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A Study of Clinico-Radiological and Operative Findings in Childhood Acquired Cholesteatoma.

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ABSTRACT

Background: AIM: To study the clinical, radiological and operative findings in childhood acquired cholesteatoma. **Methods:** Totally 50 patients of age less than 18 years with active squamosal chronic otitis media (COM) underwent thorough clinical examination and pre-operative high resolution computed tomography (HRCT) of temporal bone followed by surgery. Their clinical examination findings, HRCT temporal findings and operative findings were noted and correlated. **Results:** According to the present study, commonest age group was 11-15 years, average duration of complaints was 7.9 years, commonest complaint was ear discharge, commonest examination finding was central perforation in tympanic membrane (TM), most patients had moderate conductive hearing loss, on HRCT temporal bone most common finding was soft tissue attenuation in middle ear cavity, per-operatively cholesteatoma was found in middle ear cleft in all the cases. **Conclusion:** Cholesteatoma is more aggressive especially in children where it has a short course of duration, high incidence of ossicular involvement and is more often associated with complications. High resolution computerized tomographic scan of temporal bone was highly accurate in diagnosing cholesteatoma, assessing the extent of the disease, identifying bony erosion and ossicular chain destruction and detecting destruction of lateral wall of mastoid, dural plate erosion and sinus plate erosion.

Keywords: Cholesteatoma, Chronic otitis media.

INTRODUCTION

Otitis media is a very common ear condition in India. It is especially seen in the low socio-economic strata and rural population. As described by A G Pusalkar,[1] ear infections are common in children because their eustachian tubes are shorter, narrower and more horizontal than in the adults. Moreover, children at this age are prone to frequent upper respiratory tract infections which ascend to the middle ear. Due to delayed detection and treatment, the ear infection may lead to Chronic Otitis Media (COM). In some cases, COM may be associated with the formation of cholesteatoma, which is dangerous because of its bone eroding properties and ability to spread towards the vital surrounding areas. The word "cholesteatoma" was used for the first time by the German anatomist Johannes Mueller in 1838.[2] Cholesteatoma in children is more aggressive due to anatomic and physiologic differences and is harder to eradicate.[3,4] There is little disagreement regarding its sinister threat. It is known to cause a wide spectrum of complications like disabling facial paralysis, labyrinthine fistulae and even life threatening conditions such as meningitis and brain abscess.[5] Furthermore, bilateral disease associated with hearing impairment may profoundly retard the development of speech and acquisition of linguistic skills.[6] Some authors have utilized lateral X-ray view to measure the surface area of the mastoid process as an index of the degree of pneumatisation.[7] However, plain X-ray has a limited capability to assess the mastoid pneumatization especially in clinically equivocal cases. On the other hand High Resolution Computed Tomography (HRCT) has a unique ability to map out the mastoid air cells as well as any pathological changes in this region.[8]

Surgery is the mainstay of management of unsafe COM. The primary surgical objective is eradication of all diseased tissue from the middle ear cleft with establishment of a dry safe ear thereby preventing recurrence of the disease and its complications. So in popular view, restoration of hearing is a secondary goal. Management of cholesteatoma requires prolonged and diligent postoperative follow-up due to the significant rate of residual disease. The current study was planned to evaluate the clinical, radiological and radiological features of cholesteatoma in children.

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Aim and Objectives

AIM - The aim of the present study was to study the correlation of clinical and radiological findings with operative findings in childhood acquired cholesteatoma.

Objectives

- To study the clinical findings and rate of complications in children with acquired cholesteatoma.
- To study the HRCT (temporal bone) findings in children with acquired cholesteatoma.
- To study the operative findings in children with acquired cholesteatoma.

