Original Article

Spectrum of radiological findings on HRCT temporal bone in patients with CSOM: A hospital based study from South Kashmir

Mir Saiqa Shafi, Sabeeha Gul, Arif Ahmad Wani

Abstract:

Background: Chronic suppurative otitis media is one of the most common childhood infections worldwide and represents a leading cause of hearing impairment in resource-limited settings. Although a clinical diagnosis, imaging plays a crucial role in cases where there is suspicion of cholesteotoma and to look for the associated intracranial complications, which may otherwise prove fatal. Due to its excellent spