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Original Article

Is diffusion-weighted magnetic resonance imaging (DW-MRI) a requirement for suspected cholesteatoma in patients to undergo primary surgery?

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Abstract

Aim: In this study, the aim was to investigate the correlation of preoperative diffusion-weighted magnetic resonance imaging (DW-MRI) with postoperative pathology findings in patients undergoing tympanomastoidectomy with suspicion of primary cholesteatoma.

Materials and Methods: The study consisted of the retrospective evaluation of preoperative MRIs, surgical findings and pathology results of patients who underwent tympanomastoidectomy and had preoperative DW-MRI at the Department of Otorhinolaryngology between the years 2017 and 2019.

Results: The study was conducted with 199 patients who underwent tympanomastoidectomy surgery. A retrospective examination of patient files revealed that 80 (40.2%) of the patients underwent echoplanar diffusion-weighted magnetic resonance imaging (DW-MRI) because of suspected cholesteatoma in the preoperative period. Of these 80 patients, cholesteatoma was detected in 22 (27.5%) as a result of pathological analysis and/or surgery, but no diffusion restriction was found in MRI interpretation; in 44 (55%) of them, both cholesteatoma in pathological analysis and/or surgery and diffusion restriction in MRI interpretation were detected. In 10 (12.5%) of these 80 patients, cholesteatoma was not detected either in the MRI interpretation or in the pathological analysis and/or surgery. In the remaining 4 (5%) patients, there was a cholesteatoma suspicion in MRI, but it was not detected as a result of pathological analysis or surgery. In this study, the sensitivity of MRI for the diagnosis of cholesteatoma was 66.6%, and its specificity was 71.4%.

Conclusion: MRI provides moderately (66.6%) reliable information in the diagnosis of cholesteatoma patients. However, it is more reliable (71.4%) when it comes to exclusion of the disease. Therefore, it should not be used as the sole determining factor in patients who will undergo primary surgery with suspected cholesteatoma. As much as our study results provide guidance for a more accurate use of imaging methods, series with higher numbers of patients are needed.

Keywords: Chronic otit; cholesteatoma; diffusion-weighted magnetic resonance imaging

INTRODUCTION

Cholesteatoma comprises epidermal inclusion cysts in the middle ear, petrous apex and mastoid cells covered with keratinized squamous epithelial cells and containing squamous debris (1). Despite being benign lesions, they are capable of concentric expansion and may damage surrounding tissues. Middle ear structures may cause bone erosions in the mastoid and petrous apex, which in turn brings about inner ear, facial nerve and intracranial complications (2). In most cases, the diagnosis of cholesteatoma is based on clinical examination only, especially on otoscopic and microscopic and/or endoscopic findings. Where it is not possible to diagnose cholesteatoma by clinical examination alone, radiological examinations are used to determine the type of surgery to employ. In case of clinical and radiological suspicion of cholesteatoma, the patient should be operated on as early as possible.

Radiological examinations are important in the diagnosis of cholesteatoma, in planning of surgery and in post-operative follow-up. Computed tomography (CT) provides useful information about middle ear bones, facial nerve, semicircular canals and other important anatomical formations, but it has a lower specificity for soft-tissue lesions such as cholesteatoma, middle ear scar, cholesterol granuloma, mucosal swelling and even secretion (3-6). On the other hand, conventional magnetic resonance imaging (MRI) can hardly distinguish cholesteatoma from other soft tissues or mucoid secretions (7). However,

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diffusion-weighted magnetic resonance imaging (DW-MRI) delivers a better diagnostic performance in detecting cholesteatoma in comparison to CT and conventional MRI (8). Diffusion-weighted MRI with the echoplanar and non-echoplanar imaging technique was demonstrated to be reliable for the diagnosis of cholesteatoma in various studies (9-11).

The aim of this retrospective study was to evaluate the accuracy of echoplanar DW-MRI in the diagnosis of cholesteatoma prior to tympanomastoid surgery.

