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Assessment of Temporal Bone Cholesteatoma with High Resolution Computed Tomography

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ABSTRACT
Cholesteatoma is a potentially risky disorder since it can spread and wear away nearby structures, leading to numerous severe problems. Temporal bone HRCT provides a clear depiction of the anatomy of several tiny and significant structures within the middle and inner ear cavity. Therefore, it is a highly effective method and preferred approach for diagnosing and determining the size of cholesteatoma. It has become crucial research in preoperative planning for surgeons. The current study demonstrates a strong association between different preoperative HRCT findings and intraoperative findings. The purpose of this study is to investigate how effective pre-operative HRCT is in evaluating disease in patients with middle ear cholesteatoma. Pre-surgical high-resolution temporal bone CT scans were performed and compared with findings after the operation. This was a study that comprised 70 individuals in a row with chronic suppurative otitis media with hazardous type cholesteatomas. Every patient underwent a complete clinical evaluation and HRCT examination. Some patients with probable intracranial consequence received intravenous contrast media. Radiological data before surgery were compared with data from the postoperative findings. The most prevalent pathology observed was infection (otomastoiditis), accounting for 29 cases (41.5%). The erosion of the scutum and lateral attic wall was the most often observed finding, occurring in 20.3% of patients. This was followed by the erosion of Korner's septum, which was identified in 617.2% of patients. Table 4 displays the erosion in the middle ear cavity. Based on the findings of our research, HRCT scan is a useful imaging technique that otologists can use before surgery to assess the condition of the ossicles and inform the patient about potential hearing outcomes.

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Key Words
Cholesteatoma, high resolution, computed tomography

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INTRODUCTION

A cholesteatoma is an atypical development or movement of skin from the ear canal into the middle ear. The term is rather perplexing because it is unrelated to cholesterol. Cholesteatoma is a fluid-filled growth made up of layers of skin cells and connective tissue, which is surrounded by an inflammatory response. Skin can enter the middle ear due to long-term negative pressures in the middle ear caused by Eustachian tube dysfunction, by skin directly moving into the middle ear through a hole in the eardrum. When the skin enters the middle ear, it has a tendency to build up and occupy the gaps in the middle ear and mastoid (the bone located behind the ear). This can lead to many issues, such as the wearing away of bone structures and persistent infections[1,2].

The treatment of cholesteatoma remains a difficult task for ear, nose and throat specialists worldwide. Even in countries with advanced healthcare facilities, where regular physical check-ups are done and there is easy access to medical specialists and efforts are made to prevent, detect early and treat cholesteatoma, there is still a significant occurrence of cholesteatoma and its complications in both children and adults. The diagnosis of cholesteatoma is carried out by otolaryngologists using various methods. These methods include gathering the patient's medical history, looking for signs of cholesteatoma during a physical examination using otoscopy and otomicroscopy and analysing imaging results such as computed tomography and magnetic resonance. Although cholesteatoma is identified globally, there are variations in how it is defined, classified and managed. The variations complicate the comparison of the accounts in the literature and restrict the capacity to draw additional implications from individual or regional outcomes. Thus, it is crucial to establish a shared scientific terminology, with the definitions of a problem as a foundation. Moreover, using a same categorization method will enable researchers to exchange their knowledge globally, resulting in improved evaluation and treatment of cholesteatoma[3,4].

HRCT is important in the surgical treatment of people with CSOM, especially those with atticoantral illness. Traditional methods of imaging the temporal bone, such as X-ray of the mastoid bones, have been supplanted by High Resolution Computed Tomography (HRCT) in recent times. Preoperative planning for surgeons now includes an indispensable inquiry[5,7]. HRCT scan has an important function in preoperative surgical approach determination by validating the clinical otoscopic findings and specifying the form and degree of the disease. The decision about the selection of a surgical procedure is especially important in order to maintain a better rate of hearing and avoid problems[8,9]. HRCT imaging of the temporal bone is becoming more and more useful for diagnosing, making surgical decisions and monitoring progress. Nevertheless, using routine HRCT screening before surgery in every patient with CSOM should only be deemed reasonable if it can be demonstrated to impact clinical care. We undertook this study to assess the use of preoperative HRCT in determining the breadth and severity of ossicular pathology in patients with CSOM of atticoantral illness and how it aids in planning for ossicular reconstruction and enhancing hearing outcomes. The purpose of this study is to examine the function, importance and influence of HRCT in identifying, assessing and diagnosing middle ear cholesteatoma[10-13].

