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Research article

Fetal development and variations in the cartilages surrounding the human external acoustic meatus

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SUMMARY

In contrast to the osseus part that develops from the tympanic ring of the squamous part of the temporal bone after birth, there is little information on fetal development of the cartilages surrounding the human external acoustic meatus. Using routine histology and immunohistochemistry, we examine sections of 22 fetuses (CRL 100–270 mm) to study the development of these cartilages. Early external ear cartilages are composed of three groups: (1) a ring-like cartilage at the putative tragus on the anterior side of the meatus, (2) two or three bar-like cartilages along the inferior wall of the meatus, and (3) a plate-like cartilage in a skin fold for the putative helix on the posterior side. In contrast to the first and second pharyngeal arch cartilages, all the external ear cartilages express glial fibrillary acidic protein. Notably, the bar-like cartilages along the meatus are connected with a fascia-like structure to the second pharyngeal arch cartilage. Later, with considerable individual variation, new cartilage bars extend from the inferior cartilages to the superior side of the meatus. Thus, via an intermediate stage showing a chain of triangular elastic cartilages, a chain of bar-like cartilages on the inferior side appears to change into a complex of H-shaped cartilages. Numerous ceruminous glands are seen in the thick subcutaneous tissue overlying the cartilaginous part of the meatus. However, they do not insert into the cartilage. The external ear cartilages develop much earlier than, and independently of, the osseus part.

1. Introduction

Fetal development of the epithelial lining of the external acoustic meatus has been a major focus of interest for embryologists because of the special topographical relationship with the middle ear and the cell death that occurs in the epithelial plug (Michaels and Soucek, 1989; Nishimura and Kumoi, 1992; Mallo et al., 2000; Masumoto et al., 2010). Likewise, much is known about the osseus part of the external acoustic meatus. In the adult, the lateral, cartilaginous part is about 8 mm long and continuous with the auricular cartilage, while the medial, osseus part is about 16 mm long, and narrower than the cartilaginous part (Williams, 1995). However, at birth, the osseus part is composed of only a small, incomplete ring originating from the squamous part of the temporal bone, i.e., the tympanic ring. After birth, the tympanic ring extends posterolaterally to become cylindrical, growing into a fibrocartilaginous tympanic plate, which forms the adjacent part of the external meatus at this stage (Williams, 1995). With ossification, this fibrocartilage develops into the osseus part. Conversely, even in late-stage fetuses, most or all of the external acoustic meatus is likely to be surrounded by only cartilages.

The cartilages surrounding the external meatus do not seem to be fibrocartilage, but rather elastic cartilage that does not readily ossify. Do they originate from the auricular cartilages? If so, does the tube-like cartilage develop from the superficial side and extend to the deep side of the meatus? In contrast to the osseus part of the external acoustic meatus, there is little information on the fetal development of cartilages surrounding the meatus. According to Kepes and Perentes (1988) and Viale et al. (1988), glial fibrillary acidic protein (GFAP) is expressed in elastic cartilage for some

