ORIGINAL RESEARCH PAPER

Radiology

"HIGH RESOLUTION COMPUTED TOMOGRAPHY (HRCT) SCAN EVALUATION OF TEMPORAL BONE CHOLESTEATOMA AND ITS CORRELATION WITH INTRA-OPERATIVE FINDINGS"

KEY WORDS: Cholesteatoma, High Resolution Computed Tomography, Chronic Suppurative Otitis Media.

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ABSTRACT

BACKGROUND AND OBJECTIVES: Chronic Suppurative Otitis Media (CSOM) is a common condition seen in patients attending otolaryngological department. The ability of High Resolution Computed Tomography (HRCT) to predict accurately the status of the structures of the temporal bone represents a major advance in delineating pathology prior to surgical exploration of ears with cholesteatoma. The aim of this study was to understand the role, value, and impact of HRCT in detection, evaluation and diagnosis of middle ear cholesteatoma and to correlate the HRCT findings with intraoperative findings.

METHODS: A prospective cross-sectional descriptive study in which 30 patients who presented to the Department of Otorhinolaryngology OPD and were diagnosed to have cholesteatoma by clinical , otoscopic and full audiological examination were subjected to HRCT scanning of the temporal bone . HRCT findings and intraoperative findings were cross-tabulated and data was analyzed using standard statistical methods .

RESULTS: HRCT temporal bone was found to have a very 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: A HRCT Temporal Bone scan acts as an excellent preoperative imaging modality for the otologist to predict disease during the surgery and to explain possible outcomes to the patient.

INTRODUCTION:

In the area of otology, imaging has until recently been of poor quality and could only be interpreted by a limited number of highly experienced radiologists. Historically, middle ear surgery has been undertaken with otoscopy, audiometry and possibly plain X-rays as the only preoperative investigations. The history of radiology of cholesteatoma dates back to 1905, when Schuller first described a lateral radiograph view of skull principally used for viewing mastoid cells. Thereafter radiography views like Stenvers's view and Law's view were developed to further enhance the visibility of pathological findings but none of them gave sufficient information. Computed Tomography (CT) was invented in 1972 by British engineer Godfrey Hounsfield of EMI laboratories England and by South Africa born physicist Allan Cormack of Tufts University. The first clinical CT scanners were installed between 1974 and 1976. High Resolution Computed Tomography (HRCT) scanning was first described in 1982 and has significantly altered the contribution of radiological imaging in pre-operative diagnosis of cholesteatoma in middle ear cleft. It allows superb pre-operative imaging of anatomy, some evidence of the disease and a screen for impending/threatening complications. It confirms and extends upon otoscopic findings, resolves clinical doubts, and in many circumstances plays a significant role in determining surgical efficacy when surgery is necessary ; the approach can be planned on the basis of HRCT findings. However, routine HRCT scanning prior to all surgery of cholesteatoma can only be justified if it can be shown to influence clinical management. Otitis media is a significant community health problem in terms of prevalence, economics, and sequelae. Otitis media is divided into two main clinical types : 1) Acute Otitis Media 2) Chronic Otitis media Chronic suppurative otitis media is divided into two main clinical types : 1) Chronic suppurative otitis media without cholesteatoma that is recognized clinically as safe type – Mucosal variety 2) Chronic suppurative otitis media with cholesteatoma, or unsafe type. This study is done on patients having unsafe type of Chronic Suppurative Otitis Media (CSOM) who need surgical management – Squamosal variety Cholesteatoma is a sac of keratinizing squamous epithelium in the middle ear cleft which may or may not extend to other areas. The presence of cholesteatoma must also be suspected beneath polyps protruding from the pars flaccida or when there is a marginal tympanic membrane perforation or granulation. Cholesteatoma is a potentially serious condition as it can progressively enlarge and erode into adjoining structures internal acoustic meatus , labyrinth , petrous apex and middle cranial fossa giving rise to serious intracranial or extracranial complications. A variety of standard surgical approaches is currently used to remove cholesteatomas. All of these procedures can be categorized as either intact canal wall or canal wall down approaches. The present study was conducted to evaluate how accurately HRCT scanning could define the extent and severity of the underlying disease in patients with unsafe type of CSOM, thereby altering the surgical plan and outcome.

AIMS & OBJECTIVES:

1. To evaluate the role , value and impact of HRCT in detection , evaluation and diagnosis of middle ear cholesteatoma (unsafe CSOM). 2. To compare the preoperative HRCT findings with intra-operative findings in patients with unsafe CSOM (squamosal variety).

