An Extreme Morphologic Variation of the Auditory Tube Cartilage: A Case Report

STEWART R. ROOD, Ph.D.
WILLIAM J. DOYLE, Ph.D.
Pittsburgh, Pennsylvania 15261

The temporal bone, cartilaginous auditory tube, and associated musculature were removed en bloc at autopsy from a 2½-month-old boy and processed histologically. The cartilaginous supporting structure of the auditory tube differed significantly in appearance and morphology from the auditory tubes of individuals with more standard morphology. The hypoplastic, enlongated, medial cartilaginous lamina seen in this specimen may be anatomic evidence of the hypothesized hypercompliant auditory tube ("floppy tube") thought to be at least one factor operative in the development of middle ear disease in children.

KEY WORDS: Temporal bone, auditory tube, middle ear disease, Eustachian tube

Introduction

Descriptions of the normal anatomy of Eustachian or auditory tube appear throughout the medical literature (Graves and Edwards, 1944; Proctor, 1967). However, variability in the anatomic structure of the tube has not been well documented, and much needs to be learned about the ontogeny of the tubal and paratubal regions. Acquisition of information about the development of these two areas will contribute greatly to our understanding of the variability in tubal structure. Our lack of knowledge of tubal structure is due in part to the currently employed techniques for temporal bone removal. As Schuknecht and Kerr (1967) point out, these techniques allow for the inclusion of only incomplete portions of the cartilaginous tube, thus presenting problems with ontogenetic or pathologic studies of this region. Pathological studies have in turn been limited to cases of severe malformation of the middle ear (atresia, cyclopia, anencephaly) in which the tube is sometimes absent, rudimentary, or abnormally narrow (Altman, 1951, 1957).

It is the purpose of this brief report to outline a methodology for the procurement of anteroinferiorly extended temporal bone specimens, which are simply typical temporal bone specimens extended anteriorly and inferiorly to include the cartilaginous auditory tube along with its associated soft tissue and musculature. We also present the results of examining an unusual auditory tube obtained from an individual apparently free of associated middle ear malformations.

Method

An unusual auditory tube was obtained from a 2½-month-old black boy diagnosed as having a coarctation of the aorta and a membraneous ventricular septal defect. At autopsy, the cause of death was determined to be congestive heart failure. Other findings at autopsy were lower nephron nephrosis, congestive splenomegaly, liver and pancreatic abnormalities, and acute congestion and focal hemorrhage of the lungs. The pathologist reported that the body appeared to be "poorly

Dr. Rood and Dr. Doyle are affiliated with the Department of Otolaryngology School of Medicine, and Cleft Palate Center, University of Pittsburgh, Pittsburgh, Pennsylvania.

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nourished," weighing 3.9 kg. No muscle, bone, or connective tissue abnormalities were observed. In addition, no chromosomal aberrations were reported, nor was there any evidence of malformation of the craniofacial complex.

This specimen is one of a series of extended temporal bones being collected in our laboratory. Each bone is removed at autopsy by one of the investigators (WJD) in such a way that the specimen obtained is adequate for study of the auditory tube. Following the removal of the brain, excess connective tissue is cleared from the middle cranial fossa. Using a Stryker saw, four cuts are made which outline the future borders of the tissue block (Figure 1). The first cut is made through the left sphenofrontal suture. A second cut is extended sagitally from the sphenofrontal suture, through the body of the sphenoid, hypophyseal fossa, and clivus to the sphenooccipital synchondrosis. A third cut is made through the petrosaloccipital suture to the jugular foramen. The last cut connects the first and third incisions. Once the block has been cut, it is freed using a chisel. The block is grasped and elevated to expose the carotid sheath (carotid artery and jugular vein), which is then ligated to prevent leakage of embalming fluid. Tissue on the under side of the block is then cut with scissors. The block, which is thus freed, contains the middle cranial fossa, auditory tube, and paratubal soft tissues, including muscles. The blocks are trimmed of excess tissue, fixed in buffered formalin, and decalcified in trichloroacetic acid. The specimens are then embedded in celloidin and sectioned coronally at 30 microns using a sliding microtome. Every 10th section is stained with hematoxylineosin.

Results

We compared findings from this 2½-month-old infant's auditory tube to those from several other specimens. All the tubes were prepared in the manner described above.

