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ORIGINAL ARTICLE

Diagnosis of recurrent cholesteatoma using diffusion weighted MRI

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KEYWORDS

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Abstract *Objective:* To assess the role of diffusion weighted images (DWI) MRI in differentiating post mastoidectomy recurrent cholesteatoma from infected postoperative granulation tissue.
Materials and methods: 13 patients who performed mastoidectomy for previous cholesteatoma that now presented with clinical and CT signs of recurrence were referred to perform non contrast MRI using T2 and DWI sequences in order to differentiate recurrent cholesteatoma from infected postoperative granulation tissue.
Results: 8 patients showed MRI evidence of recurrent cholesteatoma, findings were confirmed intra-operative, -ve cases showed good response on medical treatment with regression of their clinical and radiological signs.
Conclusion: DWI MRI accurately differentiates recurrent cholesteatoma from infected post operative granulation tissue avoiding unnecessary second look operations.

1. Introduction

Cholesteatoma is an epidermal cyst of the middle ear or mastoid air cells and is filled by desquamated keratin. A cholesteatoma is eradicated from the temporal bone by surgical resection by either radical or modified radical mastoidectomy. The choice of surgical approach depends upon the extension into the middle ear and mastoid cavity and the status of the ossicular chain and tympanic membrane (1). A major disadvantage is the narrow surgical field, a feature that is associated with a high rate of residual and recurrent cholesteatomas (35% and 18%, respectively) (2).

It is difficult to clinically diagnose a recurrent cholesteatoma in a closed postoperative cavity except if a typical white mass is seen under the drum membrane. Thus, second look operations are the accepted management by many otologists. These procedures can be associated with postoperative complications as infection, bleeding, delayed healing, disequilibrium, taste disturbances, hearing loss and facial nerve paralysis. In addition, they are done using general anesthesia with possible anesthesia-related complications (3).

Computed tomography (CT) has been considered the imaging technique of choice for the evaluation of middle ear cholesteatoma in the preoperative cases, however it cannot, differentiate between cholesteatoma, granulation tissue,

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retained secretions or cholesterol granuloma in the postoperative bed (4).

Magnetic resonance imaging (MRI) showed good evaluation capability in the evaluation of the recurrent cholesteatom. Various MR imaging protocols have been proposed that are mainly based on the use of delayed gadolinium-enhanced T1-weighted sequences, diffusion weighted imaging (DWI) sequences, or a combination of both techniques (4).

DWI images are known to have a low spatial resolution, a high-resolution T2-weighted sequence is required to correlate DWI findings with the patient's anatomy. Delayed postcontrast T1-weighted sequence did not show significant increase in sensitivity or specificity in diagnosis of recurrent cholesteatoma (4).

The echo-planar (EP) is the standard technique used in DWI, often used for the early diagnosis of cerebral infarction. In the temporal bone, EP DWI showed limited diagnostic value because of susceptibility artifacts. Non-EP DW imaging which has a slightly longer acquisition time but much less susceptibility artifacts showed a higher sensitivity and specificity for cholesteatoma diagnosis than EP DWI (5).

The aim of this study was to assess the accuracy of noncontrast MRI with DWI to diagnose recurrent cholesteatoma.

2. Materials and methods

2.1. Study population

After the approval of our ethical committee and obtaining informed consent from all patients, thirteen patients (6 male and 7 females) with age range from 23 to 55 years with mean age of 37 years were included in this study between August 2013 and June 2014. All patients previously resected cholesteatoma of the middle ear, now are showing suspicious partial or complete opacity in the operative bed on computed tomography (CT) performed due to recurrence of discharge, pain or progressive hearing loss. The mean interval between the mastoidectomy operation and the CT assessment was 30 months, all patients were further assessed by MRI imaging of the petrous temporal bone on an average of 1-3 weeks after the CT examination, they all tolerated the study that did not exceed about 15 min from the patient's positioning, there were no need for sedation or anaethesia. Positive cases were referred for second-look surgery, while -ve cases received medical treatment and then were followed up using the CT scanning.

2.2. CT protocol

CT examinations of the petrous bone were performed on a 128-section CT scanner (Phillips Ingenuity PET/CT Scanner, Netherlands) with 0.32-mm section thickness. Scan conditions were 140 kV, 300 mA s, and 1 s/rotation in helical mode. All studies were performed without contrast and included the entire petrous bone, reconstruction of the axial and coronal sections was done and all images were evaluated by the same radiologist.

2.3. MRI protocol

MRI was performed using a superconductive Philips scanner (Intera, 1.5Tesla, Philips Healthcare, Best, The Netherlands), following the patients' informed consent and exclusion of contraindications. The following sequences were acquired on the middle ear using an 8 channel head coil and applying the Parallel SENSE imaging is used to obtain better resolution, faster dynamic scans and to reduce susceptibility artifacts.

1. 3D CISS (constructive interference in steady state) with a gradient echo component
   tilt angle: 70°, slice thickness: 0.7 mm, repetition time (TR): 11.5 ms, echo time (TE): 5.75 ms, SENSE factor 2, field of view: 230 mm. Acquisition time 3 min and 50 s.
2. Axial nonecho-planar single shot turbo spin echo diffusion-weighted imaging:
   2.5 mm thick axial slices, TE: 98 ms, TR: 2000 ms, SENSE factor 2, diffusion factor: B 1000 s/mm^2, FOV: 230 mm. Acquisition time 2 min and 50 s,
3. Coronal T2-weighted coronal spin echo (TSE).
   TR/TE, 5270/119 ms; matrix, 512; section thickness, SENSE factor 2, 3 mm; field of view, 230 mm. Acquisition time 3 min and 12 s.

3. Image analysis

CT and MRI images were reviewed by one radiologist not informed about the results of surgery. cholesteatoma was diagnosed by the presence of suspicious opacity in the middle ear on CT. Cholesteatoma was diagnosed on MRI in the presence of high signal intensity on T2-weighted sequences, showing high signal intensity and diffusion restriction on diffusion-weighted imaging without calculation of the ADC value yet the ADC maps were used to exclude the presence of T2 shine through effects. No merging between the CT and MRI images was done. Statistical analysis was done using SPSS 20.0 statistical software (SPSS Inc., Chicago, IL, USA).

4. Results

Thirteen patients (6 males and 7 females) who had been operated for previous cholesteatoma (5 were right sided and 8 were left sided), have now presented with clinical and CT signs of recurrence, noncontrast MRI showed recurrent cholesteatoma (Fig. 1) in 8 patients (61.5%) 3 were right sided and 5 were left sided while 5 patients showed no signs of recurrence (38.5%) 2 were right sided and 3 were left sided, +ve cases underwent surgery that confirmed the diagnosis in all cases with sensitivity, specificity, +ve and -ve predictive value of 100%. The 5 -ve cases were treated conservatively and followed up clinically and by CT scans (Table 1), all showed regressive course that confirmed that the primary opacities seen were mostly postoperative granulation tissue (Fig. 2). the average size of cholesteatomas detected by DWI was ±4.8 mm, we did not encounter lesions less than 3 mm, there were no false positive or negative cases in this study group.

5. Discussion

Cholesteatomas are either primary or secondary acquired chronic inflammatory lesions of the middle ear and mastoid. The destructively and erosive epithelium requires complete surgical excision. The pathogenesis of cholesteatoma as well as the