MATERIALS and METHODS

This study was approved by the Experimental Ethics Committee (2020/922). In this retrospective study, patients who underwent tympanomastoidectomy at the Inonu University Department of Otorhinolaryngology between 2017 and 2019 upon a diagnosis of chronic otitis media and preoperative MRI for suspected cholesteatoma were included. It was found that MRI was performed on 80 (40.2%) of the 199 patients who underwent tympanomastoidectomy. The mean time between MRI and surgery was 4.19 (0.5-18) months. The female patients made up a 44.5% of the sample, while the male patients constituted 55.5%. The mean age of the patients was 34.4 (7-78) years. Patients with primary surgery were included in the study.

At our clinic, patients with a diagnosis of chronic otitis media are routinely given a temporal bone CT in the preoperative period. Moreover, DW-MRI is performed on patients with suspected cholesteatoma in clinical examination and imaging. Patient characteristics were recorded including age, sex, history of any cholesteatoma surgery, pathology result, surgical findings and preoperative MRI findings.

Imaging was performed with 3 different MRI devices as echoplanar: 3 Tesla Siemens Skyra (TE: 78 MS, TR: 5900 ms, number of sections: 25, section thickness: 2.5 mm, matrix: 44 x 90, 3-way diffusion sequence with b value 50, 400, and 800), 1.5 Tesla Siemens Avanto (TR: 4000 ms, TE: 95 ms, number of sections: 15, section thickness: 3 mm, matrix 160 x 100, 2-way diffusion sequence with b value 0 and 1,000) and 1.5 Tesla Philips Achieva (TR: 1000 ms, TE: 90 ms, section thickness 2 mm, number of sections 18, matrix 132 x 85, 2-way diffusion sequence with b value 0 and 1,000).

Restricted diffusion in MRI was evaluated as the presence of cholesteatoma. The surgeons were preoperatively informed about the radiological results. The findings during surgery were recorded by the surgeon as the presence/absence of cholesteatoma. Furthermore, tissue samples from the mastoid bone and middle ear were sent for pathological analysis, which then confirmed the intraoperative diagnosis of cholesteatoma through histological examination. As a result of the comparison of MRI findings to surgery and histological diagnosis, the patients were divided into four categories: true positives (TP), false positives (FP), true negatives (TN) and false negatives (FN). The positive and negative predictive values of MRI were calculated on the basis of these data obtained from the classification (TP, FP, TN and FN). According to these results, calculations were made for sensitivity: [(TP/TP + FN) × 100]; specificity: [(TN/TN + FP) × 100]; positive predictive value (PPV): [(TP/TP + FP) x 100]; negative predictive value (NPV): [(TN/TN + FN) x 100], and efficiency: [(TP + TN) / (TP + TN + FP + FN) × 100].

Written informed consent was obtained from the patients or their relatives prior to surgery, and the principles of the Declaration of Helsinki were followed in all steps of the study.

RESULTS

In 27.5% (n=22) of the 80 patients included in the study, cholesteatoma was found in pathological analysis and/or surgery, but restricted diffusion was not found during the interpretation of MRI. On the other hand, in 55% (n=44) of the patients, cholesteatoma was detected in pathological analysis and/or surgery, and restricted diffusion restriction was found in MRI. In 12.5% (n=10) of these 80 patients, cholesteatoma was not detected either in MRI or pathology and/or surgery. Finally, in 5% (n=4) of the patients, cholesteatoma was suspected in MRI, but it was not detected in pathological analysis or surgery (Table 1.). In the study, the values found for MRI in the diagnosis of cholesteatoma were as follows: sensitivity: 66.6%, specificity: 71.4%, PPV: 91.6%, NPV: 68.7% and efficiency: 67.5%.

Table 1. Magnetic resonance imaging in the diagnosis of cholesteatoma

		Surgery / pathological diagnosis		
		Disease positive	Disease negative	TOTAL
Magnetic Resonance Imaging	Positive	44	4	48
	Negative	22	10	32
	TOTAL	66	14	80

DISCUSSION

With early diagnosis of cholesteatoma, surgical treatment becomes more functional and effective (1,12). When the diagnosis is unclear, and/or the exact size/location of the lesion is not known, surgery has little chance of success (12,13). High-resolution CT and DW-MRI are the most common imaging techniques used in the diagnosis of cholesteatoma (13,14). Conventional MRI techniques (T1, T2, postgadolinium) have limitations in distinguishing cholesteatoma from cholesterol granuloma, granulation tissue, fibrosis or hemorrhage (15,16). However, the ability of CT to distinguish between cholesteatoma and other soft tissue pathologies is quite limited (15,16). In fact, high-resolution CT proved inadequate in the diagnosis of recurrent or residual cholesteatoma (43% sensitivity and 48% specificity) (15). Studies support DW-MRI as a reliable diagnostic tool for previously unoperated and recurrent/residual cholesteatoma and have found surgery as an appropriate option for the latter (17).

