Egyptian Journal of Ear, Nose, Throat and Allied Sciences xxx (2017) xxx–xxx

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Contents lists available at ScienceDirect

Egyptian Journal of Ear, Nose, Throat and Allied Sciences

journal homepage: www.ejentas.com

Original article

Evaluation of diffusion weighted MRI sequence as a predictor of middle ear cleft cholesteatoma: Imaging, operative and histopathological study

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ARTICLE INFO

Article history:
Received 5 December 2016
Accepted 8 January 2017
Available online xxxx

Keywords:
Diffusion weighted MRI
Cholesteatoma
Tympanomastoidectomy
Revision surgery
Second look

ABSTRACT

Objectives: Non-echoplanar imaging (Non-EPI) MRI has been recently introduced to improve the detection of small sized cholesteatoma and decrease different artifacts occurring in the echo-planar diffusion weighted image (EPI DWI) technique. It is a time saving procedure in comparison to the delayed post-contrast imaging. We prospectively assessed the diagnostic accuracy of Non-EPI-DW sequences in the detection of middle ear cleft cholesteatoma.

Material and methods: Forty patients suspected to have cholesteatoma were collected from the ENT out-patient clinic of a tertiary referral center. Twenty patients underwent primary mastoid surgery, ten patients scheduled for revision mastoid surgery, while the remaining patients underwent second look operation after one year of their first surgery. All patients underwent Non-EPI-DW sequences prior to their planned surgery. Diagnosis of cholesteatoma was based on evidence of a hyperintense lesion on diffusion-weighted images that were correlated with the surgical findings and histopathological examination, which was used as the gold standard for diagnostic confirmation. Sensitivity, specificity and predictive values of MRI were estimated.

Results: Diffusion weighted imaging accurately predicted the presence of cholesteatoma in 88.2% of cases, and it correctly excluded it in 100% of cases. Sensitivity, specificity, positive and negative predictive values were 88.24%, 100%, 100% and 60%, respectively. Non-echo-planar DWI has been shown to have a high sensitivity and specificity for detecting recurrent cholesteatoma.

Conclusions: Non-echoplanar DWI is an effective technique in cholesteatoma diagnosis. It is capable of detecting lesions larger than 2 mm.

1. Introduction

A simple definition of cholesteatoma is skin at the wrong place with retention of keratin; which frequently recurs and naturally erodes the structures of the middle and inner ear.[1] The diagnosis of cholesteatoma is based on clinical findings, in which otoscopy and otomicroscopy play a major role.[2] It might be obscured by a polyp or granulation tissue, which makes it difficult to access with direct human vision.[3,4] In these circumstances meticulous preoperative assessment of the temporal bone is crucial for diagnosis and planning of the surgical procedure.[5] Preoperative radiological studies of the temporal bone play an important role in the diagnosis and management decisions of cholesteatoma. High resolution computed tomography (HRCT) of temporal bones is mandatory for the initial preoperative evaluation of the extension of cholesteatoma and for correct surgical planning, but it cannot differentiate between various types of middle ear cleft opacifications as it has poor specificity.[6,7] This is the reason that clinicians seek alternative imaging modalities for better evaluation of the various types of tissues that may be present in the middle ear cleft.[7,8] Magnetic resonance imaging (MRI), including delayed post contrast T1-weighted MRI and echo planar (EPI) diffusion weighted (DW) MRI, has emerged as an alternative technique, especially in ruling out residual or recurrent disease after cholesteatoma surgery.[3]

Recent studies have investigated the possibility of screening for residual and/or recurrent cholesteatoma by use of the non echo-planar diffusion weighted images (Non-EPI DWI) sequence as the

Peer review under responsibility of Egyptian Society of Ear, Nose, Throat and Allied Sciences.

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http://dx.doi.org/10.1016/j.ejenta.2017.01.004
2090-0740/

Please cite this article in press as: Bassiouni M.A.K., et al. Evaluation of diffusion weighted MRI sequence as a predictor of middle ear cleft cholesteatoma: Imaging, operative and histopathological study. Egypt J Ear Nose Throat Allied Sci (2017), http://dx.doi.org/10.1016/j.ejenta.2017.01.004

only sequence in the imaging protocol.[9–11] The high cost of delayed post contrast T1 weighted MRI (DPI) techniques in terms of examination time and contrast material administration can be avoided. Therefore the technique is fast, cost effective, and reliable, with easy to interpret findings, and does not involve injection of paramagnetic contrast material.[4]

Non-EPI techniques have more recently been proposed for the reliable detection of smaller cholesteatomas with a size limit as small as 2 mm; even those surrounded by inflammation were seen, as the sequence only highlights the keratin inside the cholesteatoma.[9] It is highly probable that the lack of susceptibility artifacts, thin slice thickness and the higher resolution allow it to detect these small cholesteatomas.[7,12] Although use of Non-EPI DWI screening after surgery implies additional coast, many second look operations with negative results could be avoided.

