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CT-based Cholesteatoma staging using intraoperative correlation

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Abstract
Background: Cholesteatoma is a potentially fatal non-neoplastic lesion of the temporal bone that is common in low-income communities in developing countries such as India. It is typified by the aberrant development of keratinizing squamous epithelium, which has invasive characteristics that might cause the middle ear cleft to alter destructively and perhaps result in major issues in the extracranial and cerebral areas.
Methods: The current study is set up as an observational study that will be conducted in the Department of Radiodiagnosis, KBN Institute of Medical Sciences, Gulbarga, Karnataka, India, between February 2016 to January 2017, with the approval of the ethics committee and the patients' written agreement.
Results: The study demonstrates that HRCT staging for middle ear cholesteatoma has a sensitivity of 85.6% and an excellent agreement and relationship with surgical results. The cholesteatoma sac, accompanying granulation tissue, mucosal edema, and effusion that could go unnoticed in HRCT pictures could be the cause of the underestimating of cholesteatoma at CT.
Conclusion: In order to reduce comorbidity, the surgeon can choose the optimum type of surgery to undertake with the use of the new non-invasive HRCT staging method proposed in this study for middle ear cholesteatomas.

Keywords: Cholesteatoma staging, CT, intraoperative correlation

Introduction
Accurate assessment of each patient's unique temporal bone structure, including any changes, and the severity of the disease aid surgeons in choosing the best surgical strategy and reducing complications [1]. Research has assessed the precision and use of preoperative CT scans in cholesteatoma detection and surgical management planning [2-4]. While X-rays were previously a popular imaging method, they also had disadvantages. These days, good bone characteristics of the petrous temporal bone are available using thin-section high resolution computed tomography. Magnetic resonance imaging (MRI) generates sectional pictures similarly to CT. However, HRCT is far superior at imaging the temporal bone since it can display both soft tissue and bone characteristics [5-7].
Currently, HRCT Temporal bone imaging is considered to be the most useful imaging modality for illustrating the expansion of the middle ear into the cranial cavity, as well as its bony characteristics and soft tissue attenuation. It is believed that intracranial issues can be identified with CT screening [8, 9].
There are two types of cholesteatomas: Acquired and congenital. Primary and secondary acquired cholesteatomas are the two varieties [10]. Based on its place of origin, cholesteatoma is further classified into the pars tensa, tympanum, and attic. The suggested clinical staging of cholesteatoma classification is determined by the location, extent, and any related issues. However, because it did not provide a management plan, it was unable to achieve clinical significance [11, 12].
The aim of the study was to illustrate the benefits of HRCT for patients with cholesteatoma. This study looks into the effect of middle ear Cholesteatoma CT staging on the choice of surgical method. Determine the middle ear Cholesteatoma CT staging and select the surgical method with the fewest comorbidities.

Methodology
The current study is designed to be an observational study, and it will be carried out between February 2016 and January 2017 at the KBN Institute of Medical Sciences, Gulbarga, Karnataka, India, in accordance with the patients' written consent and the ethical committee's

clearance. Between the CT scan and the surgery, five to ten days pass. Every patient's surgery is scheduled according to the Cholesteatoma stage determined by CT scan. A CT scanner with 16 slices and multiple detectors was utilized for all imaging procedures. Using a 0.5 mm slice thickness, 0.3 mm overlapped spacing, 250 ms mA, 120 ms kV, 0.625 helical pitch, 0.8 seconds rotation time, and 240 mm field of view, helical transverse scans of the temporal bone were created. A skeletal algorithm was used to rebuild the acquired data in order to produce the best possible image of the temporal bone structure.

Inclusion criteria

All patients who had clinical examinations with an otoscope and an otoendoscope and were diagnosed with cholesteatoma are included.

Exclusion criteria

People with inactive chronic otitis media, inactive squamosal chronic otitis media, revision surgery, congenital ear disease, suspicious malignant ear pathology, a history of temporal bone fracture, systemic diseases that may affect the ear, and those who are unfit for surgery or CT scanning are not allowed to participate in this study.

Results

A clinical investigation using a prospective cohort was carried out on forty patients who were referred to our Radiology Department. The patients were between the ages of 6 and 85, with a mean age of 15 to 30. The largest number of patients were in the age range of 10 to 30 years.

Table 1: Distribution of age

Sr. No.	Age	Patients
1	< 20	10
2	21-30	11
3	31-40	09
4	41-50	9
5	> 50	01

Table 2: Distribution by gender wise

Gender	Patients	%
Male	24	60%
Female	16	40%

P value - 0.321: No discernible difference between male and female incidence

Table 3: The cholesteatoma's side

Side	Patients	%
Right	24	60%
Left	16	40%

There is no prevalence based on side involvement, with 24 patients (60%) having right side pathology and 16 patients (40%) having left side disease.

Table 4: Participation with attic

Participation with attic	On CT	On surgery
Present	22	22
Absent	18	18

On HRCT, attic involvement was seen in twenty-one of the forty patients, and similar results were observed following surgery. Both the sensitivity and specificity for attic participation are 100%.

Table 5: Engagement of the tympanum

Engagement of the tympanum	ON CT	On Surgery
Present	22	22
Absent	18	18

Twenty-two of the forty patients had involvement of the tympanum on HRCT, and similar results were observed during surgery. Both the sensitivity and specificity for tympanum involvement are 100%.

Table 6: Anterior mastoid and air cells

Anterior mastoid and air cells	ON CT	On Surgery
Present	26	26
Absent	11	14

26 of the 40 patients had involvement of the Mastoid Antrum on HRCT, and similar results were seen during surgery. When it comes to the mastoid antrum's involvement, both sensitivity and specificity are 100%.

