Original Research Article

Cholesteatoma staging on CT with intraoperative correlation

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Abstract

Background: Inflammatory disease of the temporal bone called cholesteatoma is caused by the growth of keratinizing squamous epithelium, keratin debris and various perimatrix thicknesses, with or without a concomitant inflammatory response. As a result of the release of osteoclasts and mononuclear inflammatory cells, surrounding structures such the scutum, tegmen and ossicular chain deteriorate.

Methods: The current study is set up as an observational study that will be conducted in the ENT and Radiology departments of Kamineni Institute of Medical Sciences, Narketpally, Telangana, India, between November 2021 to October 2022, with the approval of the ethics committee and the patients' written agreement.

Results: In this study, the sensitivity of HRCT staging for middle ear cholesteatoma is 86.6% and the agreement and association with the surgical outcomes are excellent. The underestimation of cholesteatoma at CT may be due to the cholesteatoma sac, associated granulation tissue, mucosal edema and effusion that may be undetected in HRCT images.

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

Inflammatory disease of the temporal bone called cholesteatoma is caused by the growth of keratinizing squamous epithelium, keratin debris, and various perimatrix thicknesses, with or without a concomitant inflammatory response. As a result of the release of osteoclasts and mononuclear inflammatory cells, surrounding tissues such the scutum, tegmen and ossicular chain deteriorate [1-4].

X-rays were once a common imaging technique, but they had their own drawbacks. These days, thin-section high resolution computed tomography offers good bone features in the petrous temporal bone. Similar to CT, magnetic resonance imaging (MRI) also produces sectional images. But because it can show both soft tissue and bone features, HRCT is significantly better at imaging the temporal bone [5-7].

Now HRCT The most effective imaging technique for displaying the middle ear's expansion into the cranial cavity and its bony features and soft tissue attenuation is thought to be temporal bone imaging. It is thought that CT scanning is quite useful for identifying intracranial problems [8, 9].

Congenital and acquired cholesteatomas fall into two groups. The two types of acquired

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cholesteatoma are primary and secondary [10]. Cholesteatoma is further divided into categories based on where it originated, including the attic, tympanum, and pars tensa. According to the location, the extent, and any associated problems, the recommended clinical staging of cholesteatoma classification is made. However, it was unable to attain clinical importance because it did not offer a management plan [11, 12].

The study's objectives and purpose were to demonstrate the advantages of HRCT for cholesteatoma patients. In this study, the middle ear Cholesteatoma CT staging and its impact on surgical procedure selection are being investigated. Locating the sac and measuring its diameter while evaluating the ossicles, facial nerve canal, tegmen, sinus plate, and any related problems. Before continuing with the procedure, should compare intraoperative findings and HRCT results. Choose the surgical procedure that has the fewest comorbidities while also determining the middle ear Cholesteatoma CT staging.

Materials and Methodology

The current study is set up as an observational study that will be conducted in the ENT and Radiology departments of the Kamineni Institute of Medical Sciences, Narketpally, Telangana, India, between November 2021 to October 2022, with the approval of the ethics committee and the patients' written agreement. Five to ten days pass between the CT scan and the surgery. Surgery is planned based on the Cholesteatoma stage identified by CT for all patients. For all imaging procedures, a 16-slice multidetector CT scanner was used. Helical transverse scans of the temporal bone were produced using a slice thickness of 0.5mm, spacing of 0.3mm with overlap, mA of 250ms, kV of 120ms, helical pitch of 0.625, rotation period of 0.8 seconds, and field of view of 240mm. To provide the best image of the temporal bone anatomy, the collected data was rebuilt using a bony algorithm.

Inclusion criteria

- Included are all patients who underwent otoscope and otoendoscope clinical examinations and were found to have cholesteatoma.

Exclusion criteria

- Excluded from the study are people with active mucosal chronic otitis media, revision surgery, inactive chronic otitis media, inactive squamosal chronic otitis media, congenital ear disease, suspicious malignant ear pathology, a history of temporal bone fracture, systemic disease that may affect the ear and people who are unfit for CT scanning and surgery.

Results

The prospective cohort clinical investigation was conducted on 40 patients who were referred to our Radiology Department between November 2021 to October 2022, after being suspected of having chronic otitis media using an otoscope at Kamineni Institute of Medical Sciences, Narketpally, Telangana, India. The patients' ages ranged from 6 to 85 years old, with a mean age of 15 to 30 years. The age range of 10 to 30 years saw the greatest number of patients.

