The Role of Mri Diffusion Weighted Images in Assessment of Cholesteatoma

Abdallah Mohammed El Kheshen[1], Ali khalaf mahrous[2], Hussien Montaser Roshdy[1] and Hamza Mohammed Abd Elazem[1]

[1]Radio-Daiagnosis Department, Sayed Galal University Hospital, Faculty of Medicine, Alazhar University, Cairo, Egypt
[2]Otorhinolaryngology Department, Faculty of Medicine, Alazhar University, Cairo, Egypt
abdulaziz.oraby@gmail.com

Abstract: Background: CT is the primary tool for the evaluation of the extent and complications of middle ear cholesteatoma. However, it is inaccurate in differentiation of cholesteatoma from granulation or fibrous tissue as well as other middle ear pathologies e.g. cholesterol granuloma. MRI can be a beneficial tool in the confirmation or exclusion of cholesteatoma. **Aim of the Work:** The aim of work is to evaluate the role of MRI diffusion weighted images in the assessment of cholesteatoma. **Patients and Methods:** 30 patients with cholesteatoma suspected clinically or by CT examination or known patients with cholesteatoma with suspected post-operative recurrence were tested by MR thin cut multi-shot EPI diffusion weighted images of the skull base that were acquired by using a 1.5-T Achieva system in our department. **Results:** Our study revealed that the use of thin cut multi-shot EPI is a beneficial tool in the evaluation of both primary and recurrent cholesteatoma with excellent specificity that reduces the need of second look surgeries in multiple cases. It also revealed improved sensitivity and smallest detectable size compared to SS-EPI techniques. However, it shows relatively less sensitivity compared to non-EPI techniques with the smallest detectable size being about 4.5 mm. **Conclusion:** DWI is a beneficial tool in the evaluation of both primary and recurrent cholesteatoma with excellent specificity that reduces the need of second look surgeries in multiple cases. The use of multi-shot diffusion weighted techniques improved its sensitivity significantly compared to single shot techniques. It still could not detect lesions smaller than 4 mm.
[Abdallah Mohammed El Kheshen, Ali khalaf mahrous, Hussien Montaser Roshdy and Hamza Mohammed Abd Elazem. **The Role of Mri Diffusion Weighted Images in Assessment of Cholesteatoma.** *Researcher* 2018;10(7):16-20]. ISSN 1553-9865 (print); ISSN 2163-8950 (online). http://www.sciencepub.net/researcher. 3. doi:10.7537/marsrsj100718.03.

Key words: DWI, MRI, EPI, MS, SS, Cholesteatoma.

1. Introduction

Cholesteatomas are enlarging collections of keratin within a sac of squamous epithelium and may be congenital or acquired. Congenital cholesteatomas compose only 2% of middle ear cholesteatomas {1}. Middle ear cholesteatoma is a common inflammatory disease requiring prompt surgical treatment to prevent local and intracranial complications due to the activation of osteoclastic function. The diagnosis is generally based on clinical presentation, otoscopic examination, and audiometry. CT scan is used routinely to assess disease extension before surgery. Nevertheless, when the global picture is nonspecific and differential diagnosis is needed, MRI can be used {2}. CT is an excellent image test to show anatomy but cannot differentiate between soft tissue middle ear pathologies and cholesteatoma {3}. MRI has dramatically improved in the last two decades in the field of otolaryngology, acquiring high-definition images of the head and neck and particularly in the detection of cholesteatoma {4}. There are different DW MRI techniques, which include echo-planar imaging (EPI) DW MRI and non-EPI DW MR, which are useful in the evaluation of primary or recurrent cholesteatoma {5}. DWI is a valuable tool to prevent unnecessary second-look surgeries in patients suspected for cholesteatomas and is therefore a reliable alternative to CT{1}In addition DWI MRI is extremely useful for the assessment of possible complications such as erosion of the semicircular canal or invasion of the membranous labyrinth or the middle cranial fossa and to assess abscess formations {1} DWI can be used for distinguishing scar tissue, granulation tissue, and inflammatory changes from cholesteatoma in patients with prior cholesteatoma resection, particularly when CT findings are equivocal. Newer DWI techniques with thinner section acquisition and decreased susceptibility artifacts allow detection of small lesions. The DWI technique may be used in place of second-look surgery, sparing patients the morbidity of repeat exploration. {5}

2. Patients and Methods

Between November 2017 and june 2018, a total of 30 patients were included in this study. the study was conducted on patients with cholesteatoma suspected clinically or by CT examination or known patients with cholesteatoma with suspected post-

operative recurrence at Al Azhar university hospitals. The patients were referred from the department of otolaryngology Al Azhar University hospitals. The patients were investigated using magnetic resonance imaging (MRI). The Study place at Sayed Galal hospital -Al Azhar University -Cairo-Egypt. For the MRI examination, a 1.5 Tesla Philips (Acheiva} MRI machine. Inclusion criteria include Any age, Both sexes and Cholesteatoma suspected clinically or by CT examination or known patients with cholesteatoma with suspected post-operative recurrence. Exclusion criteria include Patients with contraindication to MR imaging (e.g. pacemaker, metallic implant, severe claustrophobia). The patients was subjected to Consent taking, History taking, Previous CT if available were obtained for comparison, Checking for contraindication to MRI imaging (e.g. pacemaker, metallic implant, severe claustrophobia), Cleaning of the external ear from wax and other secretions to avoid false positive results. Patients will lie supine and Patients are asked to breathe quietly and not to move for the duration of the scan.

MRI protocol:

MR images of the skull base or upper neck were acquired by using a 1.5-T system with the manufacturer's head coils. The images of the selected patients were obtained in thin cut (3 mm) axial and coronal planes acquiring DWIs (TR=2662, TEd=88, FOV=220/104). Multi-shot echo-planar diffusion-weighted images (EPI DWI) with b factors of 0 and 1000 s/mm2. ADC mapping was also be obtained. Additional sequences were added according to the findings such as T1 and T2 weighted images. Total imaging time: 15–20 minutes.

Image Interpretation:

Cholesteatoma was diagnosed by 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.

3. Results

Demographic Data:

The studied population included 30 patients, 10 females (33%) and 20 males (67%). The median age group was 32 years with 8 patients under the age of 20 years old (27%), 2 patients between the ages of 20 to 30 years old (6.5 %), 14 patients between the ages of 30 to 40 years old (47%), 2 patients between the age of 40 to 50 years old (6.5%) and 4 patients above the age of 50 years old (13%).

Surgical Data:

From the 30 cases, 25 cases (83%) underwent previous primary mastoid surgery (60 % canal wall up and 40 % canal wall down surgery) while 5 cases (17%) had no previous surgical history.

Clinical Data:

From the 30 cases, 19 had symptoms on the right side (63%), 9 on the left side (30%) and 2 on both sides (7 %). All cases (100%) complained of painless otorrhea while 20 cases (67%) complained of variable degrees of hearing loss.

MRI Data:

From the 30 cases, 19 cases (63%) showed areas of DWI restriction within the middle ear denoting primary or recurrent cholesteatoma. The smallest size of cholesteatoma detected was 4.5 mm.

Intra-operative and/or follow up data:

All 19 cases that showed evidence of primary or recurrent cholesteatoma on MS-***EPI*** DWI MRI images underwent primary or second look mastoid surgery will all cases (100%) showing intra-operative and/or histopathological evidence of cholesteatoma. Of the 11 cases that were negative for cholesteatoma on DWIs, 9 of these cases underwent primary or second look mastoid surgery with 4 cases (44 %) showing small cholesteatomas measuring less than 4 mm (that were not visualized by DWIs) while the other 5 cases (56%) showed only granulation and/or ***inflammatory*** tissue with no evidence of cholesteatoma. The other 2 cases that didn't undergo surgery after MRI imaging were treated medically with significant improvement of their symptoms.

