Cholesterol granuloma comprises post-inflammatory granulation tissue containing cholesterol crystals and blood. It usually occurs at the petrous apex and in the middle ear cavity, only a few cases arising from the mastoid have been reported [1]. In this article, we describe two cases of histopathologically proven cholesterol granuloma arising from the mastoid.

Case Reports

Case 1
A 51-year-old woman presented with abrupt right-side hearing loss. Otoscopy revealed swelling of the wall of the extra-auditory canal and bulging of its cartilaginous wall. Excision of the wall, preformed at an outside clinic, led to the aspiration of blood. CT scans depicted a large lobulated expansile mass involving the right mastoid antrum and middle ear cavity, and extending to the right posterior cranial fossa. The overlying tegmen tympani and sigmoid sinus plate had bony defects, and there was thinning of the adjacent temporal and occipital bones. The mastoid bone showed sclerosis, and in the middle ear cavity there was underlying chronic inflammation (Fig. 1A). MR imaging of the temporal bone demonstrated a bilobular mass that showed high signal intensity at T1WI and heterogeneous mixed signal intensity at T2WI (Figs. 1B, C, D), and mastoidectomy and tympanopectomy were performed. Histopathologic examination showed that the tumor was a cholesterol granuloma with soft brown fragments which were chronically inflamed and had cholesterol clefts (Fig. 1E).

Case 2
A 26-year-old man complained of right-side hearing impairment which had begun four years earlier. At otoscopy, a dark bluish tympanic membrane was visible, and CT scanning revealed a lobulated soft tissue mass involving most of the right mastoid antrum, and causing osteolytic change to adjacent bone. Underlying chronic inflammation of the middle ear cavity was also noted, and T1- and T2-weighted MR imaging revealed the presence of a high-signal mass (Figs. 2A, B, C). Mastoidectomy was performed, and histopathologic examination showed that the mass was a chronically inflamed cholesterol granuloma with cholesterol clefts, foreign body reaction, and focal necrosis (Fig. 2D).
Discussion

Cholesterol granuloma consists of postinflammatory granulation tissue containing cholesterol crystals and blood. It occurs at the petrous apex and in the middle ear cavity, rarely in the mastoid, and in the context of chronic otitis [1-3]. Its presence in the middle cranial fossa after surgery for chronic otitis media has also been reported [4]. In 1907 Wagner reported cholesterol granulomas in patients with chronic suppurative otitis media. He found mastoid cells, obviously not in free communication with the antrum, which were filled with brownish胶粘like fluid and contained glittering crystals [5].

Cholesterol granuloma formation is due to a lack of aeration, or poor ventilation, which may be caused by the mucosal swelling occurring during the chronic disease of the middle ear. Steinbach and Redianu suggested that important contributory factors are poor ventilation, impaired mucus drainage, and pathologically increased mucus production. They suggested that, in some way, this thick mucus and its solid metabolic waste products are organized and then give rise to granulomas in unaerated portions of the middle ear system [6].

The induction of cholesterol granulomas in experimental animals also helps clarify our understanding of this entity. Ojala and Beaumont obliterated the pneumatic foramen of the chick humerus, permanently occluded with muscle graft or enbucrylate (Histoacryl), after exposing it in the disarticulated proximal humeral joint. The pneumatization process was thus arrested,

Fig. 1. Cholesterol granuloma in a 51-year-old women with sudden right hearing loss. A. Axial temporal bone CT scan shows a large lobulated expansile mass involving the right mastoid antrum and middle ear cavity. B, C. Axial [B] and coronal [C] T1-weighted MR images show a bi-lobular mass with high signal intensity in the right mastoid. D. The mass is of heterogenous mixed signal intensity on T2-weighted MR image. E. Photomicrograph shows many cholesterol-laden macrophages (open arrow) and some cholesterol clefts (solid arrow) [H & E stain, × 100].
and two or three months after surgery cholesterol granulomas were observed throughout the obstructed pneumatic system [7, 8]. Sade reaffirmed that when the ear is chronically underaerated, an inflammatory granuloma with deposits of cholesterol crystals appears [9].

In our two cases of cholesterol granuloma, large lobulated expansile masses involving the right mastoid and the otitis media were present, and high signal intensity was observed at T1- and T2-weighted MR imaging. As described above, otitis media, the cause of poor ventilation leading to cholesterol granuloma formation, was also a feature of our cases.

From the imaging point of view, granulation should be considered as either typical or cholesterol granuloma. Both types appear at CT as nonspecific, nondependent areas of radiopacity, though a few fluid levels may be present. Typically, granulation tissue is vascularized and enhances intensely in the presence of gadolinium at T1-weighted MR imaging. The evaluation of enhanced and unenhanced T1-weighted MR images thus permits, respectively, differentiation from cholesteatoma (no enhancement), and from cholesterol granuloma (bright signal at all sequences) [10].

In conclusion, where T1- and T2-weighted MRI shows that a high signal intensity lesion arises from the mastoid, especially in the presence of underlying chronic otitis, the possibility of cholesterol granuloma should be considered.

References