Table 1: Distribution of age

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

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Table 2: Distribution by gender wise

Gender	Patients	%
Male	22	55%
Female	18	45%

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

Table 3: The cholesteatoma's side

Side	Patients	%
Right	25	62.5%
Left	15	37.5%

According to the side involvement, there is no preponderance, with 15 patients (35.5%) having left side pathology and 25 patients (62.5%) having right side pathology.

Table 4: Participation with attic

Participation with attic	On CT	On surgery
Present	21	21
Absent	19	19

Twenty-one of the forty patients had attic involvement visible on HRCT, and comparable findings were discovered during surgery. For attic participation, the sensitivity and specificity are both 100%.

Table 5: Engagement of the tympanum

Engagement of the tympanum	ON CT	On surgery
Present	23	23
Absent	17	17

Out of 40 patients, 23 individuals had tympanum involvement on HRCT, and comparable findings were seen during surgery. For tympanum involvement, the sensitivity and specificity are both 100%.

Table 6: Anterior mastoid and air cells

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

Out of 40 patients, 26 individuals had Mastoid Antrum involvement on HRCT and comparable findings were observed during surgery. The sensitivity and specificity for the involvement of the mastoid antrum are both 100%.

Table 7: Scutum participation

Scutum participation	ON CT	On Sugary
Present	28	28
Absent	12	12

Out of 40 patients, 28 individuals had scutum erosion visible on HRCT, and comparable results were found during surgery. It is 100% sensitive and 100% specific for Scutum involvement.

Table 8: Malleus's participation

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

Thirty of the 40 patients had Malleus erosion on HRCT, however ten individuals had it discovered during surgery. HRCT has a sensitivity of 89% but a specificity of 100% for detecting involvement of the Malleus.

Table 9: Incus participation

Incus participation	ON CT	On Sugary
Present	18	18
Absent	22	22

Out of 40 patients, incus erosion was seen in 18 patients on HRCT, however it was discovered in 22 patients during surgery. Here, HRCT has a sensitivity of 79% and a specificity of 90.91% for detecting incus erosion.

Table 10: Involved facial nerve canals

Involved facial nerve canals	ON CT	On Surgery
Present	09	09
Absent	31	31

Facial Nerve canal involvement was visible in 09 of the 40 patients with HRCT, although only 31 patients had it discovered during surgery. The specificity in this case is 97.60%, but the sensitivity is 100%.

Table 11: Complications inside the skull

Complications inside the skull	ON CT	On surgery
Present	3	3
Absent	37	37

Three of the 40 patients had intracranial problems identified by HRCT, and other tests revealed similar results. 100% of the sensitivity and specificity.

Table 12: An additional cranial problem

An additional cranial problem	ON CT	On surgery
Present	02	02
Absent	38	38

Out of 40 patients, two patients had extra cranial complications, which were detected intraoperatively in two more patients. Here, the specificity is 100% and the sensitivity is 33%.

Discussion

In this study, the sensitivity of HRCT staging for middle ear cholesteatoma is 86.6% and the agreement and association with the surgical outcomes are excellent. The underestimation (13.4%) of the cholesteatoma area at CT may be attributed to the cholesteatoma sac, associated granulation tissue, mucosal edema, and effusion that may be visible on HRCT images. Despite having a lower attenuation value than granulation tissue, cholesteatoma cannot be distinguished from granulation tissue using attenuation values since the difference is unnoticeable on CT. In order to differentiate between cholesteatoma and scar tissue, non-echo planar diffusion weighted MR imaging is necessary [13-15].

Attic cholesteatoma, tympanic cholesteatoma and atticotymapnic cholesteatoma were all found in this study's participants. While attic cholesteatoma appears on HRCT as a nondependent soft dense mass opacity in Prussak's space lateral to the middle ear ossicles, tympanic cholesteatoma occupies the tympanic space medial to the middle ear ossicles and frequently involves the facial recess and sinus tympani. In attico-tympanic cholesteatoma, cholesteatoma predominately fills the tympanic cavity [16-19].

Cholesteatoma is primarily a disorder of the middle ear rather than the mastoid. As a result, cholesteatoma surgery should only be performed on the middle ear before moving on to the mastoid cavity [20, 21]. The aditus-ad-antrum refers to the connection between the attic and the mastoid antrum. A cholesteatoma may erode the "figure of 8"'s" wall and enlarge the "waistline" (aditus) when it is present. The care of cholesteatoma patients will depend on the degree of mastoid involvement. To avoid a disease recurrence, HRCT is crucial for determining the extent of the mastoid air cells that must be exenterated [22-25].