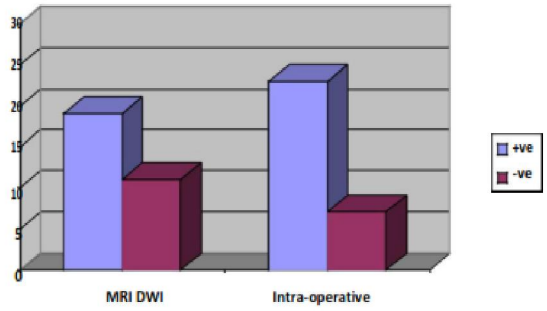

Fig.1: Chart Diagram of the number of positive and negative cases for cholesteatoma by MS-EPI MRI and intra-operative/ follow up.

Correlation of MRI data with intra-operative/ follow up data:

On comparison of the data produced by MS-EPI DWIs to those produced by intra-operative data/histopathology or follow up, the MS-EPI DWI shows the following diagnostic value according to our study in the detection of primary or recurrent cholesteatoma.

4. Discussion

When assessing DWI in the evaluation of cholesteatoma, investigators have used a wide range of techniques from traditional spin-echo EPI-based to

TSE-based techniques such as HASTE and BLADE (Siemens, Erlangen, Germany). These techniques use a similar method for encoding diffusion, but are different in the method of image acquisition. This methodology significantly impacts the sensitivity to factors such as bulk or physiologic motion and field inhomogeneities ***{5}.***

The current study was done to highlight the diagnostic value of Multi-shot Echo-planar DWI in the detection of middle ear cholesteatoma. The results were compared to intra-operative data during mastoid surgeries and/ or follow up data Sensitivity of thin cut MS-EPI in detection of cholesteatoma according to our study was 82 % which is considerably better than other studies using SS-EPI such as **Vercruysse et al., 2006** (12.5%){6}, **Jeunen et al., 2008** (54%){7} and **Venail. et al, 2008** (60%) {8} and comparable to other studies using MS-EPI such as **Yamashita et al., 2011** (76%). However the sensitivity of ourstudy was less than other studies using Non-EPI DWI such as **Dubrulle et al., 2006** (100 %) {9} and **De Foer et al., 2008** (90%) {10}. It was also relatively less than other studies using delayed post-contrast MRI such as **Ayache et al., 2005** (90%{11}) and **Venail. et al, 2008** (90%){12}.

Specificity of MS-EPI in detection of cholesteatoma according to our study was 100% which correlates well with multiple previous studies using both EPI and Non-EPI techniques.

Table 1: Table showing the diagnostic value of MS-EPI DWI in detection of cholesteatoma according to our study.

Sensitivity	82 %
Specificity	100 %
Positive Predictive value	100 %
Negative predictive value	63 %
Accuracy	86 %
Least size of cholesteatoma	4.5 mm

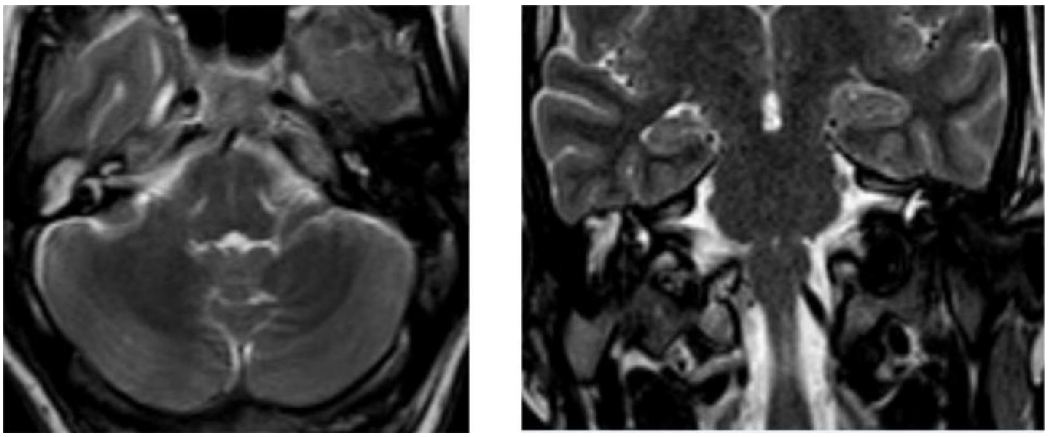

Fig. 2:. Axial and Coronal T2 images: show diffuse T2 hyperintensity within the right middle ear cavity.