MATERIALS AND METHODS

Data was gathered from patients who were clinically suspected and recommended to get a CT scan at Medical college in Haldia. The size of the sample was 70. Individuals with recurring chronic suppurative otitis media (CSOM) and individuals who had undergone additional surgeries, individuals with a history of temporal bone fracture, individuals with known cases of temporal bone neoplastic or granulomatous disease, individuals who were not suitable for surgery or scanning due to conditions such as ischemic heart disease or pregnancy and individuals with a history of head and neck radiotherapy were not included in the study. These 70 patients all had a CT scan before undergoing surgery to explore the middle ear and mastoid. At first, all patient's ears were checked with an otoscope at the outpatient clinic before to surgery. All patients had received pure tone audiometry (PTA) testing for hearing evaluation. For HRCT, consecutive 1mm thick sections with excellent resolution were obtained in both axial and coronal orientations. Axial pictures were captured in alignment with the orbitomeatal plane. Coronal sections were obtained parallel to the vertical ramus of the mandible. The radiographs were examined specifically to determine the condition of the ossicles, without any knowledge of the surgical results. All the scans were reviewed or confirmed by a single senior radiologist. Mastoid examination was performed on all patients and the surgical approach was decided based on the clinical diagnosis, HRCT findings and intraoperative observations. The amount of disease during the surgery was examined. Operative records were documented and data gathered on the condition of the ossicles. Operative data were compared with pre-operative HRCT images to determine the condition of the ossicular chain. The results were examined, researched and compared with previous similar studies.

A clinical history was obtained for each patient and all patients underwent a comprehensive examination of the ear, nose and throat (ENT) that

included a thorough inspection of the ear using an otoscope and microscope. Furthermore, a comprehensive audiological assessment was conducted, which included pure tone audiometry, tympanometry, speech discrimination score and stapedial reflex. Exclusion criteria included prior ear surgery, prior head trauma and a documented history of sensory neurological hearing loss. All patients were thoroughly prepared. The operative methods performed included intact canal wall (ICD), canal wall down (CWD), or atticotomy. The specific surgical procedure was determined by the location and size of the abnormal tissue. An analysis was conducted to determine the relationship between the data obtained during the operation and the results of imaging investigations.

RESULTS

Among the 70 patients involved in the study, 39 were male (55.7%) and the remaining 31 were female (44.3%). The average age of the group was 57 yrs, with a range of 16-74 yrs. The results are displayed in Fig 1. The patients were categorised into seven categories based on age: 10-19, 20-29, 30-39, 40-49, 50-59, 60-69 and 70-79 years and are referred to as groups I-VII. The researchers examined the demographic features of the patients, including their gender, age and comorbidity data, which are displayed in table 1. The many types of cholesteatoma are listed in Table 2. The most often reported kind of cholesteatoma was a combination of pars flaccida and pars tensa, which was found in 37.1% of patients. Another frequently identified kind was pars flaccida.

Table1: Demographic data of patients

Age (Years)	Benign	Malignant	Total
10-19	9	7	16
20-29	4	10	14
30-39	6	6	12
40-49	7	3	10
50-59	5	4	9
60-69	2	5	7
70-79	-	2	2
Total	33	37	70

Table 2: Type of cholesteatomas.

Type of cholesteatoma	No. of patients	%
Pars flaccida cholesteatoma	26	37.1
Pars tens cholesteatoma	19	27.1
Combined cholesteatoma	25	35.7

Table 3: Classification of cases based on the type of pathology observed.

Pathology	Population
Infection of Middle ear cleft	29 (41%)
Anomalies	18 (25.17%)
Tumours of external and middle ear	13 (18.5)
Fibrous dysplasia	10 (14.2%)
Total	70 (100%)

Table 4: Middle ear bony wall erosion.