MATERIALS AND METHODS

The present study was conducted in the Department of Otorhinolaryngology, Teerthanker Mahaveer Medical College and Research Centre, Teerthanker Mahaveer University, Moradabad, U.P. for a period of 18 months (from January 1, 2017 to June 30, 2018) in which 50 patients of age <18 years with active squamosal COM (choleastatoma) were identified. They all underwent detailed clinical examination, HRCT temporal bone and subsequently, tympanomastoidectomy in our institution. All the patients who were diagnosed with active squamosal COM were included in the present study while those with active mucosal COM, inactive mucosal COM, inactive squamosal COM, revision surgery, congenital ear disease, suspicion of ear pathology to be malignant, history of fracture temporal bone, systemic disease which may affect the ear (e.g., collagen vascular or granulomatous diseases), and patients unfit for CT scanning and surgery (pregnancy, ischemic heart disease, etc.) were excluded.

A thorough history and clinical examination of ear, nose, and throat were carried out. Ear examination under microscope, tuning fork tests, pure tone audiometry and laboratory investigation were also performed. HRCT scan of the temporal bone was performed before surgery in all the cases in both axial and coronal planes. Findings were recorded and tabulated.

After detailed counselling regarding the nature of the disease, its complications & the possible outcome of surgery, informed consent was obtained from each patient. All the patients underwent mastoidectomy via postaural route, under general anesthesia and intraoperative findings were noted by the operating surgeon.

RESULTS

Clinical Findings

Table 1: Age Distribution.

Age Groups	Frequency	%
<5 yrs	0	0.0%
6-10 yrs	9	18.0%
11-15 yrs	22	44.0%
>15 yrs	19	38.0%
Total	50	100%
Mean ± SD	14.10 ± 2.80	
Min – Max	6 – 17	

The [Table 1] above shows the age distribution of the group under the study. It was observed that 44% of the patients were under 11-15 years of age group, 38% under >15 years and 18% were under the age group of 6-10 years. Further, it was observed that mean age of the group was 14.10 ± 2.80 years.

Table 2: Gender Distribution.

Gender	Frequency	%
F	24	48.0%
M	26	52.0%
Total	50	100%

The [Table 2] above shows the gender distribution of the group under the study. It was observed that 52% of the patients were males while 48% were females.

Table 3: Distribution of the patients according to ear involved.

Ear Involved	Frequency	%
B/L	10	20.0%
Left	21	42.0%
Right	19	38.0%
Total	50	100%

The [Table 3] above shows the distribution of the patients according to ear involved. It was observed that for 42% of the patients left ear was involved, for 38% right ear was involved and for 20% there was B/L involvement.

Table 4: Distribution of the patients according to duration of illness.

Duration of illness (years)	Frequency	%
<5 years	15	30.0%
6-10 years	20	40.0%
>10 years	15	30.0%
Total	50	100%

The table 4 and chart above shows the distribution of the patients according to duration of illness. It was observed that duration of illness for 40% of the patients was 6-10 years and for 30% each duration of illness was <5 years & >10 years, respectively.

Table 5: Percentage of patients with various symptoms.

	Frequency	%
Ear Discharge	50	100.0%
Decreased Hearing	48	96.0%
Tinnitus	12	24.0%
Headache	28	56.0%
Nausea / Vomiting	13	26.0%
Vertigo	15	30.0%

The [Table 5] above shows the percentage of patients with various symptoms. It was observed that 100% of the patients had ear discharge, 96% had decreased hearing, 24% had tinnitus, 56% had headache, 26% had nausea/vomiting and 30% had vertigo.

Table 6: Distribution of patients according to postauricular region.

Postauricular Region	Frequency	%
Fistula	5	10.0%
Normal	39	78.0%
Scar Mark (I&D)	1	2.0%
Swelling	5	10.0%
Total	50	100%

The [Table 6] above shows the distribution of patients according to postauricular region. It was observed that 78% of the patients had normal postauricular region, 10% each had fistula and swelling and 2% had scar mark (due to previous I&D).

Table 7: Distribution of patients according to examination of pinna.

Pinna	Frequency	%
Normal	43	86.0%
Pushed Anteriorly & Laterally	7	14.0%
Total	50	100%

The [Table 7] above shows the distribution of patients according to examination of pinna. It was observed that 86% of the patients had normal pinna while 14% had their pinna pushed anteriorly and laterally.

Table 8: Distribution of patients according to EAC status.

