Imaging Prior to Endoscopic Ear Surgery: Clinical Note

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ABSTRACT: Cholesteatoma is an epidermoid cyst that is characterized by independent and progressive growth with destruction of adjacent tissues, especially the bone tissue, and tendency to recurrence. Treatment of cholesteatoma is essentially surgical. The choice of surgical technique depends on the extension of the disease, and preoperative otoscopic and radiological findings can be decisive in planning the optimal surgical approach. Cholesteatoma confined to the middle ear cavity and its extensions can be eradicated by use of the minimally invasive transmeatal endoscopic approach. Computerized tomography of the temporal bones fails to distinguish a cholesteatoma from the inflammatory tissue, granulations, fibrosis or mucoid secretions in 20–70% of cases showing opacification of the middle ear and mastoid. Using the turbo-spin echo (TSE), also known as non-echo planar imaging (non-EPI) diffusion-weighted (DW) magnetic resonance imaging, cholesteatoma can be distinguished from other tissues and from mucosal reactions in the middle ear and mastoid. Current MRI sequences can support the clinical diagnosis of cholesteatoma and ascertain the extent of the disease more readily than CT scans. The size determined by the TSE/HASTE (half-Fourier acquisition single-shot turbo-spin echo) DW sequences correlated well with intraoperative findings, with error margins lying within 1 mm. Our experience with more than 150 endoscopic surgeries showed that lesions smaller than 8 mm confined to the middle ear and its extension, as depicted by the non-EPI images, can be managed with transmeatal endoscopic approach solely. We call upon our otolaryngologist and radiologist colleagues to use the newest MRI modalities in the preoperative evaluation of candidates for cholesteatoma surgery.

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KEY WORDS: cholesteatoma, surgery, imaging, endoscopic, diagnosis

Cholesteatoma is a cystic lesion covered by stratified squamous cell epithelium over a fibrous stroma of variable thickness, which can contain some elements from the original mucous lining [1]. This epidermoid cyst is characterized by independent and progressive growth with destruction of adjacent tissues, especially the bone tissue, and tendency to recurrence [2]. The annual incidence of cholesteatoma ranges from around 3/100,000 in children to 9/100,000 in adults, and it is more predominant in males [3,4]. The prevalence of cholesteatoma was estimated to be between 0.07% and 0.4% in different Israeli populations [5,6].

The treatment of cholesteatoma is essentially surgical. In the last decade the use of endoscopes dramatically changed the surgical approach to cholesteatoma. The transmeatal endoscopic approach is a minimally invasive technique to expose and excise cholesteatoma confined to the middle ear cavity and its extensions, allowing excellent access to the middle ear structures [7-10]. Cholesteatoma is usually endoscopically accessible when the lesion does not involve the mastoid beyond the level of the lateral semicircular canal [7]. In more extended cases mastoid obliteration techniques can be used [11]. Since the choice of surgical technique depends on the extension of the disease, preoperative otoscopic and radiological findings can be decisive in planning the optimal surgical approach. Preoperative high resolution computed tomography can depict the anatomy of the middle ear and mastoid, predict the involvement of the sinus tympani and facial recess, and has excellent spatial resolution allowing delineation of small soft tissue masses against bony structures and air [12].

Figure 1 presents the case of retraction pocket cholesteatoma correctly diagnosed by CT and operated on exclusively with the transmeatal endoscopic approach. CT of the temporal bones, however, is mostly performed when the ear is inflamed; however, it cannot distinguish a cholesteatoma from inflammatory tissue, granulations, fibrosis or mucoid secretions in 20–70% of cases showing opacification of the middle ear and mastoid [13]. This is the main reason why it is sometimes impossible to diagnose or exclude the presence of a cholesteatoma or to predict its extension on the basis of CT findings alone, and why CT is of little benefit for managing these patients [Figure 2]. However, in cases of partial or complete opacification of the middle ear and mastoid, magnetic resonance imaging can provide essential information on the extension of the lesion and is useful for surgical technique planning and appropriate patient counseling [Figure 2].

