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ORGINAL ARTICLE

Preoperative High Resolution Computed Tomography of the Temporal Bone and its Correlation to Intraoperative Findings in Squamous Chronic Otitis Media–A Prospective Observational Study

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ABSTRACT

Introduction: Cholesteatoma is traditionally diagnosed by otoscopic examination and treated by surgery. Imaging in an uncomplicated case remains a controversy. This study was planned to correlate preoperative high-resolution computed tomography (HRCT) and intraoperative findings in patients with squamous chronic otitis media and to investigate the usefulness of a preoperative HRCT scan in depicting the status of middle ear structures in the presence of a cholesteatoma.

Materials and methods: (a) To compare the preoperative HRCT temporal bone and surgical findings in patients with squamosal chronic otitis media; (b) To evaluate the role of HRCT temporal bone in the assessment of squamosal chronic otitis media. A prospective observational study was conducted between September 2015 and August 2017 in the Department of Otorhinolaryngology, Dr Ram Manohar Lohia Hospital and PGIMER, New Delhi. Total seventy diagnosed cases of squamous chronic otitis media were included, and their preoperative HRCT temporal bone findings and intraoperative findings were correlated.

Results: The sensitivity, specificity, and positive and negative predictive values of HRCT were 73%, 97%, 80%, and 95% respectively, for determining the presence of lateral semicircular canal dehiscence 75%, 93%, 86%, and 88% respectively, for determining the presence of facial canal dehiscence; 84%, 71%, 87%, and 75% respectively, for determining the presence of scutal erosion; 91%,90%,62%,98% respectively for presence of tegmen erosion; 100%, 96%, 50%, and 100% respectively, for detecting the presence of dural plate defects.

Conclusion: The decision for surgical intervention should not be entirely based on the radiological interpretation. The operating surgeon should be well prepared to encounter conditions which are not reported by the radiologist preoperatively and modify the operating strategy accordingly. The HRCT scan acts a good preoperative imaging modality for the otologist to predict disease and to explain the possible outcomes to the patient.

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INTRODUCTION

Historically, otoscopy, audiometry, and plain X-rays were the only preoperative investigations performed before mastoid surgery.

Over the last decade, the resolution of computed tomography scans of the temporal bone has improved significantly and has become a routine preoperative workup for mastoid surgery. The HRCT provides a better understanding of normal anatomy, evidence of the extent of the disease and a possible screen for asymptomatic complications, thereby helping surgeons to anticipate complications before surgery. However, one should be well aware of the limitations and pitfalls of HRCT imaging. Routine HRCT scanning before all surgery of cholesteatoma can only be justified if it can be shown to influence the clinical management.[1] Hence, it remains controversial as to whether it should be performed in every case.

To this objective, the present study was conducted to evaluate how accurately HRCT scanning could define the extent and severity of the underlying disease in patients with squamosal chronic otitis media, thereby altering the surgical plan and outcome.

MATERIALS AND METHODS

After obtaining clearance from the institutional ethics committee, the present prospective observational study was conducted over a 2 year period between September 2015 and August 2017 in the Department of Otorhinolaryngology in collaboration with Department

of Radiodiagnosis at Dr. Ram Manohar Lohia Hospital and PGIMER, New Delhi. A total number of 70 cases of squamosal chronic otitis media presenting to a single senior otologist were selected from the outpatient Department of Otorhinolaryngology.

All patients of either sex between 5 and 60 years of age diagnosed with a squamosal type of chronic otitis media were included as a part of this study.

Cases of congenital ear disease, patients requiring revision surgery and malignancy of ear were excluded from this study.

All patients underwent an otoscopy examination and examination under a microscope. Assessment of hearing was done by tuning fork tests and pure tone audiometry. Assessment of bacterial flora was done by sending the pus for culture and sensitivity in all cases.

HRCT scan of the temporal bone was performed using 128 slice Siemens SOMATOM perspective machine. Using standard parameters–130 kV, 146 mAs, and a scan time of 3.5 seconds, a volumetric axial computed tomography (CT) scan was taken with 3 mm slices thickness from the lower margin of external auditory meatus (inferiorly) up to the arcuate eminence of the superior semicircular canal (superiorly). Multiplanar reconstruction was done using 1 mm thin slices with 0.5 mm interval obtaining images in all planes. Anatomical variations were studied separately on each side. Intravenous contrast was used only when the evaluation was done for suspected underlying complications. Following areas of interest were observed and reported by a single senior radiologist.

