

# Role of Diffusion weighted images - MRI for primary and recurrent middle ear Cholesteatoma- Original article.

## AUTHORS:

- **First author, Corrospounding author: Dr. Janki Jaradi- Associate professor, Department of Radiology, GCS Medical college, Hospital and Research center- Ahmedabad.**  
**6/12, Umasut Flats, opp. Godavari nagar Part-1, Vasna, Ahmedabad- 380007.**  
**Email id: [janki\\_jaradi@yahoo.com](mailto:janki_jaradi@yahoo.com).**  
**Contact No: 9023017318/ 9825785745**
- **Second author: Dr. Chinmayee Biswal- Assistant professor, Department of Radiology, GCS Medical college, Hospital and Research center- Ahmedabad.**
- **Third author: Dr. Keval Makwana, Consultant Radiologist, Ahmedabad.**

## ABSTRACT

### BACKGROUND AND OBJECTIVES:

Untill now, HRCT Temporal bone is preffered imaging modality for middle ear pathology prior to surgical exploration of ears with cholesteatoma. But it lacks specificity. The aim of this study is to understand the role of DWI (Diifusion Weighted Images) in detection, evaluation and diagnosis of primary and recurrent middle ear cholesteatoma and to correlate with intraoperative findings.

### METHODS

A prospective study in which 30 patients who presented to the Department of ENT and diagnosed to have cholesteatoma by clinical , otoscopic and audiometry examination were subjected to HRCT temporal bone followed by DWI- MRI screening of the temporal bone and data was analyzed using standard statistical methods.

### RESULTS

DWI- MRI is having a high sensitivity for identification of the disease at most of the sites within the temporal bone except for the incus , stapes and facial nerve canal region .

### CONCLUSION

DWI- MRI scan acts as an excellent preoperative as well as postoperative imaging modality for diagnosis of primary and recurrent middle ear cholesteatoma .

**KEY WORDS:** Cholesteatoma , Diffusion weighted images (DWI), Chronic Suppurative Otitis Media (CSOM)

## INTRODUCTION

Cholesteatoma (unsafe type of CSOM) is a potentially serious condition as it can progressively give rise to serious intracranial or extracranial complications. In 1982, High Resolution Computed Tomography (HRCT) scanning for temporal bone was first introduced and became imaging modality of choice as it allows detailed imaging of anatomy and a screen for impending/threatening complications. But it lacks specificity when soft tissue is present as it can't differentiate between granulation tissue and residual cholesteatoma. Until recently, Postcontrast T1-weighted MR imaging has been advocated as an effective technique for distinguishing granulation tissue from residual cholesteatoma as cholesteatomas do not enhance post contrast. With this technique residual lesions less than 3 mm are not well visualized and it is inconvenient for patients and decreases practice efficiency. With advanced research, it is found that the high content of keratin of cholesteatoma is associated with restricted diffusion. Few studies are done advocating DWI for evaluation of residual or recurrent cholesteatoma following mastoidectomy. The present study was conducted to evaluate how accurately DWI- MRI scanning can be used for diagnosis of primary and recurrent middle ear cholesteatoma and can alter the surgical plan and outcome with better patient management.

## OBJECTIVES

1. To identify the role of DWI-MRI in evaluation and diagnosis of middle ear cholesteatoma.
2. To compare the preoperative findings DWI-MRI with intra-operative findings.

## Review of the Literature <sup>[1]</sup>

Initially used EPI-DWI technique was limited by large section thickness, susceptibility artifacts from the skull base, and low resolution. These EPI images were generally effective for detection lesions 4 or 5 mm, but EPI frequently missed smaller lesions. This led Vercruyse et al and Venail et al to advocate concurrent use of DWI, considered more specific, and postcontrast T1-weighted images, which were more sensitive. Non-EPI techniques have more recently been proposed for the reliable detection of smaller cholesteatomas. These non-EPI DWI techniques have the advantage of smaller section thickness and better resolution and are less degraded by susceptibility artifacts. In 1 study, De Foer et al evaluated, with SS TSE DWI, 21 patients strongly suspected of having a middle ear cholesteatoma and found 19 of 21 cholesteatomas. The false-negative cases included a cholesteatoma sac and a cholesteatoma in a child whose images had motion artifacts. The authors did note that lack of anatomic landmarks of the temporal bone on this sequence was a drawback. De Foer et al, in a different study, evaluated 32 consecutive patients with SS TSE DWI sequences 10–18 months after primary cholesteatoma surgery with canal wall up mastoidectomy and detected 9 of 10 residual cholesteatomas, measuring 2-6 mm, missing only one 2-mm lesion in a motion-degraded study. Dhepnorrarat et al detected and localized cholesteatomas by using SS TSE DWI in all 7 of 22 patients undergoing second-look surgery