Modern MRI techniques increasingly appear to be the imaging study of choice in the preoperative evaluation of a cholesteatoma and in its postoperative follow-up [14-18]. Using the turbo-spin echo, also known as non-echo planar imaging diffusion-weighted MRI, cholesteatoma can be distinguished from other tissues and from mucosal reactions in the middle

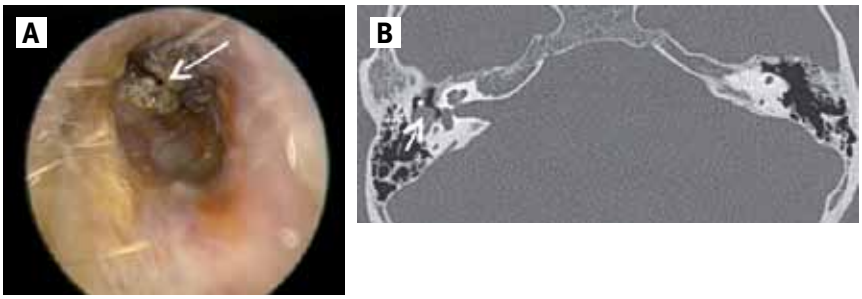


Figure 1. [A] Endoscopic view of a retraction pocket cholesteatoma presenting with right-sided chronic otitis media and moderate conductive hearing loss. **[B]** Preoperative axial CT scan images precisely matching the surgical findings of a cholesteatoma limited to the middle ear with no extension beyond the level of the lateral semicircular canal (arrow)

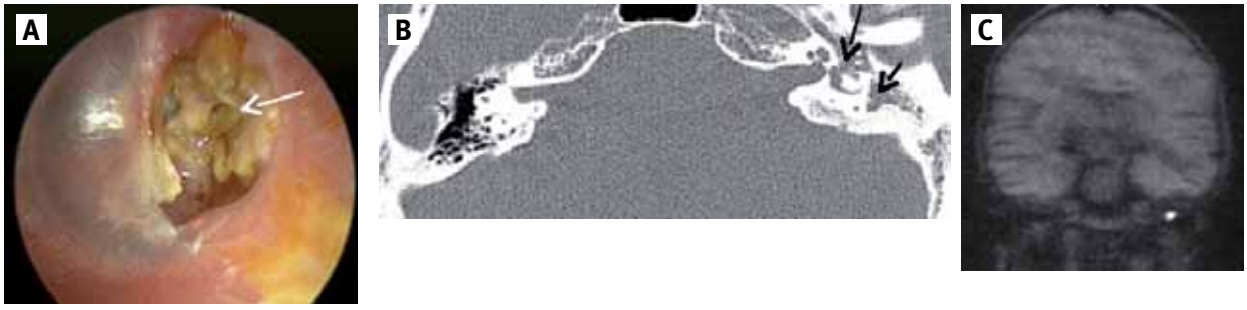
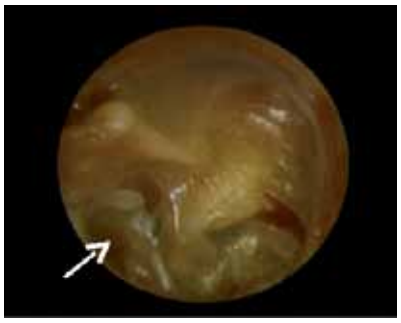


Figure 2. [A] Endoscopic view of a retraction pocket cholesteatoma presenting with an 8 month history of otitis media and mild-to-moderate conductive hearing loss in the left ear. **[B]** Axial CT scan showing complete opacification of the middle ear and mastoid air cells (arrows). **[C]** HASTE coronal images showing a 7 mm hyperintense lesion in the tympanic cavity (arrow). This cholesteatoma was completely excised solely via the transmeatal endoscopic approach

ear and mastoid [15-18]. Current MRI sequences can support the clinical diagnosis of cholesteatoma and ascertain the extent of the disease more readily than CT scans. It was demonstrated that the combination of coronal and axial TSE sections allows precise localization of a cholesteatoma [16,17]. Moreover, by using non-EP DW imaging sequences alone, 2 mm cholesteatoma can be detected [15]. The size determined by the TSE/HASTE (half-Fourier acquisition single-shot turbo-spin echo) DW sequences correlated well with intraoperative findings, with error margins lying within 1 mm [16]. However, it has been reported that certain cholesteatoma or retraction pockets auto-evacuate keratin debris, resulting in "dry cholesteatoma" [Figure 3] that does not produce a restricted diffusion signal on the HASTE DW MRI sequence [15,16]. This is definitely expected considering that the physical basis of DW MRI is restricted motion of water molecules. In cases of a clinical diagnosis of "dry cholesteatoma," the absence of cholesteatoma on the HASTE can favor transmeatal endoscopic removal of the pathology.