MATERIALS AND METHODS

Source of data: Patients attending the E.N.T. OPD of S.P. Medical College & Hospital and diagnosed as middle ear cholesteatoma (unsafe CSOM) on clinical , otoscopic and audiometry parameters ; subsequently sent to the Department of Radiodiagnosis for HRCT of temporal bone . Study design: A prospective cross-sectional descriptive study . Study area: S.P. Medical College, Bikaner. Study period: 2 years (November 2019 – November 2020. Sample size: 30 cases were studied. Sample design: The following criteria proposed by Liu and Bergeron was used to diagnose cholesteatoma by HRCT in addition to the presence of non-dependent soft tissue mass in the middle ear cavity--- a) Erosion \ destruction of the lateral wall of the attic (scutum), b) Widening of the aditus ad antrum, c) Displacement of the ossicular chain , d) Destruction of the ossicles , e) Erosion of the facial nerve canal , f) Dehiscence of tympanic roof (tegmen tympani) , g) Destruction of the mastoid (auto-mastoidectomy cavity) , h) Erosion of the sigmoid plate i) Complete or partial destruction of the malleus and incus and sometimes displacements medially or laterally . Thereafter

the subjects will be included into the study according to the following inclusion-exclusion criteria.

INCLUSION CRITERIA:
Patients diagnosed clinically as CSOM with acquired cholesteatoma (unsafe CSOM) and presented with chronic scanty ear discharge which is offensive , marginal tympanic membrane perforation , conductive hearing loss & / or signs of intracranial complications .

EXCLUSION CRITERIA:
•Patients with malignancies of the ear. •Patients with conductive hearing loss due to CSOM with central perforation (mucosal variety i.e, tubo-tympanic disease) and otosclerosis . • Patients with diseases of the external and inner ear. • Patients with CSOM not willing for tympanomastoid surgery. • Known h/o sensory –neural hearing loss .

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

Study Tools : Siemens Somatom perspective 128 - slice Multi-Detector CT scanner with 130 KVp and 97 mAs with 0.6 mm slice thickness.

The sample size of the study was fixed at 30 cases after a retrospective analysis over the last 3 years ; of the number of patients attending the department of Radiodiagnosis for HRCT temporal bone after being clinically diagnosed to have CSOM(unsafe type)

RESULTS:
SPSS (Statistical Package For Social Sciences) version 20. [IBM SPASS statistics (IBM corp. Armonk, NY, USA released 2011)] was used to perform the statistical analysis

Data was entered in the excel spread sheet.
Descriptive statistics of the explanatory and outcome variables was calculated by mean, standard deviation for quantitative variables, frequency and proportions for qualitative variables.

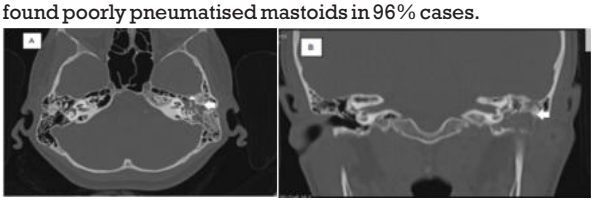
Inferential statistics like o Chi square test was used to test the significance between qualitative variables.

The level of significance was set at 5% o Sensitivity, specificity, positive predictive value and negative predictive value are calculated to test the accuracy of HRCT as compared to intra operative findings. 30 cases were studied in which HRCT findings and intra-operative findings were cross- tabulated and data was analyzed using above mentioned standard statistical methods .

