Section: ENT

Original Research Article

TO INVESTIGATE THE ASSOCIATION BETWEEN PREOPERATIVE HIGH RESOLUTION COMPUTED TOMOGRAPHY OF THE TEMPORAL BONE AND INTRAOPERATIVE SURGICAL OBSERVATIONS

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Abstract

Background: Cholesteatoma is a significant health risk that may lead to severe difficulties inside the skull and surrounding areas. It has the potential to grow and infiltrate nearby structures. Therefore, it is crucial to promptly diagnose and treat a suspected cholesteatoma. HRCT of the temporal bone accurately delineates the size and position of soft tissue density in the middle ear, along with adjacent bone erosions. **Aim:** To investigate the association between preoperative high resolution computed tomography of the temporal bone and intraoperative surgical observations. **Material and Methods:** This research included all patients with chronic otitis media (squamosal illness) who visited the Department of ENT. HRCT scans of the temporal bone were performed in both axial and coronal planes and the findings were documented in the proforma format. The gathered results were presented in terms of the following statistical parameters: percentage, sensitivity, specificity, positive predictive value, negative predictive value, and accuracy. **Results:** Incus had the highest level of erosion, followed by malleus and stapes. The HRCT had a specificity and positive predictive value of 100% in determining the condition of the ossicles. However, the maximum sensitivity was seen in assessing the condition of the incus, with a sensitivity of 87.38% and a negative predictive value of 75%. Tegmen erosion was detected on CT scan in 15 out of 25% of patients. However, after surgery, tegmen erosion was seen in only 9 out of 15% of cases. The research demonstrates a sensitivity of 100%, a specificity of 87.19%, and a positive predictive value of just 54.56%. The current research can accurately determine the condition of the sigmoid sinus plate with a sensitivity and specificity rate of 100%. The HRCT scan has a sensitivity of 100% and a specificity of 86.74% in accurately detecting a dehiscent or eroded facial canal. The sensitivity and specificity were 100% and 86.74% respectively, with a positive predictive value of 62.5%. **Conclusion:** A strong correlation between HRCT temporal bone findings and intraoperative surgical findings. Therefore, HRCT of the temporal bone is quite beneficial for both identifying and providing guidance for the surgical treatment of dangerous cholesteatoma of the middle ear.

INTRODUCTION

Chronic otitis media (COM) continues to be a significant global health issue in terms of its widespread occurrence, economic impact, and the resulting consequences and problems. The condition is classified into two main clinical types: chronic otitis media (COM) without cholesteatoma, often known as the safe type, and COM with cholesteatoma, sometimes known as the dangerous type.[1] Cholesteatoma is the most often seen pathological process associated with dangerous chronic otitis media, which includes other conditions such as osteitis, ossicular necrosis, granulation tissue, and cholesterol granuloma.[2] This cholesteatoma is a potentially severe issue that may lead to worrying difficulties inside and outside the skull, since it has the ability to gradually grow and infiltrate nearby structures. Consequently, it is necessary to do a surgical mastoid exploration for early detection and immediate treatment of a suspected cholesteatoma.[3] Cholesteatoma was previously assessed using clinical presentation, microscopic inspection, and conventional radiography, namely X-ray mastoids.[4]

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Nevertheless, these procedures do not allow for the accurate assessment of the dimensions and scope of soft tissue damage, as well as the condition of middle ear structures and concealed regions such as sinus tympani and facial recess.[5] Therefore, the need for HRCT temporal bone arose. The presence of one of the following indicates the existence of a cholesteatoma on a high-resolution computed tomography (HRCT) scan of the temporal bone: The middle ear cleft contains a mass of soft tissue with no dependency. The bony walls of the middle ear, such as the scutum, attic wall, tegmen plate, sigmoid sinus plate, Korner's septum, posterior and superior metal wall, show erosions. The ear ossicles, semicircular canal, and facial nerve canal also show erosion. Additionally, there is an expansion of the middle ear cavity, aditus, and antrum.[6] The HRCT temporal bone scan is a very sensitive method for identifying early or initial bone erosions. This information clearly defines the size and position of the abnormal soft tissue density, which is useful for discussing the condition with patients before surgery. It also helps in determining the potential consequences associated with the pathology and assists in evaluating if early surgical intervention is necessary.[7] Evaluating the ossicular assembly state is advantageous for determining the probability of hearing restoration after surgery.[8] Additionally, it offers a comprehensive visualisation of concealed regions (such as the facial recess and sinus tympani) inside the middle ear, hence aiding in the thorough elimination of the condition.5 Furthermore, it is valuable for identifying the anatomical differences in the positioning of the dural plate, sigmoid sinus plate, and jugular bulb. This information aids in the preoperative planning of surgical procedures, allowing for the avoidance of potential complications.[7] Consequently, in the present day, otologists regard HRCT temporal bone scan as a standard procedure for assessing patients before any surgical intervention.