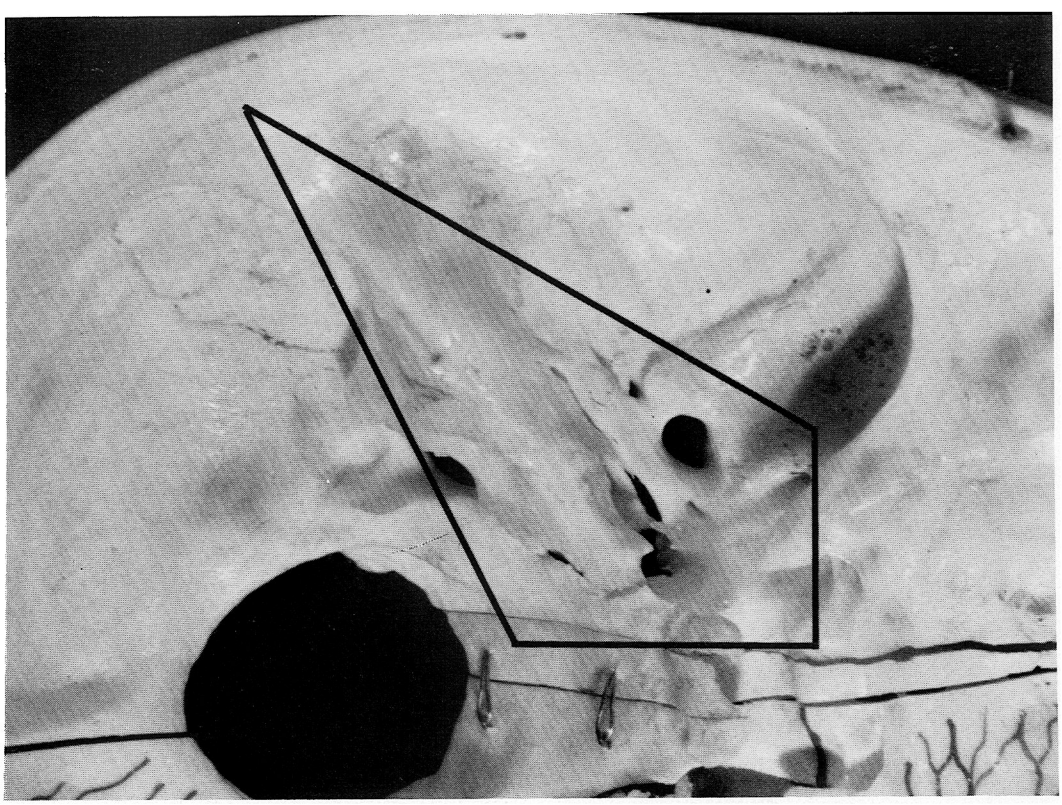

FIGURE 1. A view of the interior of the human skull base. The lines indicate the cuts that are made to recover an extended temporal bone specimen.