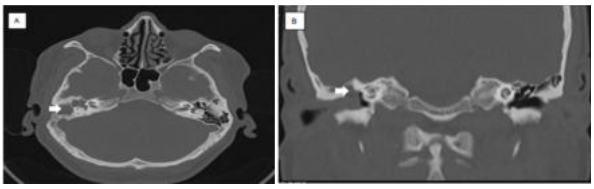
The present study was conducted in the department of Radiodiagnosis , S.P.Medical College & hospital in which 30 cases of unsafe chronic suppurative otitis media were studied clinically and radiologically following which they underwent surgery . The intraoperative findings were correlated with that of preoperative HRCT findings . AGE: The cases included in the present study were in the age group varying from 2nd to 7 th decade . Maximum number of patients was in the 31-40 years age group . Mean age of the patients in the study was 35.43 ± 13.72 years with a range of 11-65 years. SEX: Equal distribution was noted in males and females in this study . Most of the studies revealed varying distribution in this regard. CHIEF COMPLAIN: Most studies revealed a combination of conductive deafness and otorrhoea as the major chief complain as was observed in our study. SOFT TISSUE MASS : In all 30 cases , soft tissue density mass was depicted by HRCT and was confirmed in all 30 patients intraoperatively i.e. 100 % specificity, sensitivity and PPV . In past studies HRCT was found to be upto 100% sensitive in detecting a soft tissue mass 50 preoperatively .(13-16) However , we could not distinguish cholesteatoma from other soft tissue disease . Walshe et al in their study could not distinguish between mucosal disease and cholesteatoma (35) . Cholesteatoma characteristically causes bone erosion and when this feature was present in association with a soft tissue mass on CT both . In studies on efficiency of HRCT in defining the extent of disease preoperatively, O'Donoghue et al and Mafee et al independently found HRCT to be highly accurate . O'Reilly et al 15 in his study corroborated the above studies with a 100% sensitivity of HRCT in defining the extent of disease . In our study , the sensitivity and PPV were both 100% which is in agreement with the aforementioned studies (13,14) SCUTUM : Our study revealed a 100% correlation between HRCT and intraoperative findings in identifying scutum erosion . Most studies revealed similar observation. OSSICLES : Malleus on HRCT appeared to be intact in 19 (63.3%) cases and it was intact in 19 (63.3%) cases intraoperatively . Incus on HRCT appeared to be intact in 9 (30 %) cases, however it was found to be intact in 7 (23.3%) cases intraoperatively . On HRCT stapes appeared to be intact in 14(46.7%) cases and it was intact in only 11 (36.7%) cases intraoperatively . The incus was the most frequently eroded ossicle . This is consistent with the findings of Chee et al . Mafee et al were able to demonstrate the state of the ossicular chain in 89% of cases scanned .(14) O'Donoghue et al reported a sensitivity of 81.4% in identifying incus erosion whereas in our 51 study its sensitivity was 91.3 %. He also reported sensitivity of 85.71% in detecting absence of stapes suprastructure . However , in our study , its sensitivity was 84.2 % . In our study we were not completely able to detect ossicular chain integrity or disruption due to failure in identifying long process of incus and/or the stapes suprastructure (13) SEMICIRCULAR CANALS : Lateral semi-circular canal was intact in 27 (90%) patients and eroded in 3 (10%) patients in HRCT . Exactly the same was found intraoperatively. Findings were consistent with Silver et al , according to whom patients with vertigo and chronic middle ear disease may have a cholesteatoma with a fistula between the middle and inner ear and the fistula may usually involve the lateral semicircular canal FACIAL NERVE CANAL : In previous studies , the sensitivity of HRCT in detecting facial canal dehiscence varied widely with values of 0 , 25 , 44 and 100% . The specificity has been reported only by O'Reilly as 85% . In our study , the sensitivity was 100 % and specificity was 96.3 % . This lack of complete accuracy can be explained on the fact that the visualisation of thin bony structures like facial nerve canal may be misleading due to errors in computer reconstruction of their images . These structures may appear eroded due to the fact that the computer averages their density with adjacent soft tissue and air. TEGMEN TYMPANI : O'Donoghue et al reported a sensitivity of 50% in identifying tegmen tympani erosion but did not report his false positives . O'Reilly et al. 15 showed sensitivity of 46% and specificity of 84% . (13) Jackler et al. reported a sensitivity of 100% but a PPV of 33.33% in this regard . Mafee et al. showed a sensitivity of 50% , and a PPV of 100% for detecting tegmen erosion . In our study , the sensitivity was 100% and specificity was 100% which is very much acceptable .

These noncorrelating values can be explained partly by the very small number of patients with tegmen tympani erosion in the studies MASTOID CAVITY : Mastoids are almost universally involved in CSOM . HRCT was able to provide excellent views of the mastoid air cells , antrum and aditus ad antrum in either axial or coronal planes . The most common findings was of hypopneumatization or sclerosis which was found in all 30 cases [100%] in our study . Partially sclerosed mastoid was found in 19 (63.3%) cases and completely sclerosed mastoid was found in 11 (36.7%) cases. Exactly the same was found intraoperatively. Seetana Ragavoodoo et al.

found poorly pneumatised mastoids in 96% cases.



[Figure 1] Axial (A) and Coronal (B) HRCT Temporal Bone images showing soft tissue attenuation in the left middle ear cavity with erosion of ossicles (◊) ; erosion of facial nerve canal (*) in (A) and erosion of scutum (◊) in (B).



[Figure 02] Axial (A) and Coronal (B) HRCT Temporal bone images showing cholesteatoma in right middle ear cavity and mastoid antrum (◊) in (A) and erosion of scutum (◊) in (B) .

[Figure 03] Axial (A) and Coronal (B) HRCT Temporal bone images showing cholesteatoma of bilateral middle ear cavities (◊).

SUMMARY AND CONCLUSION:

The following conclusions can be reliably reached by means of this study: 1. The presence and distribution of soft tissue in the middle ear cleft and mastoid could confidently be predicted using this modality . Indeed , it was observed , that a scan showing no evidence of soft tissue essentially excluded the presence of a cholesteatoma . 2. The malleus , body and short process of incus are well visualised , even when surrounded by disease . However , the long process of incus and the stapes suprastructure cannot be reliably imaged on these scans . Thus , visualising the entire ossicular chain was not completely satisfactory. 3. The visualization of tiny bony structures (facial nerve canal , tegmen tympani, semicircular canal wall) may rarely be misleading due to errors in computer reconstruction of their images. 4. Despite these reservations it was observed that dehiscence in lateral semicircular canal wall could be reliably demonstrated using a combination of axial and coronal scans . 5. Pneumatisation status of the mastoid air cells could be accurately demonstrated with the HRCT scan images . 6. Involvement of other bony structures like scutum erosion could be efficiently depicted with the HRCT scan .

In conclusion , the present study pointed that high resolution computed tomography (HRCT) scanning is a modality which can accurately image the pathological anatomy in unsafe Chronic Suppurative Otitis media and represents a major advance in the diagnostic imaging of this disease . Its use by the otologists is encouraged , especially in patients who have or suspected to have complex problems and in whom the maximum information is desirable , as an adjunct to better preoperative assessment , and thus the surgical outcome . Its accuracy is likely to improve with larger studies and better experience , wherein its routine use may become justifiable .

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