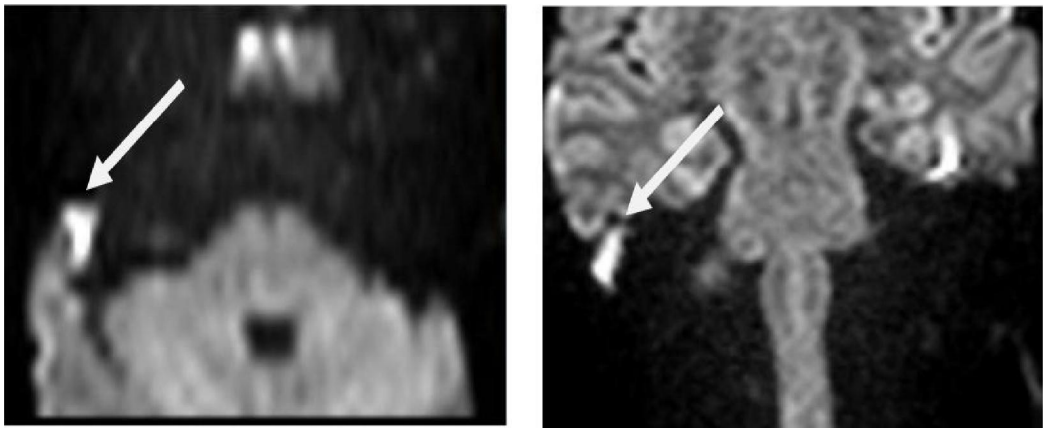

Fig. 3:. Axial and Coronal DWIs: show a large area of diffusion restriction within the right middle ear cavity measuring 11 mm.

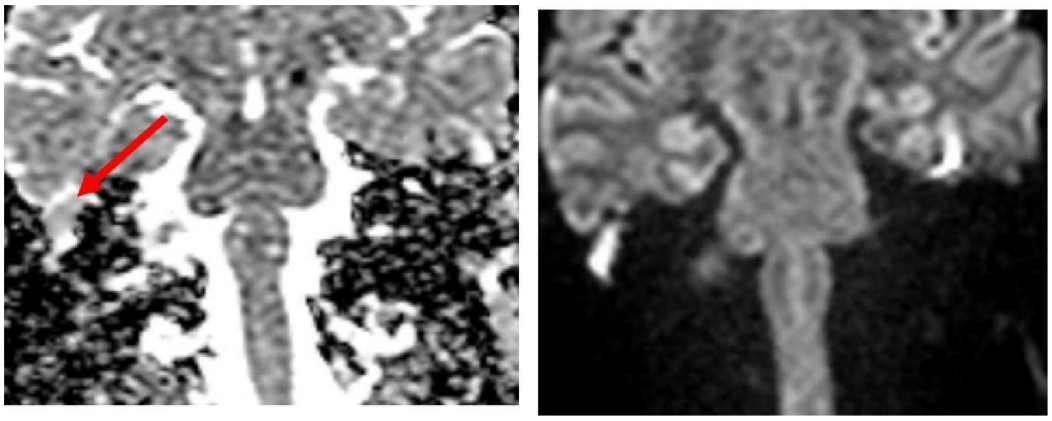

Fig. 4: Case 1. Coronal ADC map: shows a corresponding area of low signal within the right middle ear cavity.

However, MS-EPI DWIs show relatively less sensitivity compared to non-EPI techniques with the smallest detectable size being about 4.5 mm. Authors such as Migirov et al., 2009 stated that leaving such small cholesteatomas is considered safe, and some authors propose follow-up studies to detect these lesions once they have grown larger. The necessity for such follow-up studies and the interval at which they should be performed, are issues still to be determined. In addition, Non-EPI DWIs is unavailable in many MR imaging systems including our system, while MS-EPI requires no special installation and is, therefore, widely available.

5. Conclusion

Cholesteatoma is a common middle ear pathology that can be congenital or acquired. It may cause serious complication such as hearing loss, facial nerve paralysis or intra-cranial complications in advanced cases.