MATERIAL AND METHODS

This research included all patients with chronic otitis media (squamosal illness) who visited the Department of ENT. The research excluded patients with ear malignancies and persistent otitis media of the tubo-tympanic type.

Methodology

A comprehensive evaluation was conducted on all patients, which included a thorough medical history, clinical examination, microscopic investigation, and pure tone audiometry. High-resolution computed tomography (HRCT) scans of the temporal bone were performed in both axial and coronal planes and the findings were documented in the proforma format. Following a thorough pre-anesthetic examination, patients were scheduled for mastoid exploration in the operating theatre. The purpose was to assess and compare the extent and severity of the illness with the results from radiological imaging. The scanning procedure was performed using a GE Bright speed + 16 Slices CT scanner. The reconstruction thickness was set to 0.6mm, and the scanning parameters were 295mA for the current and 120Kv for the voltage. The HRCT scans were assessed for the presence, location, and degree of soft tissue density in the middle ear and mastoid bone. The anatomical structures mentioned include the anterior epitympanum, posterior epitympanum, mesotympanum, hypotympanum, and ossicles. The presence of cholesteatoma was indicated by the identification of non-dependent soft tissue density in the middle ear cavity or mastoid bone, medial displacement of the ossicular chain, and a characteristic pattern of ossicular erosion. Additionally, the facial nerve, tegmen tympani, and sigmoid sinus were also seen. The gathered results were presented in terms of the following statistical parameters: percentage, sensitivity, specificity, positive predictive value, negative predictive value, and accuracy.

RESULTS

The research included 60 confirmed instances with squamous type chronic otitis media (COM), all of whom had high-resolution computed tomography of both temporal bones, followed by mastoid exploration. The younger age group had the highest incidence of the condition, with almost similar distribution across genders and a little greater prevalence among females. [Table 1]

Cholesteatoma was the prevailing pathology, seen in 36 (60%) patients. Retraction pocket was present in 10 (16.67%) patients, while granulation was discovered in 7 (11.67%) patients. Polyps were detected in 3 (5%) patients, and cholesteatoma with granulation was identified in 4 (6.67%) patients. The patients were categorised into two groups based on the surgical findings: a group of 40 cases with cholesteatoma, and a group of 20 instances without cholesteatoma. The CT scan demonstrated a sensitivity and specificity of 100% in accurately diagnosing the characteristics of mastoid bone pneumatization. [Table 2]

Incus had the highest level of erosion, followed by malleus and stapes. The HRCT had a specificity and positive predictive value of 100% in determining the condition of the ossicles. However, the maximum sensitivity was seen in assessing the condition of the incus, with a sensitivity of 87.38% and a negative predictive value of 75%. [Tables 3 and 4].

Tegmen erosion was detected on CT scan in 15 out of 25% of patients. However, after surgery, tegmen erosion was seen in only 9 out of 15% of cases. The research demonstrates a sensitivity of 100%, a specificity of 87.19%, and a positive predictive value of just 54.56%. [Tables 3 and 4]

The current research can accurately determine the condition of the sigmoid sinus plate with a sensitivity and specificity rate of 100%. The HRCT scan, as seen in Table 3 and 4, has a sensitivity of 100% and a specificity of 86.74% in accurately detecting a dehiscent or eroded facial canal.

Within this investigation, the facial nerve canal in its tympanic portion was found to be undamaged in 43 instances (71.67%), but in 17 cases (28.33%) it exhibited

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erosion as shown on CT scans. The aforementioned results were verified during surgery in 11 instances.

The sensitivity and specificity were 100% and 86.74% respectively, with a positive predictive value of 62.5%. These values may be seen in Table 3 and Table 4. In the majority of instances, CT accurately determined if the vertical and horizontal section was impacted, providing the surgeon with valuable guidance and increasing them confidence throughout the operation. During the surgical procedure, there were no instances of anatomical variance in any of the patients.

