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A Comparative Study Between Hrct Temporal Bone V/S Intra-Operative Findings in Unsafe Ear

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Abstract

Introduction: The evaluation of middle ear conditions, particularly unsafe ear conditions like cholesteatoma, requires accurate diagnostic tools to in plan surgical procedure and predict outcomes. High-resolution computed Tomography (HRCT) of the temporal bone has emerged as a critical imaging modality due to its detailed visualization of bony structures.

Aim & Objectives: The study aims to assess the concordance between HRCT temporal bone and intraoperative observations, evaluate the sensitivity and specificity of HRCT, and elucidate its role in preoperative planning in unsafe ear.

Materials & Methods: A prospective observational time bound study was conducted at KD Medical College Hospital and Research Center in Mathura, Uttar Pradesh, on 76 patients with CSOM (unsafe ear) evaluated by otoscopy, oto-endoscopy, and HRCT temporal bone, to compare the findings with intra-operative findings.

Results: The sensitivity of HRCT for pneumatization of the mastoid is 47.3%, indicating that HRCT may not effectively detect pneumatization. However, the specificity is at 44.8%. The tympanic membrane (perforation) has a sensitivity of 54.5%, with a high specificity of 92.9%. HRCT can detect disease in sinus tympani in about half of the cases, with a sensitivity of 69.7% and a specificity of 75.0%. For the erosion of sigmoid sinus plate, it has a sensitivity and specificity of 50.0% and specificity of 98.7%respectively. The lateral semicircular canal dehiscence has a sensitivity and specificity of 33.3% and 100.0% respectively. Malleus erosion showed, the sensitivity and specificity to be 65.4% and 43.6%, whereas for incus erosion, stapes supra structure erosion and stapes footplate erosion the sensitivity and specificity was 40% and 56%, 88.7% and 53.6%, 76.8% and 40.0% respectively.

Conclusion: The study highlights the importance of High-Resolution CT (HRCT) in identifying anatomical structures and conditions relevant to unsafe ears. HRCT provides detailed anatomical information, aiding in preoperative planning and identifying dehiscent structures, such as the fallopian/facial canal and tegmen

plate. However, it has limitations such as false-positive and false-negative findings, and requires expertise for interpretation

Keywords: CSOM, HRCT Temporal bone, Facial/ fallopian canal dehiscence, Scutum, Sinus tympani.

Introduction

Chronic otitis media (COM) that results in hearing loss continues to pose a serious threat to public health due to its high incidence, cost, and long-lasting effects. Currently, it is treated with a range of conventional surgical methods, which may be divided into two categories: canal wall up and down procedures. Plain x-rays alone have been used in the past to guide surgery for chronic otitis media. High-resolution computed tomography (HRCT) scanning has been the gold standard for imaging the temporal bone in recent years, although there is still debate about whether it should be used in every patient with Chronic otitis media (attico-antral disease) before surgery. Because it is believed that surgical dissection is the best time to determine the kind and severity of the disease, but many otologists utilize computed tomography scanning to assess the severity of the condition and plan surgical procedures.[1] The diagnosis of chronic otitis media implies a permanent abnormality of the pars tensa or flaccida, most likely as a result of an earlier otitis media, negative middle air pressure, or otitis media with effusion. Chronic otitis media equates to the classical term chronic"suppurative"otitis media that is no longer advocated, as chronic otitis media is not necessarily a result of "gathering of pus". However, the distinction remains between Active chronic otitis media, where there is inflammation and the production of pus, and Inactive chronic otitis media, where this is not the case though there is potential for the ear to become active at some point. The current advancements in diagnosing the disease have led for us to a way forward from the old classification based on the anatomical distinction between "Tubo-tympanic" and "Attico-antral" diseases and the terms "safe" and "unsafe" respectively. [2]

Chronic otitis media now can be classified as Active and Inactive types with sub-classifications as Active mucosal chronic otitis media, Active squamous chronic otitis media, Inactive mucosal chronic otitis media, and Inactive squamous chronic otitis media, and healed chronic otitis media.

