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Original Research Article

Retrospective Analytical Assessment of the Correlation between High Resolution Computed Tomography of Temporal Bone and Intra-Operative Findings in Chronic Otitis Media: An Observational Study

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Abstract

Aim: The aim of the present study was to investigate the correlation between the preoperative findings of high-resolution computed tomography (HRCT) of temporal bone in chronic otitis media (COM) and the intraoperative findings.

Methods: This retrospective, analytical study was primarily conducted in patients with COM presenting at department of Radio diagnosis. All patients with COM and records of preoperative HRCT imaging of the diseases ear were considered eligible for participation. A written informed consent was obtained from each study participant prior to conducting the study. A total of 50 patients were included.

Results: A total of 50 patients were included in the final analysis in which 18 (36%) were male patients and 32 (64%) were female patients undergoing surgery belonging to the age range of 9 to 50 years. The mean age of the analyzed patients was 29 years. On comparing the preoperative findings of the HRCT with the intraoperative findings, tympanic perforation was reported on the CT of 14 patients (28%); however, 16 patients with tympanic perforation were observed intraoperatively (32%). Regarding facial canal erosion, it was reported in the CT of just 2 cases (1%), whereas it was seen intraoperatively in 10 cases (5%). As for sigmoid plate erosion, there was similar observation in both preoperative CT and the intraoperative findings with 8 patients (16%) presenting with that findings. In the same context, exposure of the dura was reported similarly during both assessments with 4 cases (8%) presenting with exposed dura preoperatively in the CT report and during operation. Meanwhile, edema of the middle ear mucosa was documented based on the preoperative CT imaging in 4 cases (8%), whereas only 2 cases (1%) showed intraoperative edematous mucosa. In 60%, cholesteatoma was absent.

Conclusion: In conclusion, HRCT has shown good results with significant correlation of diagnostic value in comparison with the findings during surgery. Preoperative CT scan is beneficial and contributory in relation to diagnosis and decision-making in indicating operation to patients with COM.

Keywords: Temporal bone, chronic otitis media, computed tomography

Introduction

Chronic otitis media (COM) remains a major international health problem in terms of prevalence, economics, sequelae and complications. It is divided into two chief clinical types: COM without cholesteatoma or safe type and COM with cholesteatoma or unsafe type. [1] Among the various pathological processes associated with unsafe COM like cholesteatoma, osteitis, ossicular necrosis, granulation tissue and cholesterol granuloma, the most frequently encountered one is cholesteatoma. [2]

This cholesteatoma is likely a serious problem which can give rise to alarming intracranial and extracranial complications as it can progressively enlarge and invade into neighbouring structures. Therefore, early diagnosis and prompt management of a suspected cholesteatoma via surgical mastoid exploration makes it an obligatory procedure. [3] Previously cholesteatoma was evaluated on the basis of clinical presentation, examination under microscope and conventional radiology i.e., X-ray mastoids. [4] However, one cannot determine the size and extent of soft tissue lesion along with the status of middle ear structures and hidden areas like sinus tympani and facial recess using these methods. [5] Hence the need for HRCT temporal bone came into existence. The indications of the cholesteatoma

on HRCT temporal bone scan being the presence of one of the following: non-dependent soft tissue density mass in middle ear cleft; erosions of the middle ear bony walls (i.e., scutum, attic wall, tegmen plate, sigmoid sinus plate, Korner's septum, posterior and superior metal wall); erosion of the ear ossicles, semicircular canal and facial nerve canal; bony expansion of middle ear cavity, aditus and antrum. [6]

A revolution took place in field of imaging of temporal bone in 1980 by development of high-resolution computed tomography (HRCT). HRCT is a modality of routine computed tomogram. In temporal bone it precisely delineates the bony structures as well as the soft tissue component which is helpful to examine the region in an organized and systematic fashion. It provides a practical approach to understanding temporal bone anatomy, localizing a pathologic process with a focus on inflammatory and neoplastic processes, identifying pertinent positives and negatives, and formulating a differential diagnosis. Thus, HRCT plays a crucial role in making diagnosis and assessing the disease extent, helping to decide appropriate management. [7]

HRCT temporal bone scan is a sensitive tool for detection of early or primary bone erosions. It well delineates the extent and location of the soft tissue density pathology which helps in preoperative counselling to patients regarding the nature of pathology and its related complications and aids in deciding the need for early surgical interventions. [8] It is beneficial in assessing the status of ossicular assembly which helps in deciding the likelihood of hearing restoration post-surgery. [9]

The aim of the present study was to investigate the correlation between the preoperative findings of high-resolution computed tomography (HRCT) of temporal bone in chronic otitis media (COM) and the intraoperative findings.