with recurrent disease, with cholesteatomas ranging from 3 to 9 mm. Lehmann et al compared PROPELLERDWI with ASSET single-shot EPI-DWI by using a 3T imaging unit. The 3T PROPELLER technique was associated with better sensitivity, specificity, and positive and negative predictive values for the detection of recurrent cholesteatoma. This improvement over the ASSET technique was thought to be due to artifact reduction, especially important at 3T, though PROPELLER DWI can be performed only with axial sections, which does not optimize visualization of the tegmen region.

## METHODOLOGY

**Source of data:** Patients attending the E.N.T. OPD of GCS Medical College & Hospital and diagnosed as middle ear cholesteatoma by clinical, otoscopic and audiometry parameters were sent to the Department of Radiodiagnosis for HRCT of temporal bone and were screened with DWI- MRI with their full informed consent. Patients were screened on GE Signa explorer 1.5T 16 Channel MRI machine.

**Study design:** A prospective cross-sectional descriptive study.

**Sample size:** 30 cases were studied.

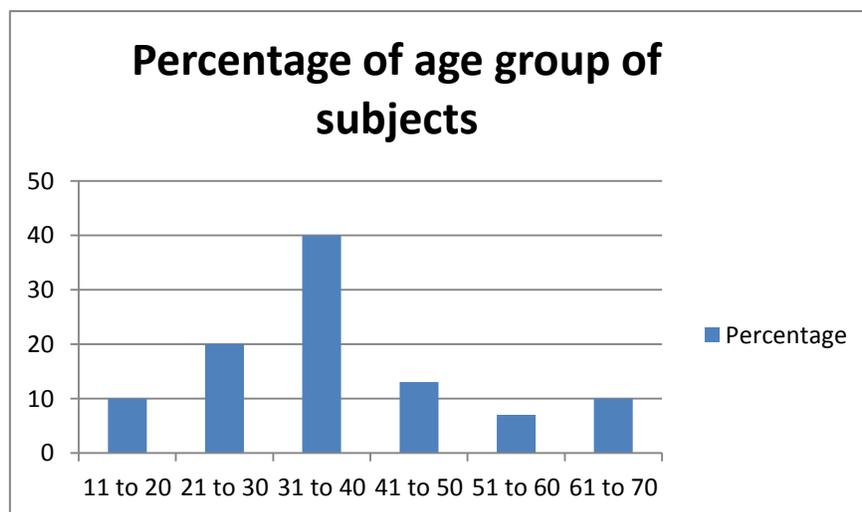
**Inclusion criteria:** Patients diagnosed clinically as cholesteatoma (unsafe CSOM ) with chronic ear discharge, marginal tympanic membrane perforation , conductive type of hearing loss or signs of intracranial complications .

