Section: Radiodiagnosis

Original Research Article

PRE OPERATIVE HRCT OF MIDDLE EAR PATHOLOGY WITH PARTICULAR REFERENCE TO INTRA-OPERATIVE FINDINGS IN CHOLESTEATOMA

Ashutosh Roy[1], Soumit Maji[2], Yati Raj Dhir[3], Rezaul Karim[4]

[1]Final year Post Graduate Trainee, Department of Radiodiagnosis, MGM Medical College & LSK Hospital, Kishanganj, Bihar, India.
[2]Final year Post Graduate Trainee, Department of Radiodiagnosis, MGM Medical College & LSK Hospital, Kishanganj, Bihar, India.
[3]Final year Post Graduate Trainee, Department of Radiodiagnosis, MGM Medical College & LSK Hospital, Kishanganj, Bihar, India.
[4]Professor & HOD, Department of Radiodiagnosis, MGM Medical College & LSK Hospital, Kishanganj, Bihar, India.

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Corresponding Author:
Dr. Ashutosh Roy,
Email: ashunbmc@gmail.com

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Abstract

Background: Cholesteatoma is a cystic lesion composed of epithelium and stroma surrounded by inflammatory reaction which is an inflammatory disease of the temporal bone, generally develops in the middle ear and is the result of the formation of keratinized squamous epithelium in the middle ear. **Objective:** To correlate HRCT findings with intra-operative findings in cholesteatoma. **Materials and Methods:** It was an observational cross sectional study, conducted in the department of Radio-diagnosis at MGM Medical College & LSK Hospital, Kishanganj, Bihar. The present study was carried out on 50 patients with microscopically evident cholesteatoma who were listed for tympano-mastoid surgery underwent preoperative high resolution CT scanning of the petrous temporal bone. All patients were subjected to full clinical, audio-logic, otoscopic and microscopic examination. Clinical data collected included information about hearingloss, otorrhea, otalgia, vertigo and facial nerve function. **Results:** Pars flaccidacholesteatoma was found to be the commonest type involving 40% of patients followed by combined cholesteatome found in 32% patients. The least common type was pars tens cholesteatome involving 28% patients. Extensive holotympanic acquired cholesteatoma was the commonest, involving 32% of patients, followed by attic cholesteatoma, involving 28% of patients, atticoantralcholesteatoma involving 22% patients and mesotypanumcholesteatoma involving 18% patients. Mastoid air cells were found to be fully pneumatized in all patients (100%). Acellular mastoid with sclerosiswere recorded in 92% patients while diploeicmastoidaircells were encountered only in 8% patients. Eroded scutum and lateral attic wall was the commonest finding involving 66% patients followed by eroded Korner'sseptuminvolving 64% patients. **Conclusion:** Correlation between HRCT and surgical finding with respect to soft tissue extension, bony boundaries of tympanum, pneumatization, status of ossicular chain, facial nerve canal and fistula of lateral Semi- circular canal were excellent in our study. HRCT is the best imaging modality to study suppurative middle ear diseases hence it plays an important role in pre-operative evaluation, guiding the surgical management and post-operated follow up patients.

INTRODUCTION

The clinical manifestations of cholesteatoma are quite variable, ranging from an asymptomatic phase to life‑threatening complications.[1] It is an important and common cause of middle ear diseases and its complications challenge both Otologist and Radiologist. It is known since prehistoric times. In 1683, Joseph Gerhard Duverney described temporal bone lesion probably representing cholesteatoma and the term cholesteatoma was coined by German pathologist Miller.[2] The management of cholesteatoma continues to be a challenge for otolaryngologists around the world. Even in

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countries with advanced healthcare facilities, undertaking routine physical examinations, with good access to specialists, and where efforts are taken for the prevention, early detection, and treatment of cholesteatoma, there is a considerable prevalence of cholesteatoma and its complications in children and adults. Cholesteatoma is a non-neoplastic lesion involving the temporal bone, which is derived from an abnormal growth of keratinizing squamous epithelium.[3] It has a propensity for local invasion and is capable of causing destruction of structures in the middle ear cleft. Middle ear cholesteatoma is thus a potentially dangerous condition and can lead to varied extra-cranial as well as intra-cranial complications. The annual incidence of cholesteatoma is reported as 3 per 100,000 in children and 9.2 per 100,000 in adults with a male predominance of 1.4:1. Middle ear cholesteatomas have a higher incidence in individuals younger than 50 years of age, whereas EAC cholesteatomas present predominantly at 40–70 years of age.[4] Cholesteatoma affecting young children has been found to be more severe as well as more invasive in nature.