Table 7: Scutum participation

Scutum participation	ON CT	On surgery
Present	27	27
Absent	13	13

27 of the 40 patients showed scutum erosion that was detectable on HRCT, and similar findings were made during surgery. It is completely specific and 100% sensitive to Scutum involvement.

Table 8: Malleus's participation

Malleus's participation	ON CT	On surgery
Present	30	30
Absent	10	10

Ten patients had it found during surgery, while thirty of the forty patients exhibited Malleus erosion on HRCT. HRCT can identify Malleus involvement with a sensitivity of 75% and a specificity of 100%.

Table 9: Incus participation

Incus participation	ON CT	On surgery
Present	17	17
Absent	23	23

Incus erosion was found in 23 individuals during surgery, although it was only visible in 17 of the 40 patients on HRCT. In this case, HRCT detects incus erosion with a sensitivity of 78% and a specificity of 89.91%.

Table 10: Involved facial nerve canals

Involved facial nerve canals	ON CT	On surgery
Present	10	10
Absent	30	30

Out of the 40 patients with HRCT, 10 exhibited apparent involvement of the facial nerve canal; however, only 30 had this found during surgery. In this instance, there is 100% sensitivity but only 97.60% specificity.

Table 11: Complications inside the skull

Complications inside the skull	ON CT	On surgery
Present	03	03
Absent	37	37

HRCT revealed intracranial issues in three of the 40 patients, and additional testing produced similar findings. The sensitivity and specificity are 100%.

Table 12: An additional cranial problem

An additional cranial problem	ON CT	On surgery
Present	03	03
Absent	37	37

Two of the forty patients experienced extracranial problems, which three more patients had intra operatively discovered. In this case, the sensitivity is 33% and the specificity is 100%.

Discussions

The study demonstrates that HRCT staging for middle ear cholesteatoma has a sensitivity of 85.6% and an excellent agreement and relationship with surgical results. The potential presence of cholesteatoma sac, associated granulation tissue, mucosal edema, and effusion on HRCT images could explain the underestimating of the cholesteatoma area by 13.4%. Cholesteatoma and granulation tissue have similar attenuation values, but they cannot be differentiated by attenuation values because the difference is not visible on CT [13, 14]. Non-echoplanar diffusion weighted MR imaging is required to distinguish between scar tissue and cholesteatoma.

It was discovered that the subjects of this investigation had atticotymapnic, tympanic, and attic cholesteatoma. Tympanic cholesteatoma occupies the tympanic space medial to the middle ear ossicles and frequently involves the facial recess and sinus tympani, whereas attic cholesteatoma manifests on HRCT as a nondependent soft dense mass opacity in Prussak's space lateral to the middle ear ossicles. Choleatoma primarily occupies the tympanic cavity in atticotympanic cholesteatoma [15–19].

Instead of primarily affecting the mastoid, cholesteatoma is a middle ear condition. Therefore, before addressing the mastoid cavity, cholesteatoma surgery ought to be limited to the middle ear [20]. The junction of the mastoid antrum and the attic is known as the aditus-ad-antrum. If a cholesteatoma is present, it might weaken the wall of the "figure of 8" and increase the "waistline" (Aditus) [21]. The level of mastoid involvement will determine how cholesteatoma patients are treated. HRCT is essential for assessing the amount of mastoid air cells that need to be exenterated in order to prevent a disease recurrence [22–25].

In this study, the sensitivity of CT to identify mastoid involvement is 100%. Choleatoma patients may have intracranial as well as extracranial issues. The type of treatment chosen depends on the issues' existence and location. It has been reported that 4% of cases with labyrinthine fistulas affected the lateral semicircular canal. Pneumolabyrinths are a clear indicator of fistulas, notwithstanding their rarity [26, 27]. The most frequent extratemporal consequence, subperiosteal abscess, is brought on by infection that moves from the mastoid to the periosteal space as a result of mastoid cortical erosion. A brain abscess is the most frequent intracranial consequence of cholesteatoma, especially in the temporal lobe and cerebellum. Lateral sinus thrombosis, also known as sigmoid sinus thrombosis, is another intracranial consequence of cholesteatoma. The perisinus gap is made visible by bone loss or the growth of the mastoid emissary vein thrombophlebitis. Two patients with cholesteatoma experienced intracranial difficulties in our study, whereas one patient had extracranial problems [28, 29].

Otologists have to choose between transcanal atticotomy, canal wall down, and whole canal wall procedures for cholesteatoma. This staging method aids the surgeon in selecting the best course of action for cholesteatoma based on the location, growth into the mastoid cavity, and presence of associated comorbidities [30, 31]. It could also lead to better clinical outcomes and a successful, possibly less intrusive surgical procedure. To link this staging to patient-reported outcomes, more research needs to be done [32]. This study has certain drawbacks. The study's limited patient group is a disadvantage because multicenter studies validated on a large patient population improve the utility of CT staging for cholesteatoma. Second, sixteen multi-detector CT scanners were used in this investigation. The image quality will be improved by using more multi-detector CT scanners, such as dual energy CT, cone beam CT, and 64 or 256. Furthermore, the results will be improved by comparing CT data with diffusion MR imaging and, in more complex cases, with contrast MR imaging.

Conclusion

This work created a novel non-invasive HRCT staging technique for middle ear cholesteatomas that helps the surgeon choose the most appropriate surgical approach to reduce comorbidity. To guarantee a precise diagnosis and help with treatment planning, HRCT should be utilized in conjunction with other diagnostic modalities, just like any other medical instrument.

Conflict of Interest

None

Funding

None

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