In this investigation, CT has a 100% sensitivity for detecting mastoid involvement. Patients with cholesteatoma may experience both extracranial and intracranial problems. The presence of problems and where they are located affect the treatment option. Labyrinthine fistulas were documented to affect the lateral semicircular canal in 4% of cases. Although they are rarely found, pneumolabyrinths are a dead giveaway of fistulas [26, 27]. Subperiosteal abscess, the most common extratemporal complication, is caused by infection migrating from the mastoid to the periosteal space as a result of mastoid cortical erosion. Brain abscess, particularly in the temporal lobe and cerebellum, is the most common intracranial repercussion of cholesteatoma. Another intracranial effect of cholesteatoma is sigmoid sinus thrombosis or lateral sinus thrombosis. Bone deterioration or the expansion of mastoid emissary vein thrombophlebitis exposes the parasinus gap. In this investigation, 1 patient with cholesteatoma had extracranial issues found and 2 patients with the condition had intracranial complications [28, 29].

For cholesteatoma, otologists must decide whether to conduct an entire canal wall, canal wall down, or transcanal atticotomy. Based on the location, expansion into the mastoid cavity, and existence of related comorbidities, this staging system helps the surgeon choose the optimum procedure for cholesteatoma [30, 31]. Additionally, it might contribute to a successful and perhaps less invasive surgical operation as well as improved clinical results. More study should be done to connect this staging to patient-reported outcomes [32]. There are a few limitations to this study. Because multicenter studies with validation on a large patient population improve the use of CT staging for cholesteatoma, the study's small patient group is a limitation. Second, this study made use of 16 multi-detector CT scanners. Using more multi-detector CT scanners, such as 64 or 256, dual energy CT and cone beam CT, will enhance the image quality. Additionally, by comparing CT data with diffusion MR imaging and contrast MR imaging in complicated cases [33-35], the results will be enhanced.

Conclusion

This study developed a new non-invasive HRCT staging method for middle ear cholesteatomas that aids the surgeon in determining the best kind of surgery to perform in order to minimize comorbidity.

Conflict of Interest: None.

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References

1. Barath K, Huber A, Stampfli P, *et al*. Neuroradiology of cholesteatomas. Am J Neuroradiol. 2011;32:221-29
2. Juliano AF, Ginat DT, Moonis G. Imaging review of the temporal bone: part I. Anatomy

and inflammatory and neoplastic processes. Radiology. 2013;269:17-33.

3. Más-Estellés F, Mateos-Fernández M, Carrascosa-Bisquert B, *et al*. Contemporary non-echo-planar diffusion-weighted imaging of middle ear cholesteatomas. Radiographics. 2012;32:1197-213.
4. Lemmerling M, De Foer B, Verbist B, Vande Vyver V. Imaging of inflammatory and infectious diseases in the temporal bone. Neuroimag Clin North Am. 2009;19:321-37.
5. Bruce B, Ian G. Acquired cholesteatoma: classification and outcomes. Otol Neurotol. 2011;32:992-95.
6. Trojanowska A, Drop A, Trojanowski P, *et al*. External and middle ear diseases: radiological diagnosis based on clinical signs and symptoms. Insights Imaging. 2012;3:33-48.
7. Abdel Razek A, Huang B. Lesions of the Petrous Apex: Classification and Findings at CT and MR Imaging. Radiographics. 2012;32:151-73.
8. Yildirim-Baylan M, Ozmen C, Gun R, *et al*. An evaluation of preoperative computed tomography on patients with chronic otitis media. Indian J Otolaryngol Head Neck Surg. 2012;64:67-70.
9. Majithia A, Lingam R, Nash R, *et al*. Staging primary middle ear cholesteatoma with non-echoplanar (half-Fourier-acquisition single-shot turbo-spin-echo) diffusion-weighted magnetic resonance imaging helps plan surgery in 22 patients: Our experience. Clin Otolaryngol. 2012;37:325-30.
10. Ayache D, Darrouzet V, Dubrulle F, *et al*. Imaging of non-operated cholesteatoma: Clinical practice guidelines. Eur Ann Otorhinolaryngol Head Neck Dis. 2012;129:148-52.
11. Eshetu T, Aygun N. Imaging of the temporal bone: A symptom- based approach. Semin Roentgenol. 2013;48:52-64.
12. Yamashita K, Yoshiura T, Hiwatashi A, *et al*. Contributing factors in the pathogenesis of acquired cholesteatoma: Size analysis based on MDCT. Am J Roentgenol. 2011;196:1172-75.
13. Stasolla A, Magliulo G, Cortese A, *et al*. Preoperative imaging assessment of chronic otitis media: what does the otologist need to know? Radiol Med. 2011;116:114-24.
14. Lemmerling M, De Foer B, Vande Vyver V, *et al*. Imaging of the opacified middle ear. Eur J Radiol. 2008;66:363-71.
15. Schmerber S, Lefournier V, Karkas A. What the surgeon cannot see and needs to see before middle ear surgery. J Otorhinolaryngol Relat Spec. 2010;72:145-57.
16. Ng JH, Zhang E, Soon S, *et al*. Pre-operative high resolution computed tomography scans for cholesteatoma: Has anything changed? Am J Otolaryngol Head and Neck Med and Surg. 2014;35:508-15.
17. Corrales CE, Blevins NH. Imaging for evaluation of cholesteatoma: current concepts and future directions. Curr Opin Otolaryngol Head Neck Surg. 2013;21:461-67.
18. Manasawala M, Cunnane ME, Curtin HD, Moonis G. Imaging findings in auto-atticotomy. Am J Neuroradiol. 2014;35:182-85.
19. Saleh HA, Mills RP. Classification and staging of cholesteatoma. Clin Otolaryngol Allied Sci. 1999;24:355-59.
20. Tos M. Cartilage tympanoplasty methods: proposal of a classification. Otolaryngol Head Neck Surg. 2008;139:747-58.
21. Belal A, Reda M, Mehana A, Belal Y. TMC: A new staging system for tympano-mastoid cholesteatoma. J Int Adv Otol. 2012;8:63-68.
22. Shin SH, Shim JH, Lee HK. Classification of external auditory canal cholesteatoma by computed tomography. Clin Exp Otorhinolaryngol. 2010;3:24-26.
23. Inokuchi G, Okuno T, Hata Y, *et al*. Congenital cholesteatoma: posterior lesions and the staging system. Ann Otol Rhinol Laryngol. 2010;119:490-94.
24. Tomlin J, Chang D, McCutcheon B, Harris J. Surgical technique and recurrence in cholesteatoma: A meta-analysis. Audiol Neurootol. 2013;18:135-42.