Materials and Methods

This retrospective, analytical study was primarily conducted in patients with COM presenting at Department of Radio diagnosis, Indira Gandhi Institute of medical sciences, Patna, Bihar, India for one year. All patients with COM and records of preoperative HRCT imaging of the diseases ear were considered eligible for participation. A written informed consent was obtained from each study participant prior to conducting the study. A total of 50 patients were included. Patients who were unfit for surgery or for anesthesia or did not have a CT preoperatively were excluded from this study. The study protocol was con- ducted according to the World Medical Association Declaration of Helsinki

The CT imaging without contrast was performed at the radiology department prior to surgery in different slices in 1 and 5 minutes. The slices were 5 mm in thickness with the thin slice cuts and images being obtained in all planes. Furthermore, they were uploaded into the system and reported by the radiologist. The margin of imaging was taken from external auditory meatus up to the bony margin of the superior semicircular canal. The images were studied to compare the temporal bone HRCT findings and the intraoperative findings. The surgical findings were documented by Oto- neuro-laryngologist skull-base surgeon.

For diagnostic accuracy, the parameters of comparison between preoperative HRCT findings and the intraoperative ones were calculated by using sensitivity, specificity, negative predictive value (NPV), and positive predictive value (PPV). The operative approach was post-auricle with a V-shaped cut and elevation of the annulus. The procedure was modified radical mastoidectomy, tympanoplasty, or ear exploration.

Statistical Analysis

The differences in the findings of preoperative HRCT and intraoperative ones were estimated in numbers and proportions. Chi-square test would be used to detect any statistically significant difference in the findings in these 2 categories. A P-value of less than 0.05 was considered the cutoff point for statistical significance. Meanwhile, to determine the performance of each category, a correlation between preoperative and intraoperative findings was performed using sensitivity, specificity, NPV, and PPV. The parameters of comparison were tympanic membrane perforation, middle ear mucosa, mastoid segment, dura, sigmoid sinus, facial canal, facial recess, ossicular status and joint status, the extent of cholesteatoma or granulation tissue to epitympanum, mesotympanum, or hypotympanum, and eustachian tube status.

Results

Table 1: Sociodemographic status of study participants

SEX	FREQUENCY	%
Men	18	36
Women	32	64
Total	50	100

A total of 50 patients were included in the final analysis in which 18 (36%) were male patients and 32 (64%) were female patients undergoing surgery belonging to the age range of 9 to 50 years. The mean age of the analyzed patients was 29 years.

Table 2: Comparison between preoperative CT findings and intraoperative observations

INTRAOPERATIVE FINDING	INTRAOPERATIVE FINDINGS, N (%)	HRCT FINDINGS, N (%)	SE%	SP%	PPV (%)	NPV (%)	*P*-VALUE
TM perforation	16 (32)	14 (28)	100	22.3	55	100	0.072
Facial canal erosion	10 (5)	1 (2)	97.8	78.4	92.8	45	0.075
Sigmoid plate erosion	8 (16)	8 (16)	100	100	100	100	0.001
Dura exposed	4 (8)	4 (8)	100	100	100	100	0.001
Meddle ear mucosa edematous	4 (8)	2 (1)	95	82	96	76	0.108
Malleus erosion	6 (12)	2 (1)	77	95	94	22	0.352
Incus erosion	15 (30)	15 (30)	100	100	100	100	0.001
Stapes erosion	8 (16)	8 (16)	100	100	100	100	0.002
M-I joint discontinuous	19 (38)	19 (38)	100	100	100	100	0.002
I-S joint discontinuous	16 (32)	14 (28)	87	71	98	78	0.350
Eustachian tube granulation	12 (24)	8 (16)	96	77	95.5	75	0.585

On comparing the preoperative findings of the HRCT with the intraoperative findings, tympanic perforation was reported on the CT of 14 patients (28%); however, 16 patients with tympanic perforation were observed intraoperatively (32%). Regarding facial canal erosion, it was reported in the CT of just 2 cases (1%), whereas it was seen intraoperatively in 10 cases (5%). As for sigmoid plate erosion, there was similar observation in both preoperative CT and the intraoperative findings with 8 patients (16%) presenting with that findings. In the same context, exposure of the dura was reported similarly during both assessments with 4 cases (8%) presenting with exposed dura preoperatively in the CT report and during operation. Meanwhile, edema of the middle ear mucosa was documented based on the preoperative CT imaging in 4 cases (8%), whereas only 2 cases (1%) showed intraoperative edematous mucosa.

Table 3: Total number of cholesteatoma status intraoperatively and on HRCT

Total number of cholesteatoma finding intraoperative and on HRCT, n (%)		Total, N (%)
ABSENT	PRESENT	
30 (60)	20 (40)	50 (100)

In 60%, cholesteatoma was absent.

Table 4: Status of cholesteatoma extending during preoperative CT imaging and intraoperatively

CHOLESTEATOMA MESOTYMPANUM-HYPOTYMPANUM	EXTENDING IN INTRAOPERATIVE IN MESOTYMPANUM	IN MESOTYMPANUM AND EPITYMPANUM	NO CHOLESTEATOMA	TOTAL
Cholesteatoma extending in HRCT				
Mesotympanum-hypotympanum				
Count 14	0	0	0	14
% of total 28	0.00	0.00	0.00	28
In mesotympanum				
Count 0	4	0	0	4
% of total 0.00	8	0.00	0.00	8
In mesotympanum and epitympanum				
Count 0	0	2	0	2
% of total 0.00	0.00	4	0.00	4
Total				
Count 14	4	2	30	50
% of total 28	8	4	60	100

The significant relation between intraoperative cholesteatoma extension and its HRCT findings of the disease was found with a confidence level of 95% and a P-value of 0.001.