- Scutum
- Malleus
- Incus
- Stapes
- Fallopian canal
- LSCC
- Tegmen
- Sigmoid sinus

A canal wall up procedure or canal wall down procedure was carried out by one senior otologist depending upon the pathological process, the extent of disease, ossicular chain status, facial canal, LSC and extension of disease. Attempts were made to restore the hearing mechanism using various reconstructive techniques. Reconstruction of the canal wall and cavity obliteration were performed wherever indicated. The operative findings were recorded on a standard proforma which included all the areas mentioned above and subsequently compared to the HRCT findings.

Statistical Analysis

Categorical variables were presented in number and percentage (%), and continuous variables were presented as mean ± SD and median. Qualitative variables were correlated using Chi-square test /Fisher's exact test. The sensitivity, specificity, negative predictive value (NPV) and positive predictive value (PPV) of HRCT were calculated for all eight sites of interest considered in this study. The statistical analysis used the AC_1-coefficient of the agreement. The interpretation of AC_1 statistics has been summarized in Table 1. A p-value of < 0.05 was considered statistically significant. The data was entered in MS Excel spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

Table 1: Interpretation of AC1 statistics

AC1 value	*Strength of agreement*
>0.8	Very strong agreement
0.6-0.8	Moderately strong agreement
0.3-0.5	Fair agreement
<0.3	Poor agreement

RESULTS

In our prospective study of 70 patients , 56% (n = 39) were females while 44% (n = 31) were males. Our study showed a majority of the patients (71.4%, n = 50) were between 5 and 30 years of age. 34.29% patients (n = 24) had disease in left ear while 38.57% (n = 27) had disease in right ear while 27.14% patients (n = 19) had disease in bilateral ear. 48.57% patients (n = 34) had had more than 4 years duration of ear symptoms (scantly, foul-smelling blood stained discharge and an ipsilateral gradual decrease in hearing).

Most of the patients had a conductive hearing loss in the diseased ear (78%, n = 53). The mixed hearing loss was seen in 24.29% patients (n = 17).

Correlation of HRCT Findings with Preoperative Findings

With regard to the scutum, there was a moderately strong agreement of preoperative radiological assessment with the surgical findings (AC_1=0.7, $p < 0.0001$), suggesting that HRCT was reliable in the assessment of scutum.

As far as the malleus and stapes were concerned, there was a fair agreement between the preoperative radiological assessment and the surgical findings ($AC_1 = 0.51$, $p < 0.0001$ for malleus and stapes respectively).

In case of the incus, a moderately strong agreement was found between HRCT and intraoperative findings, suggesting that HRCT is reliable in assessing the status of the incus ($AC_1 = 0.6$, $p < 0.001$).

With regard to the fallopian canal and LSCC, a moderately strong agreement was found between the preoperative HRCT and the intraoperative findings ($AC_1 = 0.70$ and 0.72 respectively, $p < 0.0001$).

Similar findings were encountered in the tegmen area where there was moderate agreement (AC_1 = 0.68,

Table 2: Correlation of HRCT findings with peroperative findings

		HRCT preoperative	*Surgical intraoperative*	*HRCT senstivity*	*HRCT specificity*	*PPV*	*NPV*	*Ac1 ratio*	*p-value*
Scutum	Eroded	67.14% (47)	70.00% (49)	83.67%	71.43%	87.23%	75.22%	0.7	<0.0001
	Normal	32.86% (23)	30.00% (21)						
Malleus	Eroded	57.14% (40)	52.86% (37)	81.08%	69.07%	75.00%	76.67%	0.51	< 0.0001
	Normal	42.86% (30)	47.14% (33)						
Incus	Eroded	78.57% (55)	85.71% (60)	85.00%	60.00%	92.73%	40.00%	0.60	<0.001
	Normal	21.43% (15)	14.29% (10)						
Stapes	Eroded	60% (42)	50.00% (35)	85.71%	65.71%	71.43%	82.14%	0.51	< 0.0001
	Normal	40% (28)	50.00% (35)						
Fallopian canal	Eroded	30% (21)	34.29% (24)	75.00%	93.48%	85.71%	87.76%	0.70	< 0.0001
	Normal	70% (49)	65.71% (46)						
LSCC	Eroded	14.29% (10)	15.71% (11)	72.73%	96.61%	80.00%	95.00%	0.72	< 0.0001
	Normal	85.71% (60)	84.29% (59)						
Tegmen	Eroded	22.86% (16)	15.71% (11)	90.91%	89.83%	62.50%	98.15%	0.68	< 0.0001
	Normal	77.14% (54)	84.29 % (59)						
Sigmoid plate	Eroded	08.57% (06)	12.86% (09)	66.67%	100.00%	100.00%	95.31%	0.87	< 0.0001
	Normal	91.43% (64)	87.14% (61)						