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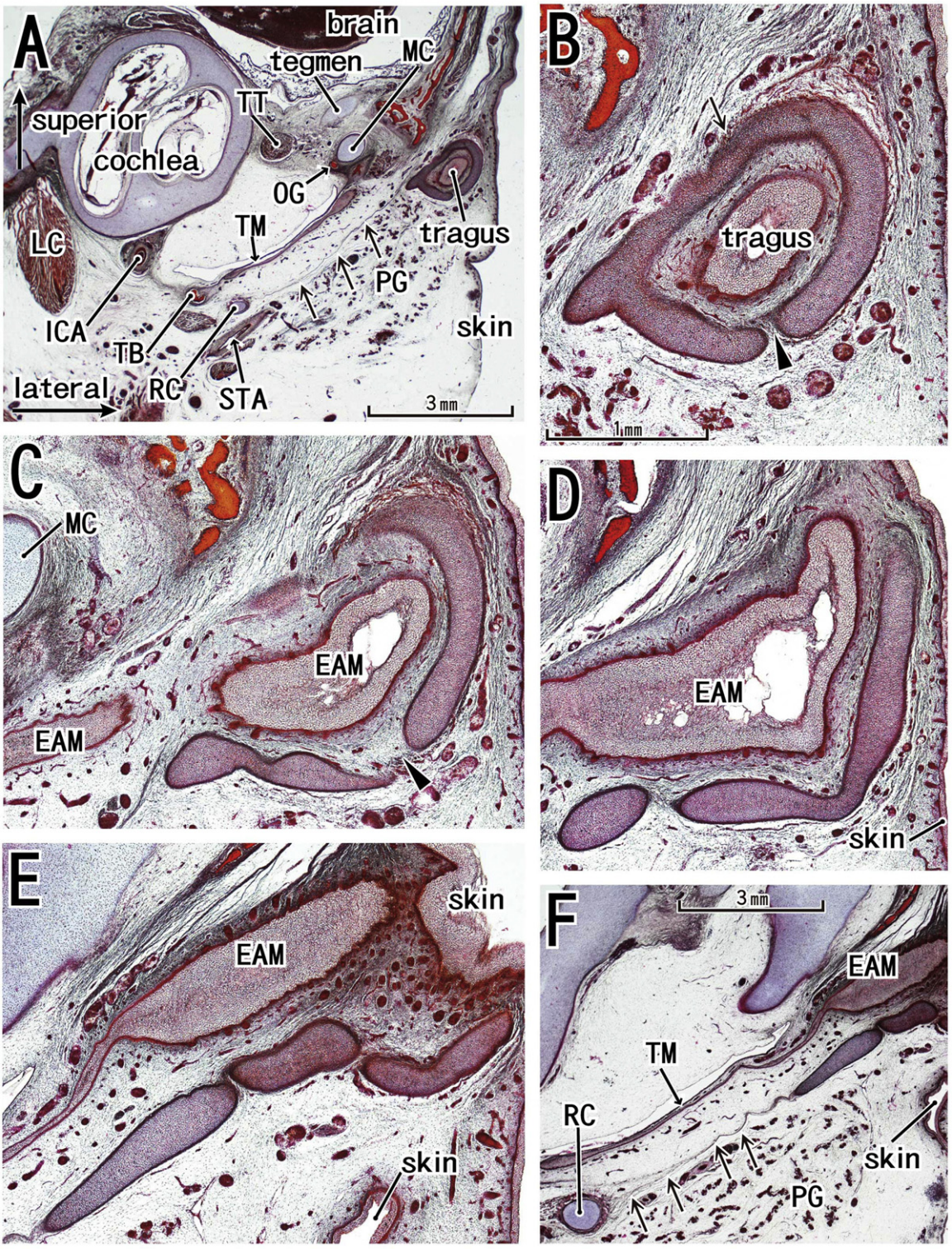

Fig. 1. Cartilage development at the tragus and along the inferior wall of the external acoustic meatus: frontal sections of a CRL 113-mm specimen. HE staining. Panels A and B (and panels E and F) represent the most anterior (and posterior) side in the figure: the distance between panels B and E is 3 mm. Panels A and F display the topographical anatomy at lower magnification (scale bars in panels A and F). Panels B–E are prepared at the same magnification (scale bar in panel B). Panels B and E are higher-magnification views of the external acustic meatus (EAM) in panel A and F, respectively. A ring-like cartilage is evident at the putative tragus (panels A and B). Along this ring, two notches are present (arrow and arrowheads in panels B and C). The tragus cartilage issues a bar- or plate-like process, and these cartilages extend along the inferior wall of the external meatus (panels C–E). A fascial structure is evident (arrows in panels A and F) extending from the second pharyngeal arch [Reichert's] cartilage (RC) to the inferior wall cartilages as well as the tragus cartilage. ICA, internal carotid artery; LC, longus capitis muscle; MC, the first pharyngeal arch [Meckel's] cartilage; OG, os goniale; PG, parotid gland; RC, the second pharyngeal arch [Reichert's] cartilage; STA, superficial temporal artery; TB, tympanic bone; tegmen, tegmen tympani of the temporal bone; TM, tympanic membrane; TT, tensor tympani muscle.