

Chapter 2

Ear Anatomy

The structure and function of the mammalian middle ear have been repeatedly studied and discussed during the past one and a half century. The middle ear of mammals are remarkably different from those of other vertebrates in that the malleus, incus, tensor tympani and stapedius muscles appear. Moreover, it goes without saying they have developed cochlear turnings. However, according to a previous study [10] rodents such as chinchilla and guinea pig have different features in middle-ear anatomies from large mammals such as cat and human. Rodents have symmetric eardrums in the anterior and posterior parts, fused malleus-incus complex, and I-beam like cross-sectional shape in the malleus handle, while larger mammals including human have asymmetric eardrums in their anterior and posterior parts, deformable joints between the malleus and the incus, and axi-symmetric cross-sectional shapes in the malleus handle.

2.1 Ossicular Chain and Ligaments

The ossicles are three in number, the malleus, incus and stapes. The malleus is attached to the inner surface of the tympanic membrane with its handle extending downwards to the centre of the drum or even further. The incus consists of a body and long and short processes. The stapes usually consists of the foot plate and two crus, whilst in some species central perforations is absent. The foot plate is principally supported by the ligamentum annulare in the oval window.

The malleus with the incus forms a uniform structure, inseparable without destroying

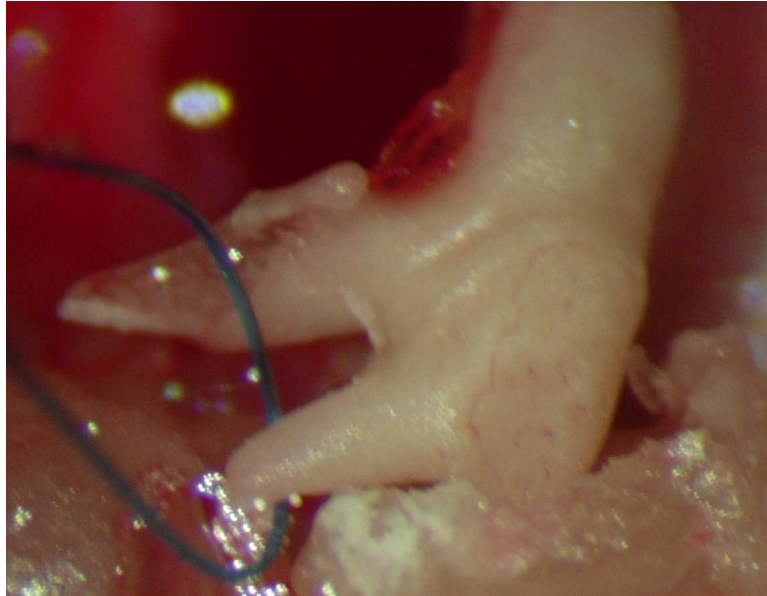


Figure 2.1: Incudo-malleal complex.

it, and called the incudo-malleal complex (MIC) (Fig. 2.1). However, thorough observation revealed a suture between the ossicles. Only the head of malleus is situated in the superior space of the tympanic cavity. The corpus of incus and its processes already lie in the ventral bulla. The axis running through the malleus head and the short process of the incus is the longest dimension of the ossicular complex. This complex, lying with its long axis in the sagittal plane, adheres to the superior wall of the tympanic ring with its lateral surface. The tympanic membrane is fixed to the tympanic ring in the place where the malleus head is connected with the malleus handle. The malleus handle, forming a thin bony lamina, adheres to the tympanic membrane with its lateral edge, which expands towards the end forming a flat bar at the “umbilicus” of the membrane. This part of the handle is cartilaginous and is called the scutum tympanicum. In the upper part of the medial edge of the malleus handle, there is an attachment of the tensor tympani muscle. The muscle is oval in shape and lies in its own small bony cavity, superior to the cochlear promontory and anterior to the oval and round window. The processes of the incus emerge from its body at a right angle. The short process of the incus lies in a depression in the medial wall of the tympanic cavity, where a delicate ligament holds it. At the extension of the process’s axis, there is

the facial nerve canal, which forms its second geniculum here.