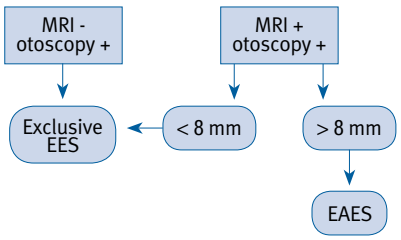
TSE = turbo-spin echo
non-EP DW = non-echo planar imaging diffusion-weighted
HASTE = half-Fourier acquisition single-shot turbo-spin echo

Figure 3. Endoscopic view of a "dry" retraction pocket cholesteatoma after evacuation of the keratin. The patient underwent excision of the retraction pocket with the cholesteatoma matrix, tympanic membrane reinforcement and ossicular chain reconstruction using the transmeatal endoscopic approach



Despite contemporary advanced imaging and surgical techniques, cholesteatoma still remains a diagnostic and surgical challenge. There is no routine single imaging technique that can be considered definitive when considering cholesteatoma surgery. Most patients still arrive for preoperative counseling in our hospital with a CT of temporal bones, and the patients with limited disease are not required to complete the preoperative investigation with MRI. Our personal experience with more than 150 endoscopic surgeries is that lesions smaller than 8 mm confined to the middle ear and its extension, as depicted by the non-EPI images, can be managed with transmeatal endoscopic approach solely. The larger lesions usually require conversion to the retroauricular approach [19]. Some 8 mm lesions may lead to traditional mastoidectomy or combined endoscope-assisted (retroauricular and transmeatal) approach due to the delay between the date of MRI and the date of surgery (approximately 10% in our series). The aggressive behavior of a pediatric and congenital cholesteatoma must be taken into consideration. Patients with retraction pockets with or without

Figure 4. Planning of surgical approach according to the findings of preoperative MRI



EES = endoscopic ear surgery, EAES = endoscope-assisted ear surgery

cholesteatoma visible on otoscopy are encouraged to undergo the HASTE DW MRI sequence. The specimens of our patients with "dry" retraction pockets demonstrated the presence of cholesteatoma despite the fact that MRI failed to depict it. Figure 4 summarizes our experience in planning cholesteatoma surgery according to the preoperative MRI. The transmeatal endoscopic approach can be applied for visible-on-otoscopy lesions measuring less than 8 mm on MRI, for visible-on-otoscopy lesions that are small enough and remain undetected on MRI, and dry or self-evacuated retraction pockets and MRI negative for cholesteatoma. For lesions larger than 8 mm, retroauricular endoscope-assisted mastoidectomy can be planned. In our opinion, to better understand the bony invasion by the cholesteatoma, preoperative CT scan can be helpful, but cannot replace MRI in complicated cases associated with intracranial extension of cholesteatoma, facial nerve-impaired movement, or disequilibrium or deafness. All the images must be interpreted cautiously in view of their limitations since motion artifacts, transplanted fat within the postoperative cavity, cerumen in the external auditory canal or a sebaceous cyst behind the earlobe, can mimic a cholesteatoma [15,17].

Advances in MRI techniques changed the protocols for the preoperative evaluation and the postoperative follow-up for cases of cholesteatoma and resulted in minimizing radiation exposure, especially in children. We call upon our otolaryngologist and radiologist colleagues to use the newest MRI modalities in the preoperative evaluation of candidates for cholesteatoma surgery.

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"Remember, no one can make you feel inferior without your consent"

Eleanor Roosevelt (1884-1962), wife of U.S. President Franklin D. Roosevelt, who served four terms in office. President Harry S. Truman later called her the "First Lady of the World" in tribute to her human rights achievements

"Humanity also needs dreamers, for whom the disinterested development of an enterprise is so captivating that it becomes impossible for them to devote their care to their own material profit. Without doubt, these dreamers do not deserve wealth, because they do not desire it. Even so, a well-organized society should assure to such workers the efficient means of accomplishing their task, in a life freed from material care and freely consecrated to research"

Marie Curie (1867-1934), Polish and naturalized French physicist and chemist, famous for her pioneering research on radioactivity. She was the first woman to win a Nobel Prize, the only woman to win in two fields, and the only person to win in multiple sciences