All 60 instances showed the presence of soft tissue masses when comparing CT scans with the results after surgery. The HRCT demonstrated perfect sensitivity, specificity, positive predictive value, and negative predictive value in determining the extent of the soft tissue mass. [Tables 5 and 6]

Table 1: Gender and age of the participants

	Number =120	Percentage	P value
Gender			0.19
Female	69	57.5	
Male	51	42.5	
Age			
Below 25	15	12.5	0.17
25-35	22	14.67	
35-45	55	45.83	
45-55	13	8.67	
Above 55	15	12.5	

Table 2: Status of Mastoid Bone

Mastoid Bone	HRCT=60		Intraoperative findings=60	
	Number of patients	Percentage	Number of patients	Percentage
Well pneumatised	4	6.67	4	6.67
Sclerotic	46	76.67	45	76.67
Cavity	10	16.66	10	16.66

Table 3: Comparative evaluation of different Structures

Ossicle	Condition	HRCT		Intraoperative Findings	
		Number of patients	Percentage	Number of patients	Percentage
Tegmen Tympani	Erosion	15	25	9	15
	Normal	45	75	51	85
Sigmoid Sinus	Erosion	8	13.33	9	15
	Normal	52	86.67	51	85
Facial Nerve	Normal	43	71.67	49	81.67
	Dehiscence	17	28.33	11	18.33
Malleus	Erosion	24	40	32	53.33
	Normal	36	60	28	46.67
Incus	Erosion	37	61.67	44	73.33
	Normal	23	38.33	16	26.67
Stapes	Erosion	28	46.67	35	58.33
	Normal	32	53.33	25	41.67

Table 4: Sensitivity and specificity of different structures

Ossicle	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Tegmen Tympani	100	87.19	54.56	100
Sigmoid Sinus	100	100	100	100
Facial Nerve	100	86.74	62.5	100
Malleus	77.85	100	100	82.5
Incus	87.38	100	100	75
Stapes	83.67	100	100	82.5

Table 5: Soft Tissue Mass

Extent of Soft Tissue Mass	HRCT		Intraoperative Findings	
	Number of patients	Percentage	Number of patients	Percentage
Middle ear and mastoid	49	81.67	50	83.33
Middle ear only	8	13.33	7	11.67
EAC, mastoid and middle ear	3	5	3	5

DISCUSSION

Currently, HRCT temporal bone is gaining popularity as a method for identifying early bone erosions and giving thorough imaging of the amount of soft tissue in middle ear cholesteatoma. The characteristic attributes of cholesteatoma on HRCT of the temporal bone consist of the existence of non-dependent material with soft tissue density in the middle ear cavity, erosion of the ossicular chain, and delicate erosions of the margins of the middle ear and adjacent structures. Cholesteatoma was the predominant pathology seen in 60% of patients in our investigation. Our findings aligns with the research

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conducted by Payal G et al,[9] and Tatlipinar A et al,[10] which likewise identified cholesteatoma as the prevailing disease. The CT scan results and surgical observations showed complete agreement about the extent of Mastoid bone pneumatisation. The tests undertaken by Kanotra S et al,[11] and Dutta G et al,[12] had comparable findings, with CT scans showing sensitivities of 100%, 96%, and 100% respectively. Identifying ossicular erosion is a significant observation on high-resolution computed tomography (HRCT) scans for diagnosing instances of Cholesteatoma. In addition to having prior information of the condition of the ossicles, it is beneficial for pre-operative planning of ossiculoplasty techniques and predicting potential outcomes. However, the final choice may vary depending on the results during the surgery. Prior understanding of ossicles before surgery is also beneficial for advising patients of their expected hearing level after the operation. The sensitivity and specificity of HRCT in identifying the state of the Malleus in squamosal type of COM is 77.85% and 100% respectively. The Positive Predictive Value (PPV) is 100% and the Negative Predictive Value (NPV) is 82.5%. Studies conducted by Rai T et al,[13] Rocher P et al,[14] and Zhang et al,[15] likewise revealed a specificity rate of 100%. Nevertheless, their sensitivity surpasses ours with a remarkable 100% in contrast to our current investigation. Regarding Incus, HRCT demonstrated a sensitivity of 87.38% and a specificity of 100% in accurately identifying the status of Incus. Additionally, the PPV was 100%, indicating a strong association between HRCT and intraoperative observations. Our work aligns with the research conducted by Datta G et al,[12] and Rai T et al,[13] which likewise reported a 100% PPV. HRCT accurately diagnosed incus erosion with a sensitivity of 76.92%, specificity of 100%, positive predictive value (PPV) of 100%, and NPV of 80%. Rai T et al,[13] Rocher P et al,[14] and Zhang et al,[15] similarly reported a specificity rate of 100% for incus erosion. Nevertheless, all of them indicated that HRCT had a sensitivity of 100%, which was greater in comparison to the current research. The HRCT had a sensitivity of 83.67% and a specificity of 100% in accurately detecting the condition of the stapes. Additionally, it had a positive predictive value (PPV) of 100% and a NPV of 82.5%. Rai T et al,[13] found that HRCT had a specificity of 100% but a lower sensitivity of 75% compared to the current study. Similarly, O Donoghue et al,[16] reported a specificity of 100%, a positive predictive value (PPV) of 100%, and a NPV of 76.2%, but a lower sensitivity of 71.2% compared to the present study in relation to stapes erosion. Chee et al,[17] found a strong association between radiosurgery and stapes, however Zhang et al,[15] found that HRCT is not effective in identifying stapes. The stapes was intermittently seen on CT scans, but when visible, it often showed as a soft tissue component in the oval window niche. Due to this reason, it was not feasible to differentiate between the destruction of the stapes and its simple encasement by soft tissue. The results align with the findings of Jackler et al,[18] Visualising the body of the malleus and the incus on HRCT is reasonably straightforward, but its clinical significance is limited unless the continuity of the ossicular chain can be established. The intricate structure consisting of the incus, malleus, and stapes is very susceptible to damage in cases of COM. However, it is also challenging to see these components accurately using HRCT. The research revealed that the tympanic portion of the face nerve is very prone to degradation. In the majority of instances, CT accurately determined whether the vertical and horizontal segments were impacted. In this investigation, we found that the sensitivity and specificity were 100% and 86.74% respectively, with a positive predictive value of 62.5. Sirigiri et al,[19] O Reily et al,[20] and Jackler et al,[18] achieved a diagnostic accuracy of 60% sensitivity and 90% specificity in detecting dehiscence in the horizontal segment of the facial canal. Nevertheless, Mafee et al,[21] discovered that CT is very precise in diagnosing erosion of the facial canal. Rai T et al,[13] found that facial canal dehiscence had a sensitivity of 33.33% and a specificity of 100%. Alzoubi et al,[22] and Garber et al,[23] obtained similar findings, but Chee and Tan et al,[17] and Zhang et al,[15] discovered a weak and inconsequential connection.