According to this classification, Active squamous chronic otitis media will be considered for the study and are referred to as CSOM unsafe ear interchangeably. In the case of Active mucosal chronic otitis media there is chronic inflammation of the mucosa of the middle ear and mastoid with varying degrees of edema, sub mucosal fibrosis, hyper vascularity, and inflammatory infiltrates. There is an increase of goblet cells and basal cell hyperplasia of the middle ear mucosa and granulation tissue can occur. This can affect the whole antrum and middle ear space. It is also often associated with ossicular chain erosion. Cholesteatoma is a benign keratinizing epithelium lined cystic structure found in the middle ear and mastoid. It leads to the destruction of the ossicles, and otic capsule and thus, leads to complications such as hearing loss, vestibular dysfunction, facial paralysis, intracranial disease, or infection. The clinical diagnosis of unsafe ear can though be made simply by otoscopic, oto-endoscopic and microscopic evaluation and is considered gold standard for diagnosing the same. [3]

HRCT Temporal bone is considered useful and essential especially for knowing the site, size, spread of cholesteatoma, mastoid involvement, ossicular involvement and complications, for the complete elimination of the disease. X-rays were once utilized as an imaging technique for the examination of ear

disorders, but they had several drawbacks. These days, high resolution with excellent bone detail of the temporal bone may be obtained by thin-section High Resolution Computed Tomography (HRCT). Similar to CT, proton magnetic resonance imaging generates sectional pictures and uses the same reconstruction techniques. However, CT is better at imaging the temporal bone because it can show both minute bone features and anomalies in soft tissues. Nowadays, radiological imaging modalities that show the bony detail in the petrous temporal bone, the density of soft tissues in the middle ear, and the extent of the disease are thought to be most helpful when it comes to knowing the anatomy of the ear and the extent of the disease. Moreover, finding intracranial problems can be greatly aided by CT scanning.[4]

As it is essential to know the location and extent of the disease, HRCT temporal bone is used before planning surgical management.[5]

The study aims to compare high-resolution computed tomography (HRCT) Temporal Bone findings with intraoperative findings in patients with unsafe ears. It also aims to determine the sensitivity and specificity of HRCT Temporal Bone in cases of unsafe ears. The study involves a comprehensive clinical history, ENT examination, audio logical evaluation, radiological evaluation of temporal bone using CT, and all surgeries performed based on pre-operative CT pictures and intraoperative findings. All data will be statistically analyzed and correlated to conclusions.

Material and Method

After obtaining informed written consent from the patients/guardians, this prospective observational time bound study is carried out among patients with CSOM (UNSAFE EAR) at the Department of Otorhinolaryngology, KD Medical College Hospital and Research Centre, Mathura, Uttar Pradesh.

The study is a prospective observational study on 76 patients diagnosed with CSOM (unsafe ear) clinically and then sent to the Department of Radio-diagnosis for HRCT temporal bone. A 16 Slice Multi detector CT 'SEIMENS" Machine was used to perform HRCT and images of the same were of 1-2mm thickness reconstructed to 750µm Coronal and Sagittal sections. After getting pre anaesthetic check-up and clearance the patients underwent Tympanomastoidectomy via post auricular approach and transcortical route. According to the intraoperative condition, a decision was made regarding type of mastoidectomy to be done and whether to do reconstruction at same stage or later. The HRCT finding wascompared with intraoperative findings.

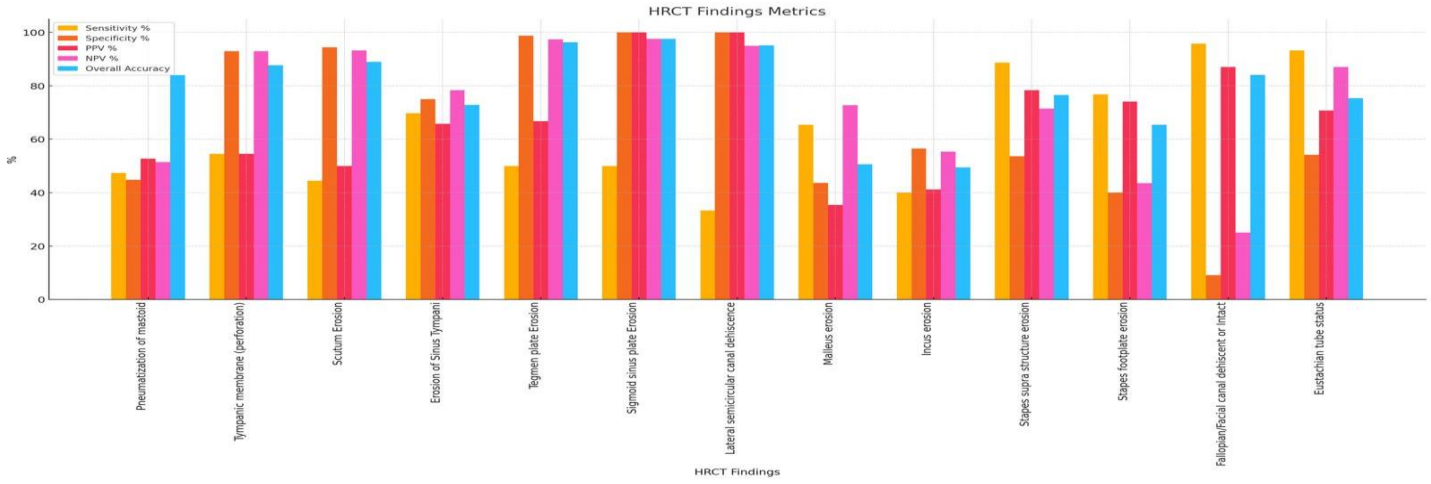
SPSS (Statistical Package for The Social Sciences) version 26.0 was used for data analysis, comparing HRCT and intraoperative findings using paired sample T-tests. Graphs were plotted using Excel or SPSS. P values were classified as non-significant (P-value > 0.05), significant (P-value ≤ 0.05), and highly significant (P-value ≤ 0.001).