Bony wall erosion	No. of patients	%
Blunted scutum	8	11.85
Eroded scutum and lateralattic wall	14	20.28
Eroded tegmen	10	14.28
Thinning of the tegmen	8	11.85
Eroded sigmoid sinus plate	8	11.85
Eroded superior and posterior meatal wall	10	14.28
Eroded Korner's septum	12	17.28

Table 5: Integrity of the ossicular chain.

Integrity of the ossicles	No. of patients	%
Completely eroded (no ossicles)	32	45.7
Eroded malleus only	26	37.14
Eroded incus only	9	12.8
Displaced intact ossicles	3	4.2
Total	70	100.0

The CT scans (Table 3) revealed several diseases including infections of the middle ear cleft (all with cholesteatoma), fractures of the temporal bone, abnormalities and tumours of the external auditory canal and middle ear. The most prevalent pathology observed was infection (otomastoiditis), accounting for 29 cases (41.5%).

The erosion of the scutum and lateral attic wall was the most often observed finding, occurring in 20.3% of patients. This was followed by the erosion of Korner's septum, which was identified in 617.2% of patients. Table 4 displays the erosion in the middle ear cavity. The incus was the most often eroded, observed in 45.7% of patients, followed by the malleus, observed in 37.14%. Table 5 shows the condition of the ossicular chain.

DISCUSSIONS

HRCT is highly useful for identifying initial erosive changes in the ossicles, especially in the smaller sections. It is also effective in detecting non-dependent soft tissue opacification that may indicate the presence of cholesteatoma. This diagnosis is typically made during an otologic examination[14]. The study comprised a total of 70 patients, with 39 being male (55.7%) and the remaining 31 being female (44.3%). The average age of the group was 57 yrs, with a range of 16-74 years. The highest occurrence of cholesteatoma was observed in individuals in their thirties, while the lowest occurrence was observed in individuals in their sixties.

It is mentioned that acquired cholesteatoma is an inflammatory condition that can happen at any age but is more frequently observed in those under 30 years old. There is usually a past of repeated middle ear infections, resulting in a hole in the eardrum. A study conducted by Kemppainen et al found that the occurrence of cholesteatoma was greater in males below the age of 50 years. In this study, 35.71% of cholesteatoma patients in the test population showed repeated episodes of Pars flaccida cholesteatoma.

The findings of our study revealed that the CT scans showed various pathologies, including middle ear cleft with cholesteatoma, fractures of the temporal bone, anomalies and tumours of the external auditory canal and middle ear. Among these pathologies, infection (otomastoiditis) was the most frequently observed, accounting for 41.5% of cases (Table 3). All of these clinical characteristics align with the presentation documented in the literature by Seiden et

al and Balleneger. They stated that patients with cholesteatoma commonly experience ear discharge and hearing loss as their main symptoms. The severity of hearing loss can range from minor to severe[15,16]. One of the key benefits of the HRCT scan is its ability to identify early cholesteatoma through the observation of little bone degradation or movement of the ossicles. An early identification using HRCT scan using a straightforward noninvasive surgical procedure (atticotomy) will address the issue and maintain auditory function. The current results indicate that erosion of the scutum and lateral attic wall was the most frequently observed in 20.3% of patients, followed by erosion of Korner's septum[17,18].

Mafee and colleagues, as well as David and colleagues, provided a description of the characteristics that indicate cholesteatoma. They stated that the blunting of the normally pointed tip of the scutum is generally the early evidence of attic cholesteatoma. Joselitol *et al* mentioned that indications of cholesteatoma in the attic include damage or destruction of the scutum and enlargement of the aditus and antrum with a change in appearance[19].

The findings of our research indicated that the occurrence of intracranial complication is 14.3%. In this study, difficulties were experienced by 8 patients in the form of cerebellar abscess, brain abscess, abscess outside the dura and hydrocephalus caused by ear infection. The patients had symptoms of general discomfort, including headache and fever. A neurosurgeon was sought for surgical intervention. Graziela and her colleagues determined in their study that brain abscess is the most frequent intracranial consequence and primarily affects the temporal lobe and cerebellum. El-Essawy et colleagues found in a study of 32 cases that all patients with cholesteatoma (100%) had temporal bone problems, such as bone erosion and cavity formation. They also observed that 93.81% of patients had sclerosis of the mastoid and ossicular degeneration. Intracranial problems were observed in 21.7% of cases[20].