EAC	Frequency	%
Normal	34	68.0%
Polyp	14	28.0%
Polyp & PS canal wall sagging	1	2.0%
PS canal wall sagging	1	2.0%
Total	50	100%

The table 8 above shows the distribution of patients according to EAC status. It was observed that 68% of the patients had normal EAC while 28% had polyp and 2% each had polyp with PS canal wall sagging and PS wall sagging only.

Table 9: Distribution of patients according to Pars Tensa status.

Pars Tensa	Frequency	%
Granulations	7	14.0%
Large CP & PSQ Pathology	1	2.0%
LCP	6	12.0%
LCP With Cholesteatoma Flakes	4	8.0%
LCP With TS Patch	1	2.0%
Multiple CP	1	2.0%
Not Visualized	15	30.0%
PSQ Perforation	1	2.0%
PSQ Pathology	3	6.0%
Retracted	4	8.0%
Small CP	6	12.0%
Subtotal Perforation	1	2.0%
Total	50	100%

The [Table 9] above shows the distribution of patients according to Pars Tensa status. It was observed that in 30% of the patients Pars Tensa was not visualized, 14% had granulations, 12% each had LCP & Small LCP, 8% each had LCP with cholesteatoma flakes & Retracted, 6% of the patients had PSQ pathology and 2% of the patients each had large CP & PSQ pathology, LCP with TS patch, Multiple CP, PSQ perforation and subtotal perforation, respectively.

Table 10: Distribution of patients according to pars flaccida status.

Pars Flaccida	Frequency	%
Cholesteatoma Flakes	1	2.0%
Granulations	2	4.0%
Normal	3	6.0%
Not Visualized	15	30.0%
Perforation	2	4.0%
Perforation & Cholesteatoma Flakes	1	2.0%
Retracted	16	32.0%
Retracted & Cholesteatoma Flakes	10	20.0%
Total	50	100%

The [Table 10] above shows the distribution of patients according to pars flaccida status. It was observed that 32% of the patients had retracted pars flaccida, in 30% of the patients it was not visualized, 20% had retracted & cholesteatoma flakes, 6% had normal pars flaccida, 4% of the patients each had granulations & perforations and 2% each had cholesteatoma flakes & perforation & cholesteatoma flakes respectively.

Table 11: Frequency.

	Frequency	%
Mastoid Tenderness	18	36.0%
Tragal tenderness	0	0.0%
Nystagmus	4	8.0%
Fistula test	0	0.0%
Facial nerve functions - Normal	50	100.0%

The above table 11 shows that 36% of the patients had mastoid tenderness, 8% had nystagmus and 100% of the patients had normal facial nerve function.

Table 12: distribution of patients according to audiometric findings.

Audiometric findings	Frequency	%
NA	1	2.0%
Mild CHL	11	22.0%
Moderate CHL	24	48.0%
Moderate MHL	1	2.0%
Profound MHL	1	2.0%
Severe MHL	12	24.0%
Total	50	100%

The [Table 12] above shows the distribution of patients according to audiometric findings. It was observed that 48% of the patients had moderate CHL, 24% had severe MHL, 22% had mild CHL and 2% of the patients each had NA, moderate MHL and profound MHL, respectively.

Radiological Findings

Table 13: distribution of patients according to radiological findings.

Radiological Findings	Frequency	%
Soft tissue density in EAC	14	28%
Soft tissue density in M.E Cavity	47	94%
Erosion of ossicles	43	86%
Erosion of scutum	40	80.0%
Dehiscent Facial nerve canal	3	6.0%
Soft tissue density in mastoid	45	90.0%
Erosion of lateral wall of masoid	8	16.0%
Erosion Of dural plate	16	32.0%
Erosion of sinus plate	3	6.0%
Lateral semicircular canal fistula	1	2.0%

The [Table 13] above shows the distribution of patients according to radiological findings. It was observed that 28% of the patients had soft tissue density in EAC, 94% had soft tissue density in ME Cavity, 86% had erosion of ossicles, 80% had erosion of scutum, 6% of the patients each had dehiscent facial nerve canal & erosion of sinus plate, 90% had soft tissue density in mastoid, 16% had erosion of lateral wall of masoid, 32% had erosion of dural plate and 2% had lateral semicircular canal fistula.