In the diagnosis of primary or recurrent/residual cholesteatoma, two DW-MRI techniques are frequently used: echoplanar (EPI) DW-MRI and non-echoplanar (non-EPI) DW-MRI. Previously published studies showed that the non-EPI technique had more benefits than the EPI technique (18-20). After all, the non-EPI technique could respond well in the presence of significant challenges, such as poor spatial resolution and the presence of radiological artifacts secondary to the air-bone interface of the skull base, which inevitably complicated the use of the EPI (17). However, one of the most important differences between these two techniques was at the minimum size of cholesteatoma they were capable of detecting (15,19,21). This size was 5 mm for the EPI technique and 2 mm for the non-EPI technique.

Garcia-Iza et al. found the sensitivity of DW-MRI for primary cholesteatomas as 86.7%, this was 97.1% for recurrent/ residual cholesteatomas, and the specificity values were 66.7% and 88.9%, respectively (17). Another study found a hyperintense signal compatible with cholesteatoma in 89% of patients with a sensitivity, specificity, positive and negative predictive values of 81%, 100, 100 and 40, respectively, for DWI in their primary surgical patients group (22). In our study the sensitivity and specificity of DW-MRI were 66.6% and 71.4%, respectively. In another study, 33 patients were evaluated with non-EP DW MRI. They concluded that non-EP DW MRI cannot replace second-view surgery when residual cholesteatoma is excluded 9 months after primary surgery (23). In another study, congenital cholesteatoma was evaluated by DW-MRI. It was detected correctly in 71% of 24 patients. False negative results were given in 7 patients (24).

In this study, we obtained 4 false positives and 22 false negatives. In the histological/surgical examination of these 4 FP cases, polyps were found in 2 patients, tympanosclerosis was found in 1 patient, and cholesterol granuloma was detected in the remaining 1 patient. In the literature, abscess or purulent tissues, hematic residue, silicones as plugs and bone powder and dental implants that cause the formation of an artifact were defined as common causes of false positives (17). As a matter of fact, it is important to keep in mind that not all brightness in DW-MRI is cholesteatoma. Such high signals may have various reasons. The main determinant for false negatives is the size of cholesteatomas. Diagnosis becomes harder in mural cholesteatomas and cholesteatomas smaller than 2-3 mm. Mural cholesteatomas sometimes spontaneously lose their keratin content completely following surgery. Even in a cyst surrounded by epithelium, diffusion positivity might not be observed as a result of the keratin content (24). In another publication, cholesteatoma restricted to the retraction pouch was the cause of false negativity (25). One of the conclusions in our study was that a prolonged waiting period (4.19 months) between MRI and surgery increased false negatives. Our study had its limitations. First of all, the number (80) of patients was limited. The size of the cholesteatomas was not measured during surgery. This hindered evaluation of the size of the cholesteatoma and its detectability with MRI.

CONCLUSION

As a result, MRI provides moderately accurate (66.6%) information in the diagnosis of cholesteatoma patients, while providing more reliable information for exclusion of the disease (71.4%). In conclusion, where cholesteatoma is clinically suspected in a patient to undergo primary ear surgery in the light of these data, an MRI result alone to the effect that no cholesteatoma is found should not change plans on surgery. False negativity should definitely be evaluated in MR results, especially if there is a retraction pouch. In the light of these data, clinical guidance of MR for primary surgery is considered rather low. Clinical examination and CT may be sufficient for the decision of surgery. It may be helpful in evaluating patients with congenital cholesteatomas or complications. The benefit for the patient is of primary importance in evaluating the presence of post-surgical residual and recurrent cholesteatoma and recovery following the second operation. As much as our study results provide guidance for a more accurate use of imaging methods, series with higher numbers of patients are needed.

Conflict of interest : The authors declare that they have no competing interest.
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