The results of our investigation indicated that every patient with cholesteatoma exhibited at least one of the HRCT criteria that suggested the presence of cholesteatoma. Additionally, 54 individuals (92.8%) displayed all three radiological signs associated with cholesteatoma. Seventy patients were precisely diagnosed using HRCT scans that matched the surgical results. This aligns with Mafee *et al* who reported in their study of 48 patients with cholesteatoma that 46 of them (96%) had been accurately diagnosed with preoperative HRCT.

According to Chee *et al's* study on 36 patients, it was found that HRCT accurately diagnosed 34 cases (94.4%). Joselito and colleagues showed in their study of 64 patients that the examination of the preoperative HRCT scan was highly accurate (96.8%) in correlating with the surgical findings and histopathologic reports. Hassman and colleagues, in a study involving 60 patients, found a strong connection between HRCT findings and surgical characteristics in cholesteatoma for the majority of middle ear structures. In a research conducted by Joselito et al on a group of 64 patients, it was discovered that 4 instances (6.3%) had labyrinthine fistula as detected by HRCT. However, only 3 cases (4.7%) were consistent with the findings from surgery. Anelise and colleagues claimed that erosion of the lateral semicircular canal was found in two patients and was accurately detected by preoperative HRCT. According to Chee et al in their study, preoperative HRCT was able to detect 5 out of 6 cases of lateral semicircular canal fistula. Stephenson and colleagues noted that preoperative HRCT scanning is highly accurate in diagnosing labyrinthine fistula (with a sensitivity of 100%) and the size of the fistula as seen on the scan can assist determine its kind. The findings of our study align with the results reported by Joselito *et al*, Anelise *et al*, Chee *et al* and Stephenson *et al*, indicating that the sensitivity of HRCT in detecting labrynthine fistula was 100%.The current study found that out of 12 patients who had proven facial canal erosion through surgery, only 10 patients were identified by HRCT with an accuracy rate of 96.4% and a sensitivity rate of 83.3%.

Joselito and colleagues mentioned that it is often challenging to show facial nerve canal involvement before surgery, not only because the canal is small, but also because it is at an angle and can have gaps in development, especially when it is next to soft tissue[12]. The results we obtained are consistent with the findings of Sethom *et al*, who reported that analysing the bone structures of the middle ear using HRCT scans showed a satisfaction rate of 83% in terms of sensibility. They concluded that preoperative computed tomography is essential for diagnosing and evaluating chronic middle ear cholesteatoma, as it helps identify the extent of the lesions and detect any complications. The HRCT analysis and surgical correlation have demonstrated that the accuracy, reliability and prediction ability of HRCT scans are influenced by the specific anatomical structures affected by cholesteatoma damage[21].

CONCLUSION

In summary, the outcomes of this study indicate that the preoperative HRCT scan imaging in cases of cholesteatoma and ossicular chain erosion are closely related to the intraoperative findings. HRCT of the temporal bone is thus a helpful tool for the surgeon in treating patients with CSOM with atticoantral illness. We think that HRCT can provide information about the nature of the disease (destructive/non-destructive), potential risks (like SCC fistula) and potential

complications. This information can help the surgeon decide which surgery to perform (simple or radical mastoidectomy, with or without tympanoplasty). Since it is crucial to identify the disease at an early stage in order to consider a surgical operation, in order to prevent the patient from experiencing hearing loss to avoid serious issues within the skull, it can be reasonable to recommend patients to undergo a routine HRCT before surgery. It is capable of forecasting the result of the procedure also aids in discussing these potential outcomes with the patient. By increasing the utilisation of HRCT scanning, a significant reduction in morbidity can be achieved. Due to the capacity to observe middle ear structures with excellent clarity, it is possible to perform more focused procedures that effectively eliminate disease while maintaining function.

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