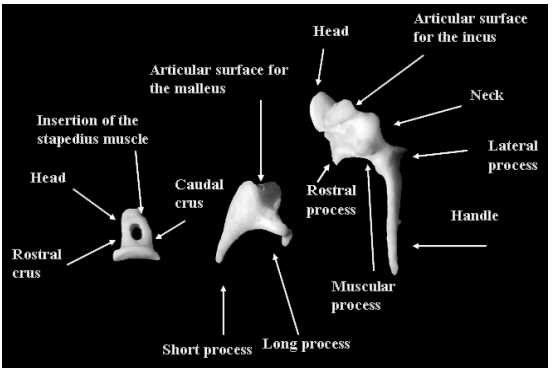

Figure 4:
Ovine: auditory ossicles. From the right malleus, incus, stapes.

It was the insertion point of the rostral ligament of the malleus that linked to the head throughout a transparent bone lamina. The muscular process was located in a medial position. It was digitiform and it gave attack to the tensor tympani muscle.

The incus was the second of the ossicles, proceeding latero-medially. It was totally located in the epitympanic recess and it was characterized by a body and by 2 processes that were very divergent (nearly to a right angle). The body of incus was short, strong and oval-shaped. It had laterally an articular surface for the head of the malleus. From the body originated 2 processes: one long and one short. The long process turned dorso-caudally in the epitympanic recess and it terminated with a thick ligament. This ligament connected the process with the dorsal wall (internal apix) of the recess. The short curve process went medially and terminated with a little lenticular relief that articulated with the head of the stapes. This relief easily fractured during the preparation setting the lenticular bone free.

The stapes showed rectangular shape and was located under the epitympanic recess. It was constituted by an head, a muscular process, 2 crura (rostral and caudal) and a base. The head had oval shape and was located laterally to meet the short process of the incus. The muscular process, for insertion to the stapedius muscle, was located caudally in respect to the head. From this process originated the caudal crus. The rostral crus originated form the head. Between the 2 crura was stretched the stapedial membrane. The base was represented by a little oval plate with major axis caudo-rostrally oriented. It was applied to the vestibular window throught an anular ligament.

Discussion

The ossicle chain in Ruminants has a similar topography in respect to the same chain in the horse. Differently there are some differences in the conformation of the single ossicle.

The head of the malleus, in the Ruminants, was lengthened. It had a trian-

gular section and the articular surface for the incus located caudally. Differently in the horse, the head of the malleus is "... regolarmente sferoidale ad eccezione di una superficie articolare [...] che prende rapporto con l'incudine" (5). Moreover in respect to the horse, the muscular process was more lengthened and more thin and it gave insertion to the tensor tympani muscle (4-5). This muscle ends, in the opinion of Pelagalli and Botte (6) "... sul processo rostrale del manubrio del martello".

The mayor differences regard the incus, that is more thin than the same of the horse even if has the same shape that "... è stata paragonata sovente a un dente bicuspide umano con radici divergenti" (3). Furthermore, in agreement with Nickel et al (4) the long and short processes had inverted proportions in Ruminants in respect to the horse. In fact, the aforesaid authors say that the short process is more developed in length than the long process. Similarly to the horse, the long process terminates with a discoidal relief, the lenticular process, that articulates itself with the head of the stapes. Our data seem to be confirmed by Nickel et al. (4) who sustain that "... l'estremità della branca lunga è unita per sindesmosi all'osso lenticolare che è molto piccolo ed ha forma sferoidale" while Bortolami and Callegari (5) sustain that in the horse "... il processo lenticolare [...] può rendersi talvolta indipendente, soprattutto a causa di fratture durante la preparazione anatomica, e viene considerato come osso lenticolare."

Finally, we can precise that the equine stapes has isosceles triangle shape with latero-lateral mayor axis. So it resembles to "... quella dell'omonimo arnese usato dai cavalieri" (5). Differently in the Ruminants the stapes had rectangular shape. Moreover in the horse, the caudal crus has a process for the insertion of the stapedius muscle. This process, in the Ruminants, was located on the head.

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