Observations

Table 1: HRCT findings in different study parameters including p-values in the present study

Hrct Findings	Sensitivity %	Specificity %	PPV %	NPV %	Overall Accuracy	Kappa Coefficient	P-Value
Pneumatization of mastoid	47.3%	44.8%	52.7%	51.4%	83.9	0.256	<0.05
Tympanic membrane(perforation)	54.5%	92.9%	54.5%	92.9%	87.7%	0.474	<0.05
Scutum Erosion	44.4%	94.4%	50.0%	93.2%	88.9%	0.409	<0.05
Erosion of Sinus Tympani	69.7%	75.0%	65.7%	78.3%	72.8%	0.443	<0.05
Tegmen plate Erosion	50.0%	98.7%	66.7%	97.4%	96.3%	0.792	<0.05
Sigmoid sinus plate Erosion	50.0%	100.0%	100.0%	97.5%	97.5%	0.655	<0.05
Lateral semicircular canal dehiscence	33.3%	100.0%	100.0%	94.9%	95.1%	0.481	<0.05
Malleus erosion	65.4%	43.6%	35.4%	72.7%	50.6%	0.074	>0.05
Incus erosion	40.0%	56.5%	41.2%	55.3%	49.4%	-0.035	>0.05
Stapes supra structure erosion	88.7%	53.6%	78.3%	71.4%	76.5%	0.449	<0.05
Stapes footplate erosion	76.8%	40.0%	74.1%	43.5%	65.4%	0.172	>0.05
Fallopian/Facial canal dehiscent or Intact (tympanic and mastoid segment)	95.7%	9.1%	87.0%	25.0%	84.0%	0.066	>0.05
Eustachian tube status	93.2%	54.1%	70.7%	87.0%	75.3%	0.487	<0.05

Figure 1: bar graph representing, sensitivity, specificity, PPV%, NPV%, Overall Accuracy for different parameters in the study



The analysis revealed

- **Mastoid pneumatization**: HRCT correctly identifies pneumatization with a sensitivity of 47.3% and accurately excludes it with a specificity of 44.8% based on intraoperative findings.
- **Tympanic membrane**: HRCT shows a sensitivity of 54.5%, meaning it detects abnormalities in the tympanic membrane in 54.5% of cases where they are present. It also exhibits a high specificity of 92.9%, indicating it correctly identifies normal tympanic membranes in 92.9% of cases.
- **Disease in sinus tympani**: Overall, HRCT detects disease in sinus tympani in about 69.7% of cases with a sensitivity of 69.7%. Its specificity in this context is 75.0%, indicating it accurately identifies normal findings in 75.0% of cases.
- **Sigmoid sinus plate**: HRCT demonstrates a sensitivity of 59.0%, meaning it detects abnormalities in the sigmoid sinus plate in 59.0% of cases where they are present. It achieves a perfect specificity of 100.0%, correctly identifying normal findings in all cases without abnormalities.
- **Lateral semicircular canal**: HRCT's sensitivity for detecting abnormalities in the lateral semicircular canal is 33.3%, indicating it identifies such issues in 33.3% of cases where present. It also shows a perfect specificity of 100.0%, correctly identifying normal lateral semicircular canals in all cases.
- **Malleus, Incus, Stapes Suprastructure, and Stapes Footplate Erosion**: The p-value for these structures is <0.05, indicating a statistically significant association between HRCT findings and the observed outcome. This suggests that abnormalities or erosions detected in the malleus, incus, stapes suprastructure, and stapes footplate on HRCT are predictive of specific conditions or outcomes related to middle ear function.
- **Fallopian/Facial Canal Dehiscence**: The p-value for fallopian/facial canal dehiscence is >0.05, which suggests that there is no statistically significant association between HRCT findings related to facial canal dehiscence and the observed outcome.