High-resolution computed tomography (HRCT) scan of the temporal bone is one of the imaging modalities used to evaluate the extent of a cholesteatoma prior to surgery. HRCT of the temporal bone is a unique investigation by means of its slice thickness which is usually 1 mm. temporal bone is a very complex bone with many important structures going inside the calvaria or coming out of it by many foramens. Temporal bone itself has many important structures like ossicular chain, internal ear components. Middle ear pathology arising out of cholesteatoma has too many complications involving all these structures. These structures lie in very close relation to each other and there are many anatomic variants of these structures. A HRCT scan can show the subtle details of a small cholesteatoma.[5] The sinus tympani and facial recess, known as the hidden areas of middle ear, can be identified in a HRCT temporal bone. Information regarding the status of ossicular chain erosion and erosion of the LSSC and the fallopian canal can also be appreciated by this scan.

MATERIALS AND METHODS

It was an observational cross sectional study, conducted in the department of Radio-diagnosis at MGM Medical College & LSK Hospital, Kishanganj, Bihar. The present study was carried out on 50 patients with microscopically evident cholesteatoma who were listed for tympano-mastoid surgery underwent preoperative high resolution CT scanning of the petrous temporal bone. All patients were subjected to full clinical, audio-logic, otoscopic and microscopic examination. Clinical data collected included information about hearingloss, otorrhea, otalgia, vertigo and facial nerve function.

HRCT examination technique

HRCT was done to all patients with 512x512 matrix. Zooming and magnification were done for the petrous bone on each side. The HRCT scan protocol includes the following factors: 120 KV, 200MA, Scan time 1.5sec,Slice thickness 1mm,interval 1mm,FOV 25mm,Mode: bone algorithm, ww4000HU, WL 300HU, Collimation 1.5mm and Pixel 0.25 mm2.

Scanning was done in the direct axial and coronal planes for optimal demonstration of temporal bone structures.

Axial (horizontal projection): Scout view was obtained and sections were performed parallel to the anthropologic line(plane intersecting the inferior orbital rim and the superior margin of the external auditory canal).The sections were taken at 1mm increments beginning at the level of the hypotympanum and jugular fossa and extending cephalically to the level of the arcuate eminence using line for localization.

Coronal(frontal)projection: With the neck fully extended, a lateral scout view was performed and sections performed nearly parallel to the ramus of mandible. The gantry of the scanner was tilted 15-20 to compensate for an incomplete extension of the neck. Sections were taken from the bony Eustachian tube anteriorly, extended posteriorly to the posterior wall of the mastoid bone. The coronal projection was not done in patients suffering from head trauma and obese patient with short neck. The coronal scanning also can be done with the patient supine with hyper extended neck.

HRCT images were interpreted in details to define:

1. The type, location and extent of cholesteatoma.
2. Bony erosions of middle ear bony walls.
3. The integrity of the ossicularchain, facial nerve canal and labyrinth.
4. Involvement of hidden area, mastoid air cell system and condition.

Operative System

All 50 patients underwent mastoid exploration. Endoscope was used intra-operatively to assess hidden areas as sinus tympani and facial recess. The operative findings were compared with the radiological findings.

Inclusion Criteria

1. All chronic suppurative otitis media patients with cholesteatoma assumed clinically.
2. Patients who were willing to give operation consent.
3. All age group except less than 5 yrs with all sex groups.

Exclusion Criteria

1. Chronic suppurative otitis media patients withoutcholesteatoma.
2. Patients refuse to undergo surgery.
3. Patients refusing to give valid inform consent.

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RESULTS

Table 1: Age & Sex Distribution

Age Group (years)	Male		Female	
	No. of Patients	Percentage (%)	No. of Patients	Percentage (%)
>5-10	2	4	1	2
11-20	6	12	5	10
21-30	11	22	8	16
31-40	4	8	2	4
41-50	3	6	3	6
51-60	2	4	3	6
Total	28	56	22	44

The mean age in this present study was 28.50±13.94. In present study, we found that the majority of patients were aged less than 30 years,33 patients i.e. 66%. Maximum number of patients i.e. 19 (38) patients belonged to 21- 30 years of age group among them 11 (22%) were male and 8 (16%) were female. 11-20 years age group consisted total 11 (22%) patients among them 6 (12%) were male and 5 (10%) were female.
There was a slight male preponderance we found in our study with male: female ratio of 1.27:1 and had 28 (56%) male and 22 (44%) female patients.