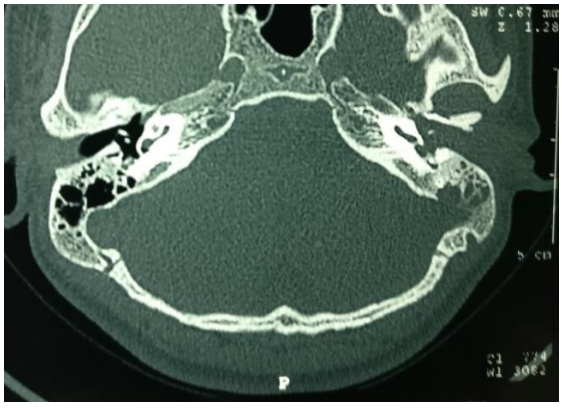

Figure 1: HRCT temporal bone Axial scan showing left ear ossicular erosion with soft tissue attenuation in middle and external ear.

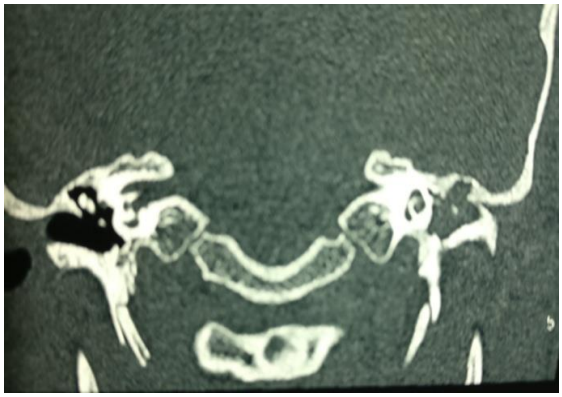

Figure 2: HRCT temporal bone coronal section showing left ear scutum erosion, ossicular erosion and thinning of tegmen tympani.

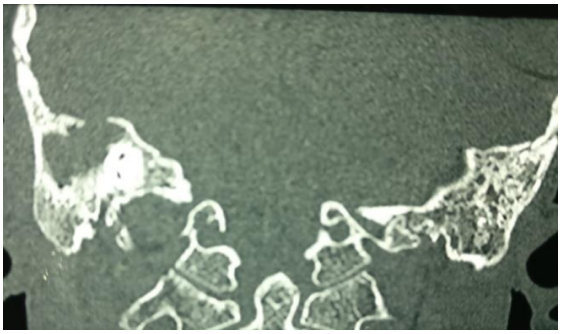

Figure 3: HRCT temporal bone coronal section showing right ear tegmen tympani erosion.

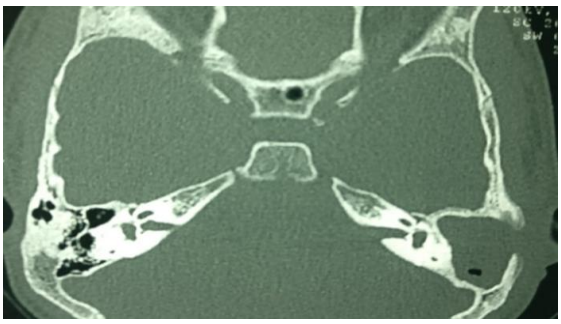

Figure 4: HRCT temporal bone axial section showing erosion of lateral wall of mastoid with soft tissue attenuating lesion in middle ear and mastoid.

Table 14: Distribution of patients according to per-operative findings of EAC.

Polyp In EAC	Frequency	%
No	36	72.0%
Yes	14	28.0%
Total	50	100%

The above [Table 14] shows the distribution of patients according to per-operative findings of EAC. It was observed that 28% of the patients had polyp in EAC while 72% had no polyp in EAC.

Table 15: Distribution of patients according to Cholesteatoma +/- Granulations in M.E. Cavity.

Cholesteatoma +/- Granulations In M.E. Cavity	Frequency	%
Yes	50	100.0%
Total	50	100%

The above [Table 15] shows the distribution of patients according to Cholesteatoma +/- Granulations in M.E. Cavity. It was observed that 100% of the patients had Cholesteatoma +/- Granulations in M.E. Cavity.

