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AJNR Am J Neuroradiol 1995, 16 (8) 1703-1706

<http://www.ajnr.org/content/16/8/1703>

This information is current as
of April 18, 2024.

High-Resolution CT of Mastoid Sinus Pneumocele with External Auditory Canal Stenosis

Richard Lichtenberg and Eric J. Russell

Summary: A 34-year-old man presented with tinnitus and conductive hearing loss. CT demonstrated an expansile, air-containing cavity contiguous with mastoid air cells, narrowing the external auditory canal. This is a case of symptomatic pneumocele resulting in an air collection beneath external canal lining, possibly related to an abnormality in mastoid fusion.

Index terms: Mastoid, abnormalities and anomalies; Pneumosinus dilatans; Temporal bone, computed tomography

Pneumoceles are hyperaerated sinuses or individual air cells associated with focal or generalized luminal enlargement and adjacent sinus wall thinning or erosion. The cause of sinus enlargement may be related to an outlet check valve mechanism, but remains unknown (1), despite the fact that sinus enlargement may be arrested by a decompressive surgically created window or "ostomy" (2). *Pneumatocoles* are extraosseous gas collections, which are contained by adjacent soft tissues, usually occurring secondary to trauma, tumor, or infection. They may increase in volume if air enters through a bone defect in the skull base or paranasal sinuses, and air outflow is restricted. *Pneumatocoles* tend to expand until significant intralésional pressure develops, and they become symptomatic by exerting a local mass effect.

We present a case of a mastoid sinus pneumocele presenting with an associated gas collection beneath the lining of the external auditory canal. Because of complete erosion of the roof of the external canal, an air pocket formed outside of the sinus, resulting in a secondary extraluminal pneumocele. This lesion may be related to a developmental abnormality in mastoid fusion.

Case Report

A 34-year-old man presented with a 1-year history of right-sided tinnitus. Otoscopy revealed a mass in the superior aspect of the right external auditory canal, narrowing the canal and compressing the tympanic membrane. Audiometry demonstrated mild right-sided conductive hearing loss. The clinical impression was of cholesteatoma or neoplasm.

Temporal bone computed tomography (CT) was performed (Fig 1). Axial images through the superior aspect of the external auditory canal (Fig 1A) demonstrated an expansile, air-containing cavity on the right, inferiorly confined by canal skin and superiorly connected to prominent mastoid sinus air cells. More-superior axial images (Fig 1B) showed an enlarged air cell in the anterolateral mastoid. Coronal images (Fig 1C) demonstrated downward displacement of canal skin by an air pocket extending medially to the area of the scutum. The air-containing structure was connected to the enlarged mastoid air cells through a dehiscence of the roof of the external canal. The left side was normal. A radiographic diagnosis of mastoid sinus pneumocele was made.

The patient underwent a mastoidectomy and canalplasty. Extensive erosion along the posterosuperior aspect of the mid-external auditory canal was encountered. There was no evidence of infection, cholesteatoma, tumor, or previous trauma. The patient had a routine postoperative course and 5 years later remains essentially asymptomatic.

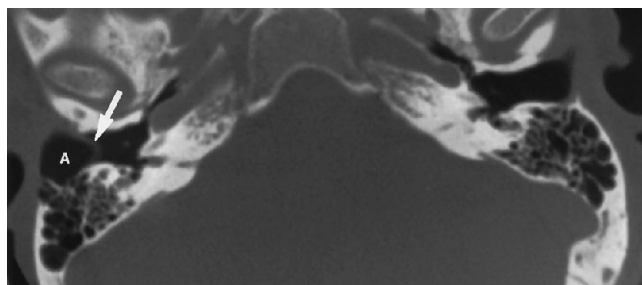
Discussion

The etiology and nomenclature of abnormal air collections in and adjacent to the paranasal sinuses and mastoid air cells have been a source of controversy. Som and Bergeron (2) have distinguished between *hypersinus* (asymptomatic enlargement without bone contour expansion), *pneumosinus dilatans* (an aerated abnormally expanded sinus retaining walls

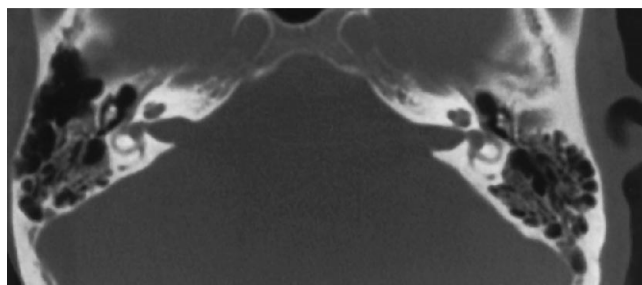
Received August 9, 1994; accepted after revision December 5.