**Exclusion criteria:**

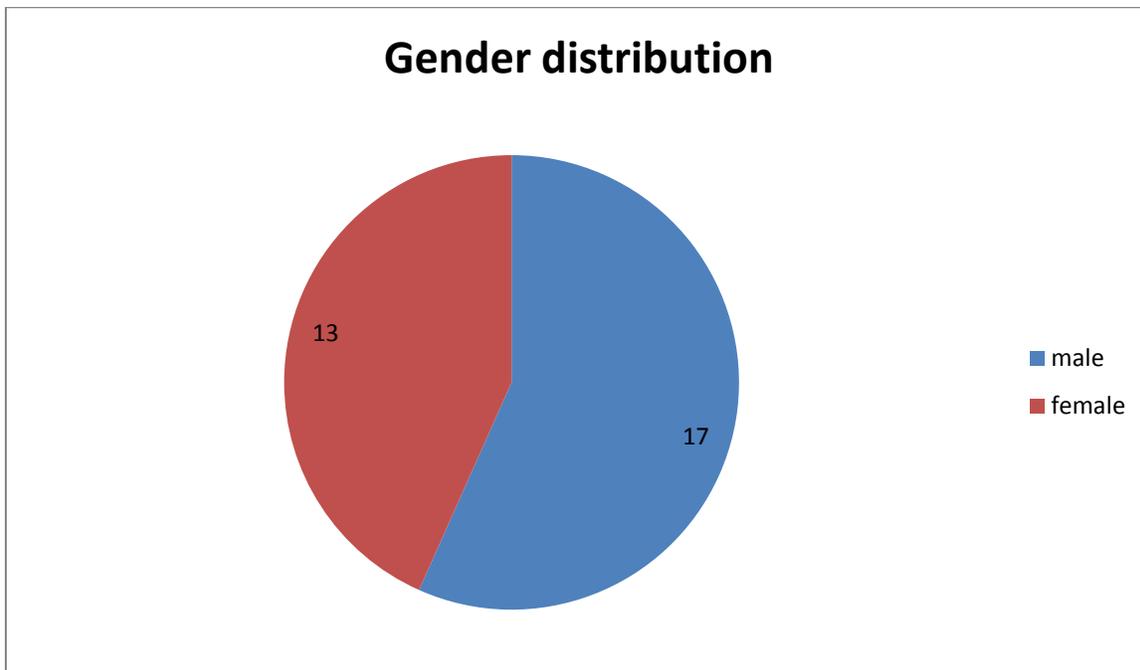
- Patients with diseases of the external ear or inner ear.
- Malignant lesions of the ear.
- Patients with conductive type of hearing loss due to CSOM with central perforation or otosclerosis.
- Patients with sensory-neural hearing loss.

**Data Analysis :** DWI-MRI findings and intra-operative findings were cross-tabulated and data was analyzed using standard statistical methods.