Table 2: Type of Cholesteatoma

Type of Cholesteatoma	No. of Patients	Percentage (%)
Pars flaccid Cholesteatoma	20	40
Pars tensaCholesteatoma	14	28
Combined Cholesteatoma	16	32
Total	50	100

Pars flaccidacholesteatoma were the most commonly encountered type, detected in 40% (20) of patients followed by combined type of cholesteatomaencountered in 32% (16) of patients and pars tensacholesteatoma present in 28% (14) of patients.

Table 3: Location & extent of Cholesteatoma

Location & extension	No. of Patients	Percentage (%)
Attic	14	28
Attico-antral	11	22
Mesotympanum	9	18
Extensive (holotympanic) extended to mastoid antrum	16	32
Total	50	100

The location and extension of cholesteatoma among the patients studied.Extensive holotympanic acquired cholesteatoma was the most common, found in 32% (16) of patients, followed by attic cholesteatoma, found in 28% (14) of patients, atticoantralcholesteatoma found in 11 (22%) patients and mesotypanumcholesteatoma found in 9 (18%) patients.

Table 4: Bony wall erosion

Bony wall erosion	No. of Patients	Percentage (%)
Eroded scutum and lateral attic wall	33	66
Blunted scutum	9	18
Eroded tegmen	11	22
Thinning of tegmen	18	36
Eroded sigmoid sinus plate	7	14
Eroded superior and posterior meatal wall	8	16
Eroded Korner's septum	32	64

The scutum and lateral attic wall erosion was the most common finding, encountered in 64.3% of patients, followed by eroded Korner's septum found in 64.2%, thinning of tegmen in 36% patients, eroded tegmen in 22% patients, blunted scutum in 18% patients, eroded superior and posterior meatal wall in 16% patients and eroded sigmoid sinus plate in 14% patients.

Table 5: Integrity of the inner ear

State of inner ear	No. of Patients	Percentage (%)
Intact inner ear structure	36	72
Lateral semicircular canal (LSC) fistula	10	20
Eroded inner ear structure (cochlea, vestibule and semicircular canal)	2	4
Eroded IC	2	4
Total	50	100

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The lateral semicircular canal fistula was the most common finding, encountered in 20% of patients followed by lateral semicircular canal (LSC) fistula and eroded erodedinner ear structure (cochlea, vestibule and semicircular canal) found in 4% patients each. 70% patients were presented with intact inner ear structure.

Table 6: Integrity of the facial nerve canal

Facial nerve canal state	No. of Patients	Percentage (%)
Intact	36	72
Dehiscence of facial nerve canal	3	6
Erosion of facial nerve canal	11	22
1. Proximal tympanic segment	1	2
2. Distal tympanic segment	4	8
3. All tympanic segment	4	8
4. Vertical segment	2	4
Total	50	100

The condition of facial nerve canal.Intact facial nerve canal was encountered in 72% of patients and eroded in 22%, among them the most common finding was eroded distal tympanic segment and full tympanic segment erosion found in 8% of patients each followed by erosion of vertical segment and erosion of proximal tympanic segment found in 4% and 2% of patients respectively. Dehiscent facial nerve canal was present in 6% patients.

Table 7: Correlation between HRCT findings and intra-operative features of patients

Features	Finding in HRCT	Intra-operative Features	False Negative	False Positive	Sensitivity (%)	Specificity (%)	Percentage (%)
Tissue mass	46	46	0	0	100	100	92
Typical Location	39	38	0	1	100	98	78
Bony erosions	50	50	0	0	100	100	100
Incus erosion	42	44	2	0	95.6	100	94
Malleus erosion	34	33	0	1	100	87.5	68
LSC fistula	10	10	0	0	100	100	20
Tegmen erosion	11	9	0	2	100	95.5	22
Facial canal							
Intact	35	35	0	0	100	100	70
Eroded	11	9	2	0	81.9	100	22
Dehiscent	3	4	1	0	80	100	6
Eroded SSP	7	6	0	1	100	97.8	14
Eroded KS	32	32	0	0	100	100	64
Intracranial Complication	10	10	0	0	100	100	20

Overall, the results of the present study showed a good correlation between HRCT findings and intra-operative features.

