Development of the Human External Ear

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Abstract

External ear development is a lengthy and complex process that extends from early embryonic life until well into the postnatal period. Initial development of the auricle and external auditory canal during the fourth and fifth weeks of gestation is closely associated with anatomical changes involving the pharyngeal arch apparatus of the human embryo. The auricle and external canal are well formed by the time of birth but do not attain their full size and adult configuration until about 9 years of age. Sebaceous and modified apocrine glands, which are responsible for cerumen production, begin their development at about 5 months gestation in association with hair follicles in the outer portion of the external canal. Although they appear anatomically mature before birth, these glands do not reach full functional capacity until puberty.

Key Words: Auricle, embryological development, external auditory canal

As emphasized throughout this special issue, the external ear plays an essential role in auditory function and occupies an important place in the clinical practice of audiology and otology. Its major components, the auricle and external auditory canal, receive sound energy from the environment and provide some degree of directional and frequency selectivity for the incoming sound stimulus. They also serve to protect the tympanic membrane from mechanical injury and from abrupt changes in temperature and humidity. Various abnormalities affecting the external ear, particularly those involving congenital defects, are best understood from a developmental perspective. This article offers a brief overview of pre- and postnatal development of the external ear to serve as a point of departure for further discussion of its anatomy, physiology, and pathology.

External ear development is a process that begins in embryonic life, progresses through the fetal period to the time of birth, and continues postnatally until the age of puberty, when the glands of the external canal become fully functional. (As usually defined, the embryonic phase of human development extends from 2 weeks gestational age up to the seventh or eighth week, while the fetal period is the interval from about 8 weeks gestation to term.)

The embryonic pharyngeal arch apparatus provides the structural foundation for formation of the external ear. As illustrated in Figure 1, the pharyngeal arches are conspicuous external features of the human embryo and are significantly involved in various aspects of head and neck development. The arches are obliquely oriented, rounded ridges separated by prominent grooves or clefts. They correspond to the gill-bearing branchial arches of fishes that are separated by clefts through which water flows for delivery of oxygen to the gills. In mammalian embryos, the pharyngeal arch apparatus never assumes a respiratory function and no communication is normally established between the pharynx and the pharyngeal clefts as occurs in the branchial arch system of fishes. The clefts do, however, come into close relationship with outpocketings of the pharynx known as the pharyngeal pouches. In fact, it is the first of these pouches that eventually elongates to form the tubotympanic recess, from which the eustachian tube and middle ear cavity develop.

By the end of the fourth week of gestation, four well-defined pairs of pharyngeal arches are externally visible in the neck region of the human embryo (see Fig. 1). The first two of these, the mandibular and hyoid arches, are important contributors to external ear development. During the fifth gestational week, nodular swellings of tissue known as the hillocks of His appear on the first and second pharyngeal arches. Six such

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hillocks, three on either side of the first pharyngeal cleft, can be distinguished. Most investigators believe that the auricle is formed by growth, differentiation, and fusion of these six tissue condensations. There is some disagreement, however, as to the exact adult structures that form from the auricular hillocks. The diagram shown in Figure 2 illustrates one widely

Figure 2 A, lateral view of the head of an embryo showing the six auricular hillocks (hillocks of His) surrounding the dorsal end of the first pharyngeal cleft. B, C, and D illustrate the fusion and progressive development of the hillocks into the adult auricle. (Reprinted with permission: Sadler TW. (1985). Langman's Medical Embryology. 5th ed. Baltimore: Williams and Wilkins.)

held view on the origin of the various parts of the auricle. During the initial stages of its development, the auricle is located in the general area of the neck, behind the lower jaw, but by the 20th week of gestation it has moved upward to attain its adult location and overall configuration. In a 4- to 5-year-old child, the auricle is about 80 percent adult size. It reaches full adult size by approximately 9 years of age.