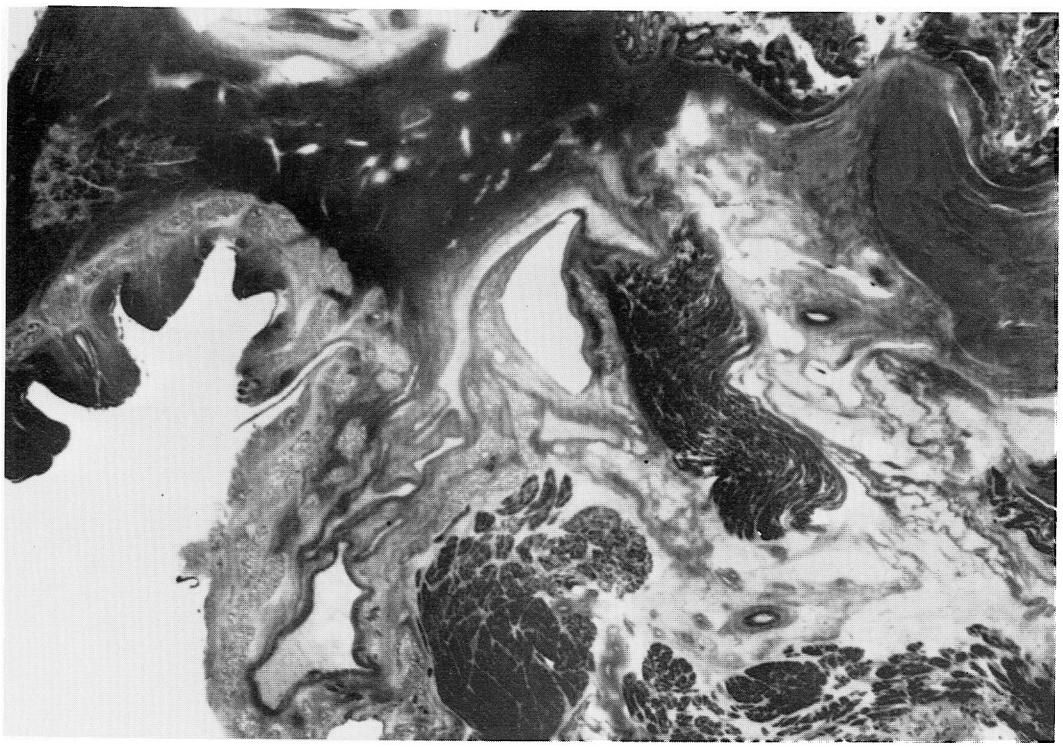

FIGURE 2A. A coronal section of the auditory tube from the three month old specimen. The cartilage appears hypoplastic. The medial lamina is elongated and broken into sections. (Original magnification 13× H & E stain).

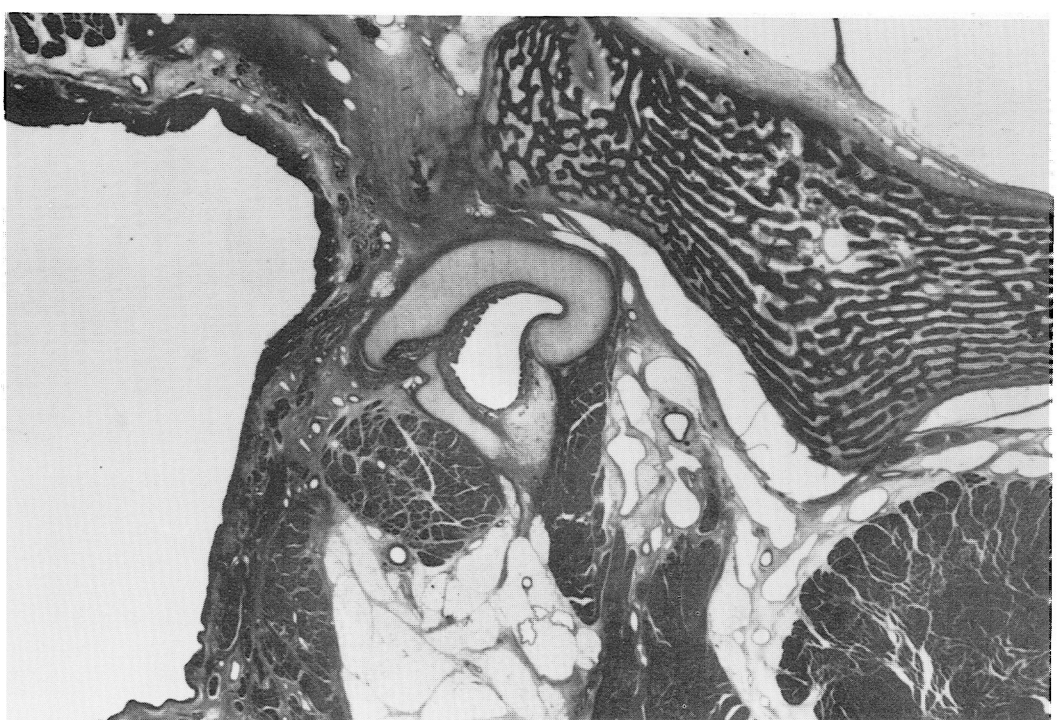

FIGURE 2B. A coronal section of the auditory tube from the one and a half month old specimen. The cartilage is shown to have its typically described "crook-shape". (Original magnification 13× H & E stain).

Figures 2A and 2B are photomicrographics of coronal sections of the auditory tube and related structures in the two specimens.