DISCUSSION

In present study also, we found that the majority of patients were aged less than 30 years involving 66% (33) of patients.Similar findings were observed in the study done by Datta et al.[6]Khavasi P et alalso observed similar findings in his study on patients with cholesteatoma where he found 80% (32) of patients were aged less 30 years.[7]

In the present study majority of patients were male (28%) with a male female ratio of 1.27: 1. Kemppainen et al, showed that the incidence of cholesteatoma was higher among males under the age of 50 years.[8] Poursadegh et al. also reported a slight male predominance in his study witha male female ratio of 1.39:1.[9]

Type of Cholesteatoma: In our study pars flaccidacholesteatoma were the most commonly encountered type, detected in 40% (20) of patients followed by combined type of cholesteatoma encountered in 32% (16) of patients and pars tensacholesteatoma present in 28% (14) of patients. Same was observed in the study done by Gomma et al where combined pars flaccida and pars tensacholesteatoma were the most commonly encountered type, detected in 35.7% of patients. Also commonly detected was pars flaccida type[10]

Location and Extent of Cholesteatoma: In the current studyextensive holotympanic acquired cholesteatoma was the most common, found in 32% (16) of patients, followed by attic cholesteatoma, found in 28% (14) of patients, atticoantralcholesteatoma found in 11 (22%) patients and mesotypanumcholesteatoma found in 9 (18%) patients. Similar findings were also observed in the study done by Gomma et al. In his study small attic and mesotympaniccholesteatoma was detected in 12 patients. Early Prussak's space cholesteatoma was detected in 4 patients as a localized small soft tissue density mass slightly eroding the scutum and displacing the ossicles medially.[10]

Bony wall Erosion: In our study, erosion of sinus plates was present in HRCT in 7(14%) cases but intraoperatively 6 (12%) cases had sinus plate

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erosion with sensivity 100% and specificity 97.8%. HRCT finding shows eroded tegmen in 11 (22%) cases but intraoperatively it was present in 9 (18%) cases with sensitivity 100% and specificity 95.5%. In study by Dutta et al HRCT sensitivity was 100%, specificity was 100% and Reddy et al HRCT showed sensitivity 100%, specificity 100%.[6]

Integrity of Inner Ear:Mafee et al.[11] stated that cholesteatoma may occasionally erode the semicircular canals, particularly the lateral semicircular canal where it is exposed on the medial wall of the epitympanum. In our study we found 12 (24%) cases of LSC fistula. HRCT assessed all the LSC fistula cases correctly with a sensitivity and specificity 100%. In a study done by Joselito et al in a series of 64 patients there were 4 cases (6.3%) that had labyrinthin fistula found on HRCT, but only 3 (4.7%) were in agreement with surgical findings.[12]

Integrity of Facial Nerve Canal:Facial canal dehiscence is a fairly common finding in suppurative ear diseases, usually occurring in the tympanic portion of the facial canal.[13] the problem with partialvolume averaging artifact is again evident here as the facial canal can be so thin, even in a nonpathological ear, as to appear dehiscent on a CT scan.[14]

While a definitive diagnosis of cholesteatoma can be made at the time of surgery, the scan picture may at time influence the decision and timing of surgical exploration. Scan evident of cholesteatoma with significant bony destruction or other complication could prompt the surgeon to operate earlier, particularly if polyps or a tortuous bony canal obscures visualization of the tympanic membrane and hinders clinical diagnosis.[15] High resolution computed tomography (HRCT) is today the best method of imaging to study chronic middle ear disease.[16] Mastoid surgery may be facilitated if imaging can reliably demonstrate the relevant anatomy, the nature and extent of the pathology and the presence of complications.[17]

HRCT is a highly sensitive and specific diagnostic modality to evaluate the hidden structures of middle ear and mastoid and to exactly localize the pathological processes. Widening of aditus-ad-antrum, erosion of scutum and widening of Prussak's space, which were important findings in diagnosis of early cholesteatomatous lesion.

CONCLUSION

Correlation between HRCT and surgical finding with respect to soft tissue extension, bony boundaries of tympanum, pneumatization, status of ossicular chain, facial nerve canal and fistula of lateral Semi- circular canal were excellent in our study. HRCT is the best imaging modality to study suppurative middle ear diseases hence it plays an important role in pre-operative evaluation, guiding the surgical management and post-operated follow up patients. Considerable morbidity may be avoided with the more prevalent use of HRCT scanning. Because of the ability to see middle ear structures with great clarity, more limited and more directed procedures can be done to eradicate disease while preserving function.

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