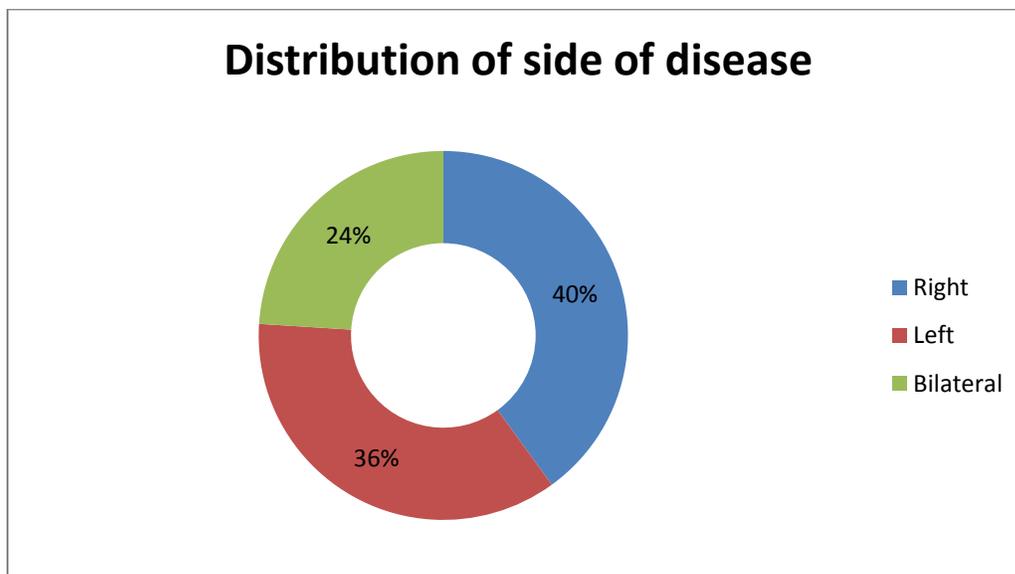
## RESULTS



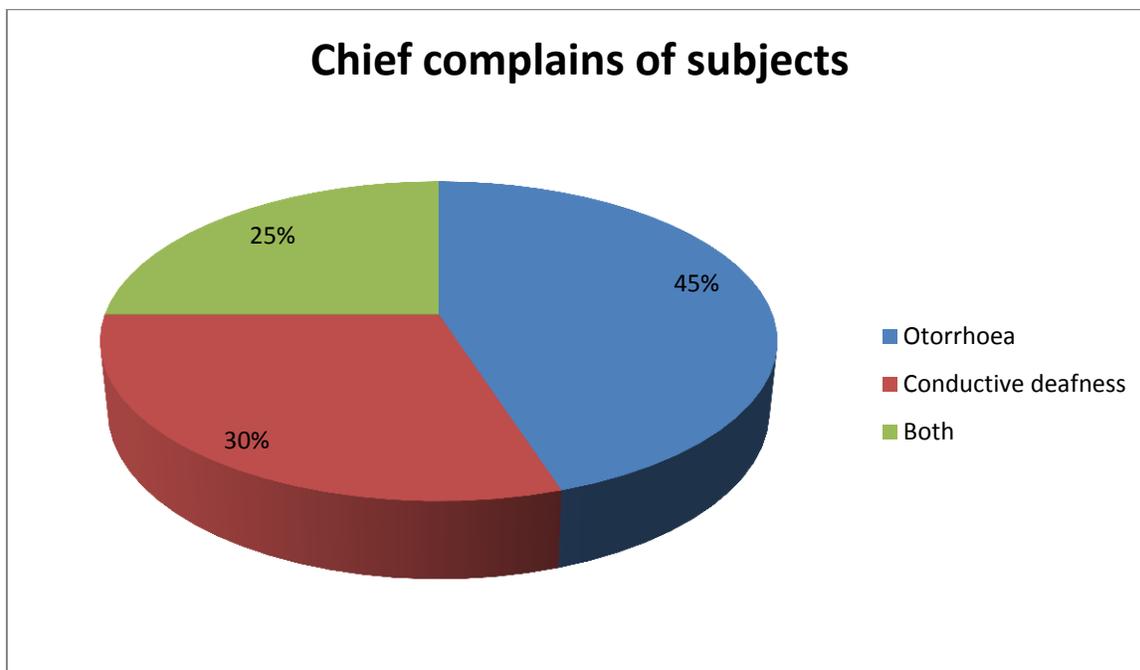
**Chart: 1 Percentage of age group of subjects: majority of the patients were of age group of 31- 40.**



**Chart 2: Gender distribution : Male predominance was observed.**



**Chart 3: Distribution of side of disease: predominantly right sided complaints were observed.**



**Chart 4: Chief complains of subjects: Majority of patients having complain of otorrhoea.**

**Table 1: Correlation of DWI-MRI with intraoperative findings:**

Soft tissue in Middle ear on HRCT showing restricted Diffusion on MRI		Intraoperative		Total	Chi square	p Value
		NO	YES			
MRI DWI	NO	7	1	8	20.45	<0.0001
		23.3%	3.3%	26.6%		
	YES	0	22	22		
		0%	73.3%	73.3%		
Total		7	23	30		
		23.3%	76.6%	100%		

**Yate’s Correlation: Chi square value is 20.45 and P value < 0.0001 , suggestive of positive association.**

## DISCUSSION

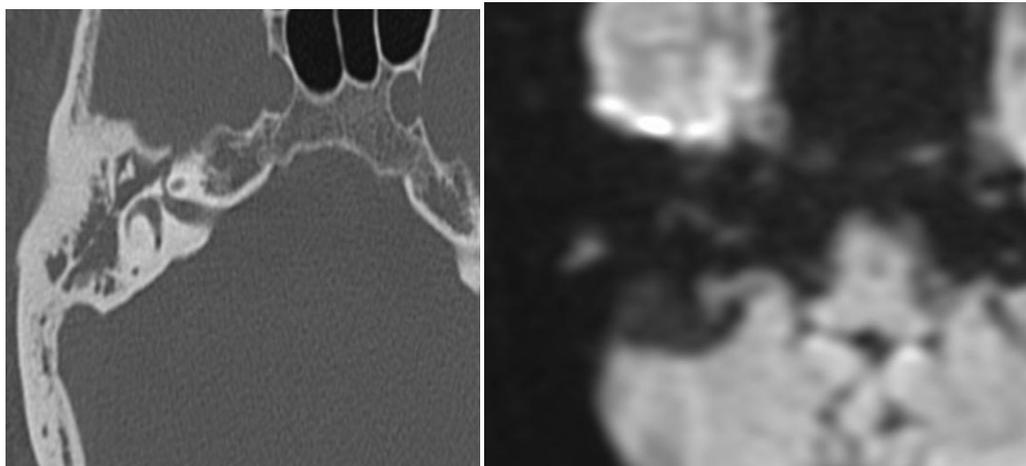
**Postoperative Ear:** Usually in patients with cholesteatoma, a second-look surgery 6–18 months after first cholesteatoma surgery is done to evaluate residual disease due to limited visibility of the mastoid or middle ear during first surgery. HRCT cannot distinguish granulation tissue or scar tissue from recurrent disease, as it lacks specificity. Recent studies reported improved results in the diagnosis of recurrent disease, with only small lesions missed when DWI sequences were used. Lesions of less than 5mm have been reliably detected with the EPI-DWI technique and even smaller lesions, with non-EPI techniques. MR imaging with DWI sequences has been used at our institution for evaluation of patients with prior cholesteatoma resection with reliable results, especially when the patient's otologic examination is obscured by an opaque tympanic membrane or cartilaginous reconstruction, when CT findings are equivocal. We did not find the apparent diffusion coefficient maps (in those cases in which they could be generated) helpful, a conclusion supporting the findings of Vercruyse et al and De Foer et al.

**Newly Diagnosed Cholesteatoma.** The initial diagnosis of cholesteatoma is usually easily made by otoscopic examination and concurrent HRCT should be performed to evaluate complications or extent of disease. MR imaging is not very useful in most of these patients. DWI- MRI should be used for evaluating patients with chronic ear discharge with inflammation or polypoidal disease which obscures physical examination and have a nonspecific CT. BLADE DWI technique in these cases are advisable due to improved resolution and decreased artifacts at the skull base compared with the HASTE and EPI DWI images. Occasionally restricted diffusion may incidentally be seen in the middle ear on MR imaging performed for an unrelated indication.