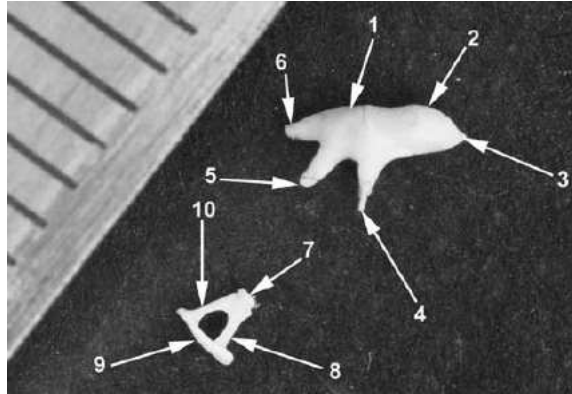


Figure 2.2: Auditory ossicles of the guinea pig temporal bone 1. Body of incus 2. Head of malleus 3. Tip of malleus head 4. Malleus handle 5. Long limb of incus 6. Short limb of incus 7. Head of stapes 8. Anterior limb of stapes 9. Footplate 10. Posterior limb of stapes

The long limb of the incus forms a ligamentous connection with the stapes, and the angle at which both ossicles are connected is a sharp angle open caudally, medially and dorsally. The direction that is determined by the long limb of the incus precisely indicates the position of the round window. The stapes is composed of two limbs and a footplate (see fig. 2.2). Between the limbs, there is a connective tissue cord, being a remnant of the stapedia artery which disappears in the early stages of embryonal development. The remnant of the artery penetrates the tympanic cavity through the infratympanic canaliculus (Huschke's foramen).

2.2 Muscles

The tensor tympani and stapedius muscles are present. The former generally consist of two parts, viz., pars petrosa and tubaria. Pars petrosa lies in a small depression of the lateral surface of the petrous portion of the temporal bone, whilst pars tubaria extends directly toward the Eustachian tube. Some mammals have both of these parts and some only one.

The stapedius muscle arises in the bone near the facial canal passing upwards and for-

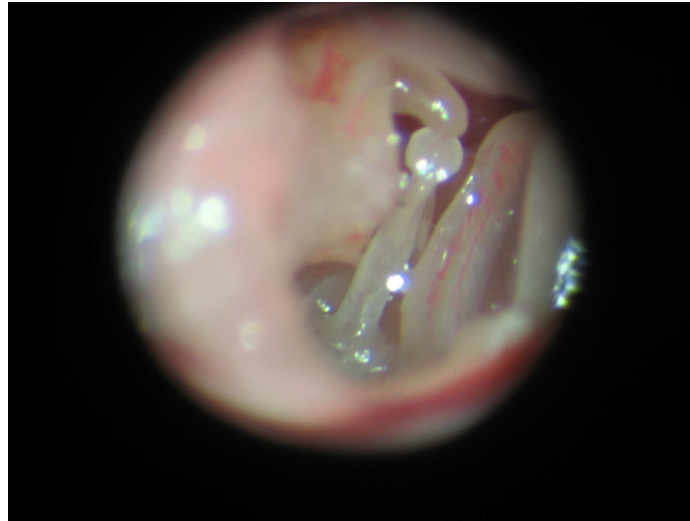


Figure 2.3: Stapes.

wards, and is inserted at the head of the stapes or at the end of the long incus process-*processus lenticularis*- or at both points. The fibres of the stapedius muscle converge on either side of the central tendon forming a type of bipennate muscle, and are similar in all mammals.

The tensor tympany muscle of the guinea-pig, cat and dog consists usually of only *pars petrosa*, which lie on the shallow or deep depression of the lateral surface of the petrous portion, whilst that of the dog or cat is almost all globular consisting of the radiated fibres which diverge from the point of attachment to the malleus. The stapedius muscles of these animals do not differ in shape. The tensor tympani muscle of the rabbit, horse, pig and sheep consists of *pars petrosa* and *pars tubaria*. In the rabbit, it is the unipennate muscle and its *pars tubaria* thinly covering the lateral surface of *pars petrosa* and extending to the opening of the Eustachian tube.