Statistically significant associations ($p < 0.05$) were observed between HRCT findings and clinical outcomes for mastoid pneumatization, tympanic membrane (perforation), scutum erosion, disease in sinus tympani, tegmen plate erosion, sigmoid sinus plate erosion, lateral semicircular canal dehiscence, and Eustachian tube status. These findings highlight HRCT's role in predicting and assessing various temporal bone pathologies, underscoring its importance alongside clinical examination for comprehensive patient evaluation and management.

Discussion

Pneumatization of Mastoid

In our study, the sensitivity of pneumatization of mastoid was found to be 47.3 % and the specificity was found to be 44.8%.

A study was conducted by Kanotra et al, where sensitivity and specificity were found to be 100% which was not similar to our study. This may be because the study sample size was smaller than ours.[6]

In our study, the sensitivity and specificity of perforation of the tympanic membrane were found was to be 54.5% and 92.9% respectively.

A study conducted by Aljehani M et al where the sensitivity and specificity were found to be 100% and 21.2% respectively.[7]

This is different from our study because this study was conducted in Saudi Arabia where the distribution of

geography is different and the pathological conditions of the ear might be different.

Tegmen Plate Erosion

In our study, the sensitivity and specificity were found to be 50% and 98.7% respectively. A similar specificity rate was found in a study conducted by Gerami H et al. where the specificity was 95%. This similarity is because the study is conducted in a similar setting of a tertiary care hospital. [8]

Sigmoid Sinus Plate Erosion

In our study, the sensitivity and specificity were found to be 50% and 98.7 % respectively. This is similar to a study conducted by Datta et al and Rai et al where the specificity was found to be 100%. This is similar because it was conducted in a similar tertiary hospital setting.[9,10]

Malleus erosion

In our study, the sensitivity and specificity were found to be 65.4% and 43.6%. The study conducted by Rai et al showed sensitivity and specificity of 90 and 100% respectively. This is different because the setting of the studies might have been different and the sample size was smaller than ours.[9]

Incus erosion

In our study, the sensitivity and specificity were found to be 40% and 56.5% respectively. This is similar to the study conducted by Datta et al where the specificity was found to be 60%.[10]

Stapes supra structure erosion

In the present study, the sensitivity and specificity were found to be 88.7% and 53.6%. This is not similar to a study conducted by Rai et al, where the sensitivity and specificity were found to be 90 and 100%. This is because our study has used 16- slice CT machine, which is less efficient is describing minute structures like stapes superstructure hence the difference in outcomes. Study should be done with higher slice like 64,128 machines for better outcomes.[9]

Disease in Sinus Tympani

In the present study, the sensitivity and specificity were found to be 69.7% and 75%. In a study done by Kanotra et al, the sensitivity and specificity were found to be 100%. This is different because the setting of the studies might have been different and the sample size was smaller than ours.[6]

Scutum Erosion

In the present study, the sensitivity and specificity were 44.4% and 94.4%. In a study done by Kanotra et al, the sensitivity and specificity were found to be 100%.[36] This is different because the sample size is different than ours and our study used 16-slice CT machine which is technologically less superior than what was used by Kanotra et al.[6]

Lateral Semicircular Canal Dehiscence

In the present study, the sensitivity and specificity were found to be 33.3% and 100%. In a study done by Kanotra et al, the sensitivity and specificity were 66.6% and 95.74%. This is different because the geographical location is different, larger sample size and use of lesser slice CT machine in our study.[6]

Dehiscent Fallopian/ Facial Canal

In the present study, the sensitivity and specificity of the fallopian canal were found to be 95.7% and 90.9 % respectively. This was similar to the study by Rai et al where the specificity was found to be 100%. Similar results are seen in study by Jadia S et al with respect to fallopian/ facial canal dehiscence in our study.[11]

Conclusion

The study highlights the importance of High-Resolution CT (HRCT) in identifying anatomical structures and conditions relevant to unsafe ears. HRCT provides detailed anatomical information, aiding in preoperative

planning and identifying dehiscent structures, such as the fallopian/facial canal and tegmen plate. However, it has limitations such as false-positive and false-negative findings, and requires expertise for interpretation as well as a higher slice machine like 64, 128 and above will help radiologists and otologists alike for detecting finer anatomy. The study emphasizes the need for integrating HRCT findings with intraoperative findings to optimize surgical outcomes. Collaboration between radiologists and otologists is crucial for accurate interpretation and optimal surgical outcomes for patients with unsafe ears. HRCT sure gives an idea pre operatively to the surgeon and helps to provide prognosis to the patient, but HRCT can't be totally reliable as intra operative findings may differ and a surgeon must be prepared for unforeseeable erosions, dehiscence and spread of disease. Nevertheless, HRCT sure provides a guide map for the surgeon

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