Erosion of the tegmen was seen in 15 out of 25% of patients, as indicated on the CT scan. During the operation, only 9 out of the total cases (15%) showed tegmen erosion. Our investigation revealed that CT scans had a tendency to over identify tegmen erosion. One possible explanation is that although even uncommon field and demineralized bone are described as eroded, they are only viewed as eroded after surgery when there is dural plate exposure. In our current investigation, we discovered that the sensitivity was 100%, the specificity was 87.19%, and the positive predictive value was just 54.56%. Kanotra S et al,[11] found a sensitivity of 100% and a specificity of 95.45%. Gerami et al,[24] reported a specificity rate of 95%. Prata et al,[25] reported a specificity rate of 91.93% and an NPV of 100%. Datta et al,[12] likewise claimed an NPV of 100%. Rocher et al,[14] Zhang et al,[15] and Dutta G et al,[12] have showed a comparable sensitivity of 100% with HRCT. According to the findings of our investigation, it was clear that the Sigmoid sinus, an anatomical feature, could be reliably identified as either normal or eroded by the CT scan with 100% sensitivity and specificity. Out of a total of 8 instances, erosion was seen in 13.33% of them, and the CT scan accurately detected and reported all of these cases. Park et al,[26] Rogha et al,[27] and Dutta G et al,[12] all reported a sensitivity and specificity of 100%. However, Payal et al,[9] found a sensitivity of 66% and a specificity of 92.6%. They also noted that the usefulness of the test in identifying individuals with a normal sinus plate was restricted, since the PPV was only 50%. Upon comparing CT scans with the results after surgery, it was discovered that soft

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tissue masses were present in all 60 instances, demonstrating a sensitivity and specificity of 100%. Additionally, the positive predictive value and negative predictive value were also 100%, accurately predicting the extent of the soft tissue mass. This result aligns with the findings of Walshe et al,[28] and Sirigiri et al,[19] who respectively found a sensitivity of 90% and 87.5%. Existing literature indicates that the presence of cholesteatoma during surgery may be seen in the middle ear and mastoid. However, it is not feasible to distinguish between masses such as granulations or cholesteatoma using HRCT.

CONCLUSION

Our results align with prior research, indicating a strong correlation between HRCT temporal bone findings and intraoperative surgical findings. Therefore, HRCT of the temporal bone is quite beneficial for both identifying and providing guidance for the surgical treatment of dangerous cholesteatoma of the middle ear. The early detection of cholesteatoma might possibly decrease the likelihood of developing late problems.

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