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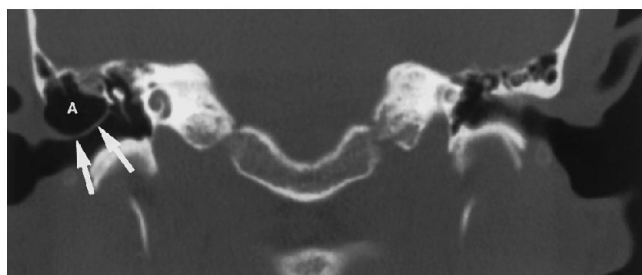
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A



B



C

Fig 1. A, Axial high-resolution CT at the level of the external auditory canal demonstrates an expansile mastoid air cell (pneumocele), contiguous with a pocket of air not contained by bone (pneumatocele) (A) and separated from the right external auditory canal lumen by the displaced canal skin (arrow). Left side comparison is normal.

B, Axial high-resolution CT at the level of the internal auditory canal demonstrates an enlarged air cell in the anterolateral right mastoid and squamous portions of the right temporal bone.

C, Coronal high-resolution CT redemonstrates expansile right-sided air collection (A) with inferior displacement of skin lining the roof of the external auditory canal (arrows). Note continuity with the dehiscent mastoid air cells superiorly.

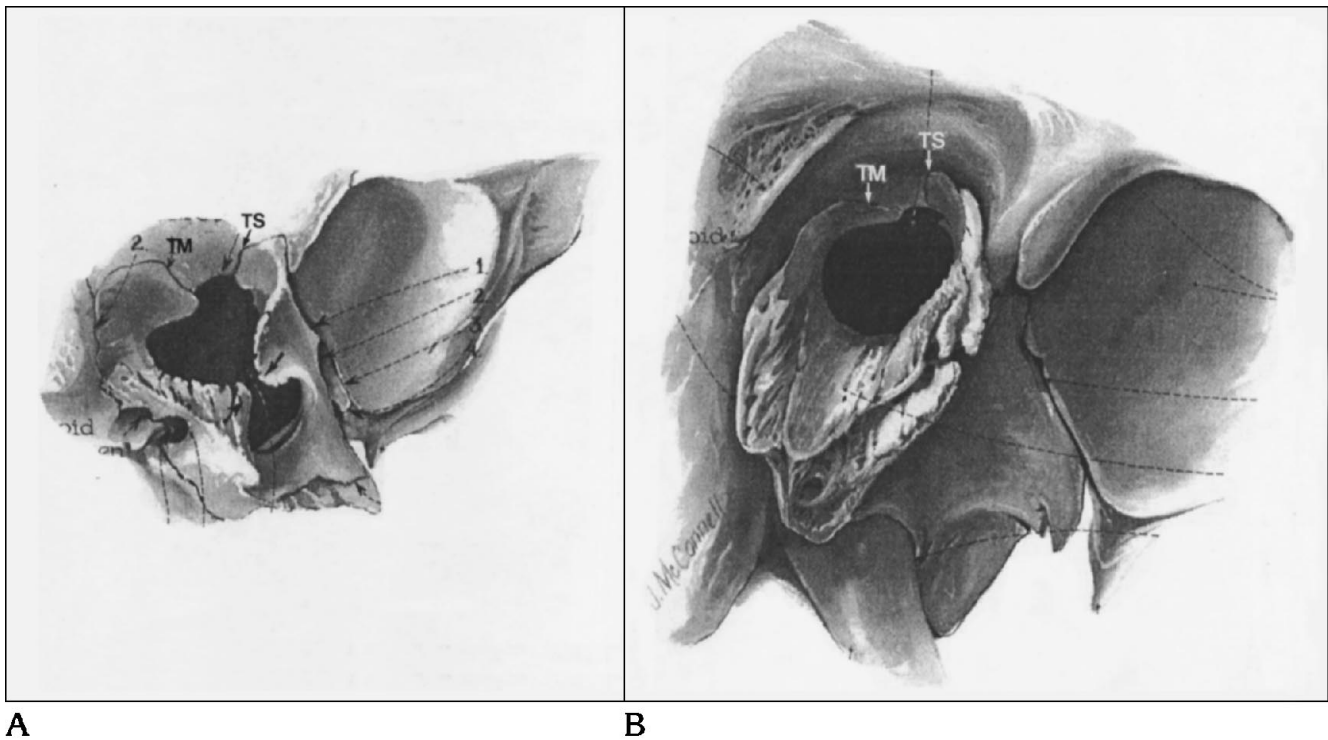
of normal thickness), and *pneumocele* (an aerated sinus with focal or generalized enlargement and sinus wall thinning). Others (3, 4) have advocated *pneumosinus dilatans* as a more descriptive and specific term for a dilated paranasal sinus regardless of cause. *Pneumatocele* (or *aerocele*) refers to a collection of loculated air under tension within the soft tissues outside the confines of an abnormal sinus or air cell. Although the expanded mastoid air cells adjacent