$p < 0.0001$) between the HRCT and intraoperative findings suggesting that HRCT is reliable in assessing the status of the tegmen.

Finally, the radiological assessment agreed very strongly with the intraoperative condition of the sigmoid sinus ($AC_1 = 0.87$, $p < 0.0001$). The HRCT demonstrated 100% specificity while the sensitivity was 66.7%. A summary of the observations made with respect to the eight areas of interest in this study has been illustrated in Table 2.

DISCUSSION

Radiological assessment is essential in cases of a squamous type of chronic otitis media in planning surgical approaches and anticipating complications. The development of HRCT has been a significant advance in imaging the temporal bone, allowing us to obtain detailed sections of images.

This prospective observational study was single blinded between the radiologist and the operating surgeon. However, for ethical reasons, the operating surgeon was aware of the HRCT findings prior to surgery.

In our study, we found that HRCT has good sensitivity and specificity for detecting ossicular erosion. This is in agreement with studies by Sreedhar et al., Mafee et al., Shaffer et al., Jackler et al. and Garber et al.[2-6] Using HRCT, Mafee et al. diagnosed ossicular erosion in 89% cases while Jackler et al. could diagnose it in 83% cases.[3,5] However, O'Reilly could detect ossicular erosion in 50% cases.[7]

In a study conducted by Sethi N et al., sensitivity and specificity of HRCT for ossicular erosion were 35% and 43% respectively.[8]

Studies performed by Sirigiri and Dwaraknath, O'Reilly et al., Jackler et al. and Garber and Dort reported a sensitivity of 60% and specificity of 90% as far as the diagnosis of dehiscence of the horizontal part of the facial nerve was concerned.[5-7,9] However, our study had a sensitivity and specificity of 75% and 93% respectively for this site.

Variable results have been reported in the literature with respect to detection of LSCC fistulas on HRCT. Rogha et al. reported a sensitivity of 75% and specificity of 87.5%.[10] Sirigiri et al., on the other hand, reported a sensitivity of 100% and specificity of 94%.[9] Our study showed a sensitivity and specificity of 72% and 97% respectively as far as the diagnosis of LSCC fistulas were concerned. All patients who were diagnosed intraoperatively with LSCC had a fistula of at least 2 mm.

However, with respect to tegmen erosion, sensitivity and specificity of 91% and 90% were observed respectively. These results do not agree with the results reported by Jackler et al., who reported a false impression of LSCC fistulas and tegmen erosion, probably due to partial volume averaging of these structures with surrounding soft tissue.[5] In another study reported by Gerami et al., a weak and insignificant agreement was observed between preoperative and postoperative findings with respect to LSCC fistulas and Tegmen erosion.[11] O'Reilly et al. suggested that the preoperative CT scan is moderately sensitive to the presence of LSCC fistulas and less sensitive to the presence of small areas of exposed dura.[7]

Hence, one should note that althoughHRCT is helpful for diagnosing possible pathology, the findings must be interpreted cautiously in view of its limitations.

The current study has certain limitations. The limited sample size in this study could have affected the interpretation of the obtained result. Moreover, sinus tympani and facial recess, more commonly known as the 'hidden areas of the middle ear' have not been included as a

part of this study. HRCT reporting was done by a single radiologist which might because of forbias in our results.

CONCLUSION

A surgeon's clinical and surgical acumen predict the outcome of the intervention. However, a radiological investigation such as an HRCT scan can be a good pre-operative tool to assess the extent of the disease.

However, it becomes essential to note that the decision for surgical intervention should not be entirely based on the findings of HRCT. The surgeon should be prepared to encounter conditions which are not reported by the radiologists and thereby modify their operating strategy accordingly.

This study has demonstrated a good correlation between HRCT scans and surgical findings, particularly in areas involving scutum, tegmen, and sigmoid plate.

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