25. Galm T, Martin TP, Raut V. Open and closed cavity mastoid operations: comparing early hearing results. Eur Arch Otorhinolaryngol. 2013;270:77-80.
26. Gaillardin L, Lescanne E, Morinière S, *et al*. Residual cholesteatoma: Prevalence and location. Follow-up strategy in adults. Eur Ann Otorhinolaryngol Head Neck Dis. 2012;129:136-40.
27. lvarez F, Gómez J, Bernardo M, Suárez C. Management of petrous bone cholesteatoma: Open versus obliterative techniques. Eur Arch Otorhinolaryngol. 2011;268:67-72.
28. Carlson ML, Latuska RF, Pelosi S, *et al*. Evolving considerations in the surgical management of cholesteatoma in the only hearing ear. Otol Neurotol. 2014;35:84-90.
29. Park M, Rah Y, Kim Y, Kim J. Usefulness of computed tomography Hounsfield unit density in preoperative detection of cholesteatoma in mastoid ad antrum. Am J Otolaryngol Head Neck Med Surg. 2011;32:194-97.
30. Marchioni D, Mattioli F, Cobelli M, *et al*. CT morphological evaluation of anterior epitympanic recess in patients with attic cholesteatoma. Eur Arch Otorhinolaryngol. 2009;266:1183-89.
31. Rogha M, Hashemi SM, Mokhtarinejad F, *et al*. Comparison of preoperative temporal bone CT with intraoperative findings in patients with cholesteatoma. Iran J Otorhinolaryngol. 2014;26:7-12.
32. Phillips G, LoGerfo S, Richardson M, Anzai Y. Interactive web- based learning module on CT of the temporal bone: Anatomy and pathology. Radiographics. 2012;32:E85-105.
33. Tawfik AM, Kerl JM, Razek AA, *et al*. Image quality and radiation dose of dual-energy CT of the head and neck compared with a standard 120-kVp acquisition. Am J Neuroradiol. 2011;32:1994-99.
34. Theunisse HJ, Joemai RM, Maal TJ, *et al*. Cone-beam CT versus multi-slice CT systems for postoperative imaging of cochlear implantation-a phantom study on image quality and radiation exposure using human temporal bones. Otol Neurotol. 2015;36:592-99.
35. Agacayak KS, Gulsun B, Koparal M, *et al*. Alterations in Maxillary Sinus Volume among Oral and Nasal Breathers. Med Sci. Monit. 2015;21:18-26.