It is mainly diagnosed by otologic examination yet CT examination is essential to confirm the diagnosis in some cases as well as assess its extensions for proper surgical excision. However, CT is poor in differentiation of cholesteatoma from other middle ear pathologies e.g. cholesterol granuloma or granulation tissue in post-operative setting.

MRI examination was advocated to confirm the diagnosis of cholesteatoma and differentiate it from post-operative granulation tissue. Delayed post contrast T1 images were used but showed low sensitivity for smaller lesions as well as patient inconvenience due to delayed imaging after 30-45 minutes. In recent years, diffusion weighted sequences have been used in diagnosis of cholesteatoma due to its bright signal on DWIs. Investigators have used a wide range of techniques from traditional spin-echo EPI-based to TSE-based techniques such as HASTE and BLADE. In our study we used thin cut multi-shot EPI diffusion weighted images in the assessment of cholesteatoma suspected clinically or by CT examination or known patients with cholesteatoma with suspected post-operative recurrence. It showed good sensitivity and excellent specificity in detection of cholesteatoma when compared to intra-operative and/or follow up findings yet it could not detect lesions smaller than 4 mm. The use of multi-shot techniques improved its sensitivity compared to single shot images yet it is still relatively less than non-EPI techniques.

References

1. Henninger B, Kremser C.: Diffusion weighted imaging for the detection and evaluation of cholesteatoma. World J Radiology 2017; 9(5): 217-222.
2. Mas-Estelles F,. Mateos-Fernandez M, Carrascosa-Bisquert B, de Castro FF,. Iciar PR, and Morera-Perez C, “Contemporary non-echo-planar diffusion-weighted imaging of middle ear cholesteatomas,” Radiographics, 2012 1197–1213.
3. Lin JW, Oghalai JS. Can radiologic imaging replace second-look procedures for cholesteatoma? Laryngoscope. 2011;121:4---5.
4. Casselman J. Diffusion weighted MRI (DW-MRI) techniques. Foreword Neuroradiol. 2010;52:771---2.
5. Schwartz KM, Lane JI, Bolster BD, Neff BA: The Utility of Diffusion-Weighted Imaging for Cholesteatoma Evaluation. AJNR Am J Neuroradiol, March 2011 32:430 –36.
6. Vercruysse JP, De Foer B, Pouillon M, Somers T, Casselman J, Offeciers E.: The value of diffusion-weighted MR imaging in the diagnosis of primary acquired and residual cholesteatoma:

a surgical verified study of 100 patients. Eur Radiol. 2006;16:1461- 1467.
7. Jeunen G, Desloovere C, Hermans R, Vandecaveye V.: The value of magnetic resonance imaging in the diagnosis of residual or recurrent acquired cholesteatoma after canal wall-up tympanoplasty. Otol Neurotol. 2008; 28:16-18. 14.
8. Venail F, Bonafe A, Poirrier V, Mondain M, Uziel A.: Comparison of echo-planar diffusion-weighted imaging and delayed postcontrast T1-weighted MR imaging for the detection of residual cholesteatoma. AJNR Am J Neuroradiol. 2008;29: 1363-1368.
9. Dubrulle F, Souillard R, Chechin D, Vaneecloo M, Desaulty A, Vincent C.: Diffusion-weighted MR imaging sequence in the detection of postoperative recurrent cholesteatoma. Radiology. 2006;238:604-610. 13.
10. De Foer B, Vercruysse JP, Pilet B, et al.: Single-shot, turbo spin-echo, diffusion-weighted imaging versus spin-echo-planar, diffusion-weighted imaging in the detection of acquired middle ear cholesteatoma. AJNR Am J Neuroradiol. 2006 Aug. 27(7):1480-2.
11. Ayache D, Williams MT, Lejeune D, Corre A.: Usefulness of delayed post-contrast magnetic resonance imaging in the detection of residual cholesteatoma after canal wall-up tympanoplasty. Laryngoscope. 2005 Apr. 115(4):607-10.
12. Venail F, Bonafe A, Poirrier V, Mondain M, Uziel A.: Comparison of echo-planar diffusion-weighted imaging and delayed postcontrast T1-weighted MR imaging for the detection of residual cholesteatoma. AJNR Am J Neuroradiol. 2008;29: 1363-1368.

7/7/2018