The lack of clear visualization of the anatomical landmarks of the temporal bone by Non-EPI DW images can be regarded as one of the major drawbacks of the sequence. However, exact location of a residual cholesteatoma in postoperative ears still has to be determined with the standard sequences, including late post-gadolinium T1-weighted images, so both sequences appear to be complementary by some authors. On other hand, precise anatomical location and accurate images of cholesteatoma could be achieved by fusion of CT images with diffusion-weighted MRI images. But still the best visualization of anatomic landmarks and the cholesteatoma is directly through intra-operative assessment.[13]

In this study, we aimed to assess the diagnostic accuracy of Non-EPI-DW MRI in the detection of cholesteatoma in suspected cases of middle ear cleft cholesteatoma. Our hypothesis was that we could avoid unnecessary surgery if MRI proved to be reliable to exclude recurrence. We also desired to avoid CT when possible in order to reduce radiation dosage to this specific area and to evaluate the possibility of shortening MRI examination time using DWI instead of delayed post gadolinium sequences.

2. Material and methods

2.1. Patient selection

This prospective study was conducted from January 2012 to June 2014 on 40 patients presenting with chronic suppurative otitis media attending the outpatient clinic of the E.N.T department of a tertiary referral hospital. These patients were clinically suspected to have cholesteatoma and planned for tympanomastoidectomy. Operations were performed as follows: 20 patients underwent primary mastoid surgery, 10 patients scheduled for revision mastoid surgery, the other 10 patients underwent second look operation after one year of their primary surgery.

2.2. Ethical consideration

The Ethical Committee of Faculty of Medicine approved the protocol of the study prior to its start. An informed consent was taken from each patient involved in the research prior to his/her participation.

2.3. Radiological evaluation

All patients had preoperative high resolution CT scan and Non-EPI Diffusion weighted sequence MRI of temporal bone.

2.4. Intraoperative procedure

Under operative microscope the middle ear cleft was mapped for the presence of various pathological tissues. Suspected tissues were harvested for pathologic verification.

2.5. Histopathological examination

The specimens were fixed in 10% buffered formalin. A representative section from each specimen was cut and processed for paraffin embedding. Five micron thick sections were prepared from the paraffin-embedded blocks and were subjected to the conventional H&E stain for microscopic examination to confirm the presence or absence of cholesteatoma.

2.6. The imaging results were compared to intraoperative findings and histopathological examination

The sensitivity, specificity, positive predictive value [PPV] and negative predictive value [NPV] were then calculated.

2.7. Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. Qualitative data were described using number and percent. Quantitative data were described using range (minimum and maximum) mean and standard deviation for normally distributed data while abnormally distributed data were expressed using median. Comparison between different groups regarding categorical variables was tested using Chi-square test. When more than 20% of the cells have expected count less than 5, correction for chi-square was conducted using Fisher's Exact test. Agreement of the different predictors with the outcome was used and was expressed in sensitivity, specificity, PPV, NPV and accuracy. Significance of the obtained results was judged at the 5% level.

3. Results

Three definitive diagnostic methods were used for cholesteatoma detection in this study (Non-EPI-DW MR images, intraoperative assessment, histopathological examination). Table 1 shows the detailed results obtained from all diagnostic methods done in the 40 patients.

The histopathological examination was used as the gold standard for diagnostic confirmation. The performance of each method used compared to that of the gold standard and was assessed separately as follows:

3.1. Cholesteatoma detection by histopathological examination

Cholesteatoma was confirmed by histopathological examination in 85% of the cases (34 out of 40 patients and distributed as follows: 16 underwent primary tympanomastoidectomy, 8 underwent second look operation and 10 cases underwent a revision tympanomastoidectomy) and there was no cholesteatoma in 15% of the cases in which 4 had primary tympanomastoidectomy and 2 underwent second look operation.

3.2. Cholesteatoma detection by Non-EPI-DW MR image

Diffusion weighted imaging accurately predicted the presence of cholesteatoma in 88.2% (30 out of 34) of the cases (13 underwent primary tympanomastoidectomy, 8 had second look operation and 9 cases underwent a revision tympanomastoidectomy), and it correctly excluded it in 100% of the cases.

3.3. Intraoperative detection of cholesteatoma

Intraoperative detection of cholesteatoma occurred in 91% (31 out of 34) of the cases (14 had primary tympanomastoidectomy,

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