Table 16: Distribution of patients according to status of middle ear ossicles.

Erosion Of Ossicles	Frequency	%
Yes	50	100%
No	0	0%
Total	50	100%

The above [Table 16] shows the distribution of patients according to status of middle ear ossicles. It

was observed that 100% of the patients had erosion of ossicles.

Table 17: Distribution of patients according to per operative status of scutum.

Erosion Of Scutum	Frequency	%
No	3	6.0%
Yes	47	94.0%
Total	50	100%

The above [Table 17] shows the distribution of patients according to per operative status of scutum. It was observed that 94% of the patients had erosion of scutum while 6% had no erosion of scutum.

Table 18: Distribution of patients according to facial nerve canal status.

Dehiscent Facial Nerve Canal	Frequency	%
No	45	90.0%
Yes	5	10.0%
Total	50	100%

The above [Table 18] shows the distribution of patients according to facial nerve canal status. It was observed that 10% of the patients had dehiscent facial nerve canal while 90% had no facial nerve canal dehiscence.

Table 19: Distribution of patients according to Cholesteatoma +/- granulations in mastoid.

Cholesteatoma +/- Granulations In Mastoid	Frequency	%
Yes	50	100.0%
Total	50	100%

The above [Table 19] shows the distribution of patients according to Cholesteatoma +/- granulations in mastoid. It was observed that 100% of the patients had Cholesteatoma +/- granulations in mastoid.

Table 20: Distribution of patients according to erosion of lateral wall of masoid antrum.

Erosion of lateral wall of mastoid	Frequency	%
No	41	82.0%
Yes	9	18.0%
Total	50	100%

The above [Table 20] shows the distribution of patients according to erosion of lateral wall of masoid antrum. It was observed that 18% of the patients had erosion of lateral wall of masoid antrum while 82% had no erosion of lateral wall of masoid antrum.

Table 21: Distribution of patients according to erosion of dural plate.

Erosion of dural plate	Frequency	%
No	32	64.0%
Yes	18	36.0%
Total	50	100%

The above [Table 21] shows the distribution of patients according to erosion of dural plate. It was observed that 36% of the patients had erosion of dural plate while 64% had no erosion of dural plate.

Table 22: Distribution of patients according to erosion of sinus plate.

Erosion of sinus plate	Frequency	%
No	47	94.0%
Yes	3	6.0%
Total	50	100%

The above [Table 22] shows the distribution of patients according to erosion of sinus plate. It was observed that 6% of the patients had erosion of sinus plate while 94% had no erosion of sinus plate.

Table 23: Distribution of patients according to lateral semicircular canal fistula.

Lateral Semicircular Canal Fistula	Frequency	%
No	47	94.0%
Yes	3	6.0%
Total	50	100%

The above [Table 23] shows the distribution of patients according to lateral semicircular canal fistula. It was observed that 6% of the patients had lateral semicircular canal fistula while 94% had no lateral semicircular canal fistula.

DISCUSSION

Clinical Findings

This study was done to study the clinico-radiological and operative findings of acquired cholesteatoma in children.

This study was done on 50 children who were all under the age of 18 years and were clinically diagnosed as a case of chronic suppurative otitis media with cholesteatoma. The upper age limit used by Palva et al,[9] Smyth,[10] Glasscock et al,[11] Wullstein,[12] Abramson et al,[13] and Eldestein et al,[14] varied from 9 to 18 years. The most common age group in our patients was 11-15 years (44%). 26 (52%) patients were boys and 24 (48%) patients were girls. Similar to our study, male predominance has been observed by all the above authors. Disease affection was marginally more in left ear (42%) than right ear (38%) and 10 (20%) patients had bilateral ear disease. In Glasscock et a1,[11] and Eldestein et a1,[14] series the right ear was predominantly involved.

The observed average duration of complaints was 7.9 years, which is slightly higher than that of results reported by Palva et al,[9] i.e., 5.8 years. This he compared with that of adults, which was 21.8 years and opined that, the cholesteatoma forming mechanism once triggered has a more active course in children.