to the air collection in our case suggest the underlying diagnosis of pneumocele, through-and-through erosion of the sinus wall permitted accumulation of free subcutaneous air, blurring the distinction between pneumocele and pneumatocele.

Proposed causes of pneumocele include developmental, inflammatory, neoplastic, and posttraumatic causes. Most authors (3–7) favor an underlying mechanism of partial obstruction at a focal site of bone defect or a sinus ostium, with a one-way ball valve causing air trapping. Associations have been described with such entities as cerebral atrophy, acromegaly, fibrous dysplasia, and arachnoid cysts (3). Spontaneous drainage of a mucocele may also result in such an appearance (8).

Our patient had no history of infection, tumor, trauma, or previous surgery. He presented with tinnitus and conductive hearing loss from a pneumocele associated with extraluminal air compromising the lumen of the external auditory canal (secondary pneumatocele). A review of the literature demonstrates that the majority of pneumatoceles are extracranial and involve the frontoethmoidal region. In the CT era, one case of intracranial epidural air collection arising from spontaneous dehiscence of mastoid air cells adjacent to the sinodural angle has been documented (9).

A recent report (10) of an extracranial pneumatocele arising spontaneously along a mastoid suture resembles the air collection present in our case. The reported patient also had conductive hearing loss with an enlarging soft-tissue swelling displacing the superior skin lining the external auditory canal. CT demonstrated asymmetric mastoid pneumatization with an air pocket extending inferolaterally from the mastoid. During surgical exploration, non-traumatic bone defects were noted at the tympanomastoid and tympanosquamous sutures. Similar definitive surgical findings were not demonstrated in our patient because of extensive destruction; however, our surgical team thought the bone erosion was centered along the posterosuperior aspect of the mid-external auditory canal. Considering this, our CT findings, and the previous report of Levenson et al (10), we believe our case to represent a pneumocele, with air extension into a tympanomastoid sutural defect, which permitted the development of the associated pneumatocele.



A Fig 2. A, Lateral view of tympanic ring formation and temporal bone fusion in the first year of life. Tympanosquamous (TS) and tympanomastoid (TM) suture formation is noted superiorly.

B, Lateral view of an adult external canal with normal fusion at TS and TM sutures superiorly. Defects at these sutures may predispose to air trapping and pneumatocele formation, potentially related to underlying pneumocele formation as in our case (Fig 1C) (from Anson and Donaldson [11]).

The temporal bone consists of three parts: the squamous (anterosuperiorly), the petrous (posteromedially), and the tympanic portions. These, separate at birth, later fuse into a single bone. The mastoid has a dual origin developing postnatally from the squamous and petrous portions. The tympanic portion is a complete ring of membranous bone forming the wall of the external auditory canal. Before fusion, the constituents of the temporal bone are separated by their respective fissures. The line of junction is seen in the form of sutures, most notably the petrosquamosal suture. On pneumatization, this suture forms Körner's septum, dividing the mastoid antrum along developmental origins. The tympanosquamous suture arises in the anterosuperior meatal wall, and the tympanomastoid suture is positioned posteriorly. These two suture lines serve as landmarks for surgical incisions on the external auditory canal (Fig 2).

The utility of high-resolution CT for assessing temporal bone pneumatization and suture fusion is well documented (12). We add this case report to the literature to redemonstrate the

efficacy of this technique for diagnosing a rare developmental anomaly, mastoid sinus pneumocele, and distinguishing it from other causes of external auditory canal stenosis. Spontaneous extracranial accumulation of mastoid sinus origin air (pneumocele) is likely chronic and progressive. It may be related to erosion into an incompletely fused temporal bone suture.

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