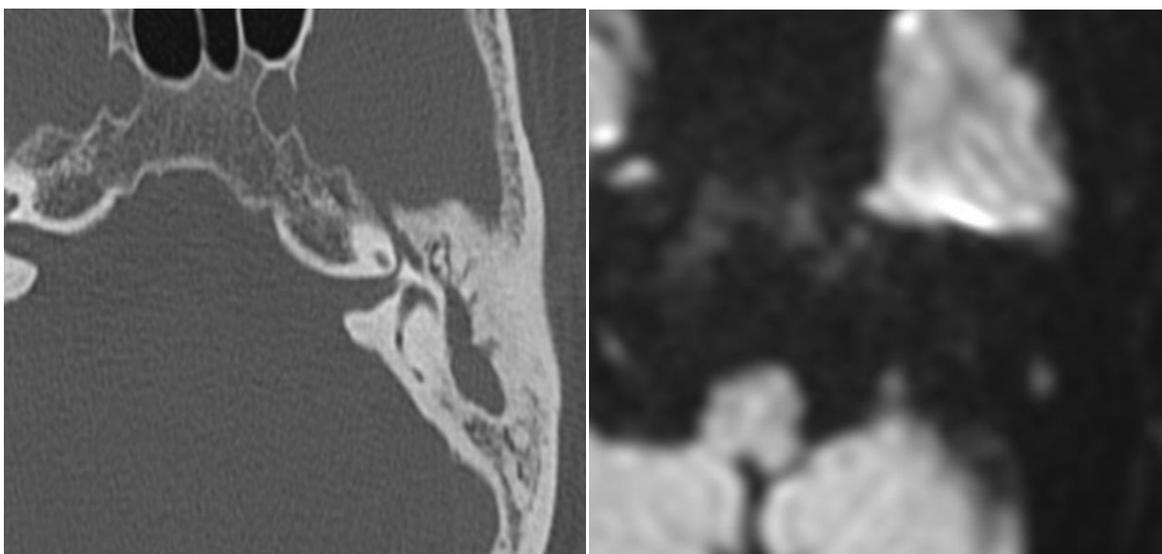
## CONCLUSIONS

Concluding the results, DWI has proven utility in the evaluation of cholesteatomas especially for distinguishing granulation tissue and inflammatory changes from cholesteatoma in patients with prior surgery- especially when visualization is impaired by canal wall up mastoidectomy or cartilaginous reconstruction - when clinical and CT findings are not confirmatory. We can use DWI technique in place of second-look surgery to reduce morbidity. With newer DWI techniques - thinner section and less susceptibility artifacts, better detection of small lesions is possible.

**IMAGES:**



**Case: 1- On HRCT -soft tissue thickening in right middle ear , mastoid antrum and mastoid air cells with partial erosion of ossicles. Correlative DWI- MRI images show small focus of restricted diffusion in right middle ear area.**



**Case: 2- On HRCT -soft tissue thickening in left middle ear , mastoid antrum and mastoid air cells with partial erosion of scutum and ossicles. Correlative DWI- MRI images show small focus of restricted diffusion in left mastoid aditus.**

**REFERENCES:**

1. Schwartz, K.M. et al "The Utility of Diffusion-Weighted Imaging for Cholesteatoma Evaluation." *American Journal of Neuroradiology* 32.3 (2011): 430-436. Web. 24 July. 2022.
2. Diffusion-weighted magnetic resonance imaging for residual and recurrent cholesteatoma: a systematic review and meta-analysis
3. J Muzaffar<sup>1</sup>, C Metcalfe<sup>1</sup>, S Colley<sup>1</sup>, C Coulson<sup>1</sup> Affiliations expand. PMID: 27701821 DOI: 10.1111/coa.12762
4. McJunkin, J., Chole, R. Clinical Utility of MRI for Cholesteatoma Recurrence. *Curr Surg Rep* 2, 63 (2014).
5. Swartz JD. Cholesteatomas of the middle ear. Diagnosis, etiology, and complications. *Radiol Clin North Am.* 1984;22:15–35.
6. Shelton C, Sheehy JL. Tympanoplasty: review of 400 staged cases. *Laryngoscope.* 1990;100:679–681.
7. Gyo K, Sasaki Y, Hinohira Y, Yanagihara N. Residue of middle ear cholesteatoma after intact canal wall tympanoplasty: surgical findings at one year. *Ann Otol Rhinol Laryngol.* 1996;105:615–619
8. Yiğiter AC, Pınar E, İmre A, Erdoğan N. Value of Echo-Planar Diffusion-Weighted Magnetic Resonance Imaging for Detecting Tympanomastoid Cholesteatoma. *J Int Adv Otol.* 2015;11:53–57
9. Williams MT, Ayache D. Imaging of the postoperative middle ear. *Eur Radiol.* 2004;14:482–495.
10. Blaney SP, Tierney P, Oyarazabal M, Bowdler DA. CT scanning in “second look” combined approach tympanoplasty. *Rev Laryngol Otol Rhinol (Bord)* 2000;121:79–81.
11. Aikele P, Kittner T, Offergeld C, Kaftan H, Hüttenbrink KB, Laniado M. Diffusion-weighted MR imaging of cholesteatoma in pediatric and adult patients who have undergone middle ear surgery. *AJR Am J Roentgenol.* 2003;181:261–265.
12. Cimsit NC, Cimsit C, Baysal B, Ruhi IC, Ozbilgen S, Aksoy EA. Diffusion-weighted MR imaging in postoperative follow-up: reliability for detection of recurrent cholesteatoma. *Eur J Radiol.* 2010;74:121–123.
13. De Foer B, Vercruyssen JP, Bernaerts A, Meersschaert J, Kenis C, Pouillon M, De Beuckeleer L, Michiels J, Bogaerts K, Deckers F, et al. Middle ear cholesteatoma: non-echo-planar diffusion-weighted MR imaging versus delayed gadolinium-enhanced T1-weighted MR imaging--value in detection. *Radiology.* 2010;255:866–872.