In our study most common complaint was ear discharge (100%) followed by hearing loss (96%), headache (56%) and vertigo (30%). These results are

comparable to the studies done by Palva et al,[9] Glasscock et al,[11] Eldestein et al,[14] and Triglia.[15] In addition, 13 (26%) and 12 (24%) of our patients presented with nausea/vomiting and tinnitus respectively.

Preauricular region was found normal in all the patients.

Postauricular region examination revealed postauricular swelling in 5 (10%) and fistula in 5 (10%) and scar mark of previous incision & drainage 1 (2%) patients. Whereas 39 (78%) patients had normal postauricular region.

Preoperative examination of pinna showed 43 (86%) patients with pinna normal in shape, size and location. Whereas 7(14%) patients had their pinna pushed anteriorly and laterally.

Preoperative examination under microscope revealed a variety of abnormalities. The presence of perforation in the tympanic membrane was the commonest finding (48%), of these 42% had pars tensa perforation and 6% had pars flaccida perforation. The presence of retraction pocket in the attic region was seen in 52% patients. 10% of the patients had PSQ pathology. These findings are in contrast with a study of 125 cases of childhood cholesteatoma by Eldestein et al,[15] where posterosuperior region retraction pocket was the commonest finding followed by attic retraction and tympanic membrane perforation. Similar to this study cholesteatoma was visualized in 32% of the cases and commonest sites of cholesteatoma were in attic and posterosuperior region.[9] 14 (28%) patient had an polyp filling external auditory canal. 1 (2%) patients had sagging posterior canal wall. 1 (2%) patients had polyp in EAC with posterio-superior canal wall sagging.

On clinical examination mastoid tenderness was found in 18 (36%) patients, spontaneous nystagmus was seen in 4 (8%) and tragal tenderness, positive fistula test, facial nerve dysfunction were found in none of the patients.

35 (70%) patients had conductive hearing loss, whereas 14 (28%) had a mixed hearing loss. Hearing loss of moderate degree was the most common range found in 50% of patients, Glasscock et a1,[11] had contrasting results in their series of 41 Children where they also observed mixed hearing loss in majority of patients."

Radiological Findings

Preoperative CT scan of temporal bones could diagnose soft tissue density attenuation in mastoid in 45 of the 50 cases (90 percent). Mafee and O'Reilly have similar results,[16,17] whereas Jackler and Garber found it in less number of patients.[18,19]

CT was able to detect soft tissue density attenuation in external auditory canal and middle ear cavity in 14 (28%) and 47 (94%) cases repectively. This is in agreement to Garber et al,[19] who did similar study.

CT could identify ossicular chain destruction in 43 (86%) cases. Mafee et al,[16] were able to define the state of the ossicular chain in 89% of cases scanned and Jackler et a1,[18] were able to predict the state of the ossicular chain in 83.3% of their cases and O'Rielly,[17] could predict an intact ossicular chain correctly in only 50% of the cases.

Dehiscence of the facial nerve canal was found in 3 (6%) cases. This is similar to studies by O'Reilly,[17] Jackler and Garber.[18,19] However, Mafee et a1,[16] found larger number of patients with facial nerve canal dehiscence on CT.

Lateral semicircular canal was reported to be eroded in 1 (2%) case. This finding is similar to that reported by Mafee et a1.[16]

CT found evidence of erosion of lateral wall of mastoid region in 8 (16%) cases.

In our study, erosion of scutum was detected in 40 (80%) of cases on CT.

CT was able to detect 16 (32%) cases with dural plate erosion and 3 (6%) cases with sinus plate erosion.

Operative Findings

Per-operative findings reveal polypoidal mass in external auditory canal in 14 of the 50 cases (28%). Granulations/ cholesteatoma in middle ear cavity and mastoid was found in 50 (100%) cases each.

Mafee and O'Reilly have similar results,[16,17] whereas Jackler and Garber found CT to be less sensitive and specific.[18,19] However, CT scan is less sensitive in differentiating cholesteatoma from granulations. Most authors are in agreement with this finding.[16-19] However Mafee et a1,[20] believed it was possible to identify cholesteatoma by its low attenuation value and Johnson et a1,[21] found that the presence of a well defined edge to mass was a sure indication of cholesteatoma.

Scutum erosion, which is seen as an additional sign for the presence of cholesteatoma was identified in 47 of the 94 cases. This is comparable to the reports by Jackler et a1,[18] and O'Denoghue et a1,[22] who found cholesteatoma to be present in 80% of the cases with scutum erosion who were explored. Using the same criteria O'Reilly,[17] detected 23 out of 29 cases of cholesteatoma (79%). Mafee et a1,[20] found scutum destruction in 9 out of 9 cases of acquired cholesteatoma.

In our study, CT detected ossicular destruction in 43 of the 50 patients who had such lesion on surgery however there were 7 false negative CT reports of ossicular necrosis. Mafee et a1,[16] were able to define the state of the ossicular chain in 89% of cases scanned and Jackler et a1,[18] were able to predict the state of the ossicular chain in 83.3% of their cases and O'Rielly,[17] could predict an intact ossicular chain correctly in only 50% of the cases. CT was found to be most accurate in detecting ossicular necrosis in studies by Mafee et a1,[16] Garber et a1,[17] Jackler et a1,[18] & Schwartz al.[23]

Dehiscence of the facial nerve canal was found in 5 (10%) cases per-operatively, this was accurately Diagnosed on CT in 3 cases and CT failed to identify the dehiscence in 2 cases. This is in agreement with studies by O'Reilly,[17] Jackler and Garber.[18,19] However, Mafee et a,[16] found CT to be very accurate in the diagnosis of erosion of facial canal.

Erosion of the lateral semicircular canal was reported on CT in 1 cases however 3 patients had a demonstrable lesion on operation. These findings are in disagreement to that reported by Mafee et a1,[16] who reported CT to be highly accurate in detecting semicircular canal erosion.

However, in our study CT was found to be most accurate in diagnosing destruction of mastoid cortex, dural plate and sinus plate which were detected on CT in 8 (16%), 16 (32%), 3 (6%) respectively and per-operatively in 9 (18%), 18 (36%), 3 (6%) respectrively which was highly accurate. This is in agreement with studies by most authors.[16-19]

CONCLUSION

This study titled 'A study of clinico-radiological and operative findings in childhood acquired cholesteatoma" was conducted on 50 children who were clinically diagnosed with chronic suppurative otitis media with cholesteatoma and were treated in otorhinolaryngology services of TMMC & RC, TMU , Moradabad (U.P.) and following conclusions were drawn:"

1. Cholesteatoma is more aggressive especially in children where it has a short course of duration, high incidence of ossicular involvement and is more often associated with complications.
2. Majority of our patients (82%) were more than 11 years of age with and the study results demonstrates male predominance (26:24) with more common involvement of the left ear (42%).
3. Common presenting complaints were ear discharge (100%) and hearing loss (96%) and average duration of complaints was 7.9 years.
4. The commonest finding on ear examination was attic retraction (52%). The second most common examination finding was perforation in the tympanic membrane (48%).
5. Moderate degree of conductive hearing loss (48%) was the most common type of hearing loss observed in our study.
6. The facial nerve canal was found to be dehiscent in 10% of the patients.
7. Lateral semicircular canal erosion was observed in 6% of the Patients.
8. Dehiscence of lateral wall of mastoid was seen in 18% of the patients.
9. Erosion of dural plate was found in 36% and sinus plate Erosion was found in 6% of the cases.
10. High resolution computerized tomographic scan of temporal bone was highly accurate in diagnosing cholesteatoma, assessing the extent of the disease, identifying bony erosion and ossicular chain destruction.
11. The high resolution computerized tomographic scan of temporal bone was highly accurate in detecting soft tissue attenuations, but was not helpful in differentiating cholesteatoma from granulations.
12. The high resolution computerized tomographic scan of temporal bone was found to be most accurate in detecting destruction of lateral wall of mastoid, dural plate erosion and sinus plate erosion.

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