A short time after the appearance of the hillocks of His on the first and second pharyngeal arches, the upper or dorsal portion of the first pharyngeal cleft deepens as shown in Figure 3 to form a funnel-shaped depression that is the precursor of the external auditory canal. At 4 to 5 weeks gestation, the primitive external canal establishes contact with the first pharyngeal pouch, as illustrated in Figure 3A. This contact is soon lost due to proliferation of embryonic connective tissue, which separates the two structures. In the eighth week, the developing external canal deepens further to once again approach the middle ear space. Shortly thereafter, the ectodermal lining of the deep portion of the primitive ear canal proliferates to form a solid tissue structure called the meatal plate (or meatal plug), which fills the medial portion of the canal (see Fig. 3C). The meatal plate ends in a rounded, disc-shaped swelling that lies

Figure 3 Schematic drawings illustrating cross-sections of the embryonic and fetal head at various stages in the development of the external acoustic meatus (or external ear canal, EAC). A and B show the relationship of the first pharyngeal cleft (also known as the first branchial groove as labelled here) to the first pharyngeal pouch at 4 (A) and 5 (B) weeks gestational age. C illustrates the meatal plug filling the deep portion of the EAC at 8 to 10 weeks gestational age. D shows the fully formed ear canal after disappearance of the meatal plug. (Reprinted with permission: Moore KL, Persaud TVN. (1993). The Developing Human: Clinically Oriented Embryology. 5th ed. Philadelphia: WB Saunders.)
immediately adjacent to the middle ear. According to some accounts of external ear development, the meatal plate remains intact until the 21st to 28th week of gestation, when it hollows out due to maturational changes affecting its central cells. Continued canalization of the meatal plate produces the medial two-thirds of the definitive external auditory canal. The innermost portion of the meatal plate becomes the outer layer of the tympanic membrane.

Recent evidence indicates that canalization of the meatal plate may occur considerably earlier in gestation than is widely believed. In a recent study that focused on this question, Nishimura and Kumoi (1992) found that the meatal plate begins to open during the 13th week of gestation and that the external canal is fully patent throughout its entire length in the 18-week fetus. These findings are also consistent with earlier observations from Anson and Donaldson (1973). The timing of canalization of the meatal plate is therefore not yet fully resolved and is an aspect of external auditory canal development that needs further study.

As noted above, the outer, or epidermal, layer of the tympanic membrane is derived from the ectoderm of the meatal plate. The inner layer, facing the middle ear cavity, is a derivative
of the first pharyngeal pouch and the intermediate layer develops as a condensation of embryonic connective tissue (mesenchyme) that separates the inner and outer layers. The three-layered structure of the tympanic membrane is illustrated diagrammatically in Figure 3D.

At the time of birth, the tympanic membrane is nearly horizontal in orientation and the external canal is short (about 20 mm long) and straight. The tympanic membrane reaches its definitive, more vertical position of 50 to 60 degrees from horizontal during the third year of life and, by that time, bone formation around the inner two-thirds of the external canal is nearly complete. The ear canal itself continues to elongate and increase its curvature until about 9 years of age.

Hair follicles in the outer one-third of the external auditory canal make their appearance rather early in the course of development at approximately 17 weeks of gestation. There is little information in the available literature specifically regarding fetal development of the glands of the external auditory canal that are responsible for cerumen production. However, in a study completed some 60 years ago, Simonetta and Magnoni (1937) describe the appearance of sebaceous glands at the 17-week stage in close association with developing hair follicles. According to these investigators, modified apocrine glands (the so-called ceruminous glands) are recognizable shortly thereafter. Figure 4 illustrates developing sebaceous and modified apocrine glands in a human ear canal at 22 weeks gestation. The more mature configuration of these glands is shown in Figure 5. Both types of glands appear structurally complete by 6 months gestational age. However, they do not reach full functional capacity until the time of puberty.

Acknowledgment. The author is grateful to Karen S. Pawlowski for the drawings used in Figure 1 and for histologic processing of the tissue specimens shown in Figures 4 and 5.

REFERENCES


SUGGESTED ADDITIONAL READINGS