Discussion

Chronic otitis media (COM) that results in hearing loss remains a significant health problem of prevalence, economics, and sequels. Short- and long-term outcomes of otitis media may be devastating but can be considered preventable if recognized early and treated properly with early surgical intervention to limit the disease. [10] The existence, site, and extent of the disease along with the presence of any complications determine the surgical approach to be followed. As such, imaging

plays an important role in providing crucial information to the surgeon in this regard. [11,12]

Moreover, facial canal dehiscence (FCD), lateral semicircular canal (LSC) dehiscence, and dural plate defect can be seen in patients who have COM with or without cholesteatoma. [13,14] Although LSC dehiscence increases the risk of developing labyrinthitis, dural plate dehiscence raises the probability of spreading the pathology to the brain. Having preoperative comprehensive knowledge of the anatomy and anomalies of the facial nerve (i.e. FCD) is crucial for preventing postop- erative morbidity in patients who require surgery due to middle ear disorders. [15] A total of 50 patients were included in the final analysis in which 18 (36%) were male patients and 32 (64%) were female patients undergoing surgery belonging to the age range of 9 to 50 years. The mean age of the analyzed patients was 29 years. On comparing the preoperative findings of the HRCT with the intraoperative findings, tympanic perforation was reported on the CT of 14 patients (28%); however, 16 patients with tympanic perforation were observed intraoperatively (32%). Regarding facial canal erosion, it was reported in the CT of just 2 cases (1%), whereas it was seen intraoperatively in 10 cases (5%). The typical features of the cholesteatoma on HRCT temporal bone includes: the presence of non-dependent soft tissue density material in middle ear cleft, ossicular chain erosion, fine erosions of the middle ear borders and adjoining structures. These changes when associated with bony expansion of the middle ear cavity and aditus ad antrum with loss its "figure of 8" appearance is highly suggestive of cholesteatoma. [16] Mafee et al and David et al illusturated the criteria indicating cholesteatoma as "blunting of the scutum's normally sharp tip" as often the earliest indicator of attic cholesteatoma. [17,18]

As for sigmoid plate erosion, there was similar observation in both preoperative CT and the intraoperative findings with 8 patients (16%) presenting with that findings. In the same context, exposure of the dura was reported similarly during both assessments with 4 cases (8%) presenting with exposed dura preoperatively in the CT report and during operation. Meanwhile, edema of the middle ear mucosa was documented based on the preoperative CT imaging in 4 cases (8%), whereas only 2 cases (1%) showed intraoperative edematous mucosa. In 60%, cholesteatoma was absent. The significant relation between intraoperative cholesteatoma extension and its HRCT findings of the disease was found with a confidence level of 95% and a P-value of 0.001. Based on our observations, the most common eroded ossicle was the incus. There was a significant relation between incus erosion intraoperative and incus erosion on CT, with a confidence level of 95% and a P-value of 0.001 and between intra- operative M-I joint discontinuity and M-I joint discontinuity on CT, with a confidence level of 95% and a P–value of 0.001. These findings go in line with those of Karki et al[12] who studied the correlation between preoperative HRCT findings and the surgical findings in cases with CSOM.

Moreover, Datta et al [19] and Rogha et al [15] found that the stapes was not consistently visualized by the preoperative CT; however, when it is seen it usually appeared as a structure of soft tissue density in the oval window niche. Subsequently, it was not possible for them to distinguish whether the stapes was eroded or was merely enveloped by soft tissue and this could explain the discrepancy in the observations. The reported minimal accuracy for stapes could be the result of the small size of the bone. Therefore, finer slices of the temporal bone CT of 2 to 3 mm are thought to help detect the status of the stapes. [20] On the contrary, some CT findings such as tympanic mem- brane perforation, facial canal erosion, middle ear edematous mucosa, and Eustachian tube granulation did not show high accuracy in detecting them preoperatively; however, they showed very high sensitivity in comparison with the markedly low specificity in certain findings. Variable results have been reported in the literatures regarding this matter as shown in Rogha et al's study.

The sensitivity of observed tympanic perforation was 100% intraoperative in correlation with the finding of the CT reports. The most reported finding in cases of COM was M-I joint discontinuity. Computed tomography findings correlated very well with the surgical observations (100%) in cases of cholesteatoma. All cases reported as cholesteatoma in CT were confirmed at surgery with a sensitivity of 100% and a specificity of 100%.

Conclusion

In conclusion, HRCT has shown good results with significant correlation of diagnostic value in comparison with the findings during surgery. Preoperative CT scan is beneficial and contributory in relation to diagnosis and decision-making in indicating operation to patients with COM. The significant correspondence between HRCT and clinical findings may lead to a better diagnosis of probable problems before surgery and improves the success rate of cholesteatoma surgeries. Limitations of HRCT should be considered and improved by newer radiologic modalities.

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