The morphology and position of the tensor veli palatini and levator veli palatini muscles are similar in the two specimens. Furthermore, the relationship of the auditory tube to the cranial base is also similar. However, whereas the cartilage depicted in Figure 2B is crook-shaped, well developed, and bound by a well-defined perichondrial barrier, the laminae of that presented in Figure 2A are extremely thin, elongated, and tortuous. The unusual auditory tube appears to be fibrous, almost immature in nature (Figure 3A), and lacking a well-defined perichondrium, thus allowing for invasion of the structure by the surrounding tissue. In contrast, the cartilaginous portions of the tubes illustrated in Figure 3B are hyaline (the degree of magnification is limited here because of the thickness of the section).

Discussion

The fibrous-like nature and thin, elongated configuration of the abnormal tubal cartilage may result in a tubal system deficient in support making the auditory tube in this case more compliant and more easily distensible. Bluestone et al. (1972, 1978) postulated the existence of a functionally "floppy tube," one that was hypercompliant, as a result of a lack of, or decrease in, cartilaginous support. The auditory tube cartilage described here may be an example of such a tube.

The question that remains is: Does the morphology of the "cartilage" as described here represent the final or an intermediate (delayed) stage of development? That is, does the morphology as observed represent an extreme of the variability in the structure within a temporal or static context? Support for either position requires an extensive study of the normal development and anatomical variability in the tubal system. We have begun, but do not yet have the answers to these questions. The findings in this one case, however, suggest tentative support for the concept of the "floppy tube" and are worth reporting at this time.

Comparisons of Figures 2A and 3A with Figures 2B and 3B show the differences in

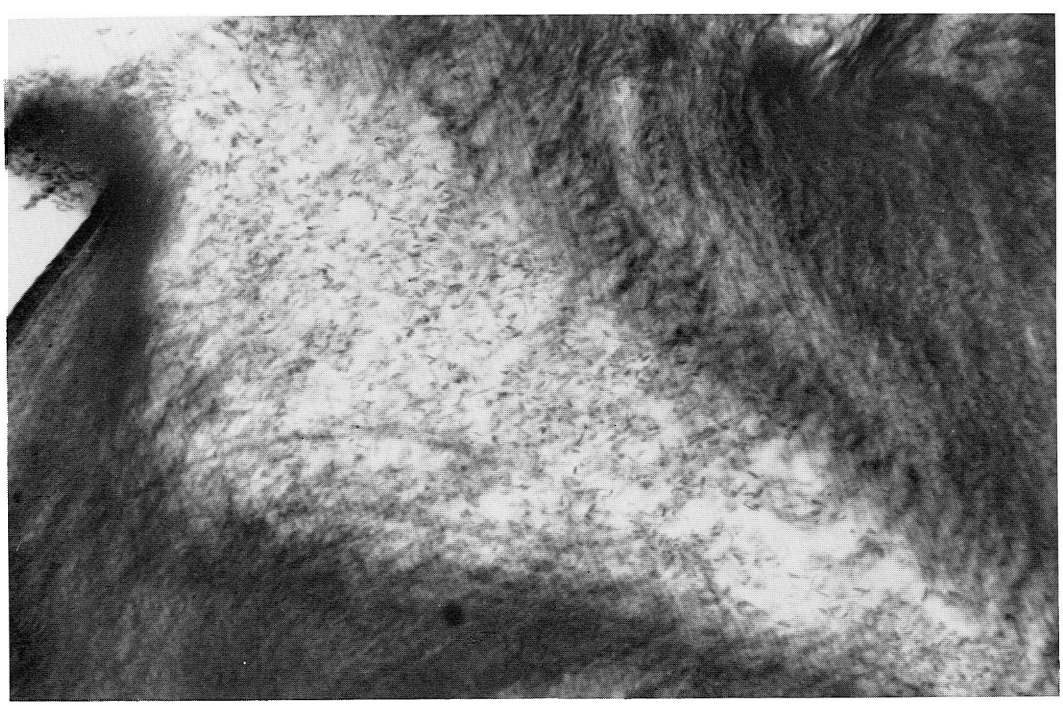

FIGURE 3A. A higher power view of a section of the cartilage illustrated in Figure 2A. Note the fibrous-like appearance and the lack of a well-defined perichondrial boundary. (Original magnification 125× H & E stain).

FIGURE 3B. (1) A higher power view of a section of the cartilage seen in Figure 2B. This area illustrates the common hyaline cartilage characteristics. (Original magnification 125×, H & E stain).

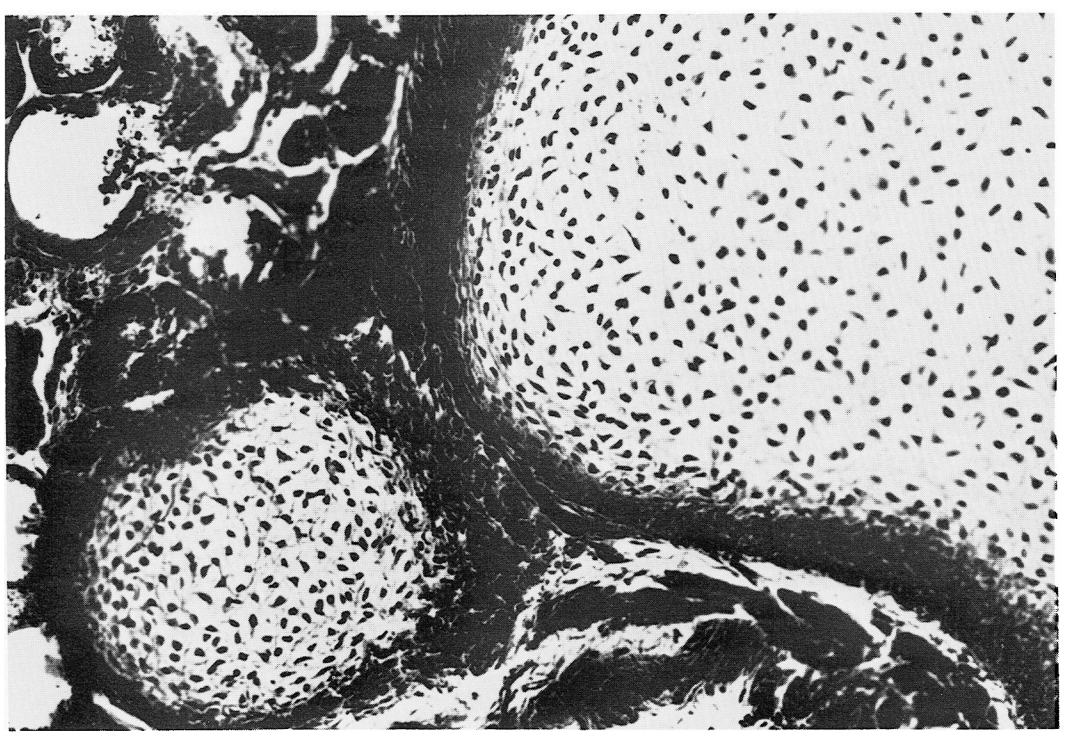

FIGURE 3B. (2). A high power view of a portion of an auditory tube cartilage removed from a two month old female. Again, note the common hyaline morphology. (Original magnification 125×, H & E stain).

structure of the auditory tube evident in the unusual tube, which is also different from that of a normal six-month-old child presented by Holborow (1975). The latter tube, in cross-section, has the common crook-shaped appearance and thick, tear-drop-shaped medial lamina of the other normal specimens in our collection.

Thus, the unusual appearance of the auditory tube cartilage described here is the first published example of an auditory tube in which the cartilage is not of the hyalin or elastic type usually observed but is, instead, of a fibrous-like nature and hypoplastic in appearance. This tube may represent a system in which a physiological dysfunction is based upon an anatomical abnormality.

If one accepts the hypothesis that a hypercompliant auditory tube could lead to middle ear dysfunction, we can imagine at least two pathologic consequences of the abnormalities in this case. If the morphology identified in this patient represents an immature cartilage in a transitional stage of development, the auditory tube-middle ear system may be characteristic of that of the patient who, as a very young child, had repeated bouts of middle ear disease, which decreased with advancing age and the attainment of adequate cartilaginous support. On the other hand, should the morphologic characteristics of the unusual auditory tube described here represent an end-stage, abnormal cartilage that would have been permanently hypercompliant, this child could well have had a chronically pathologic middle ear even into adulthood.

This meager evidence presented here strongly suggests that research directed toward understanding the growth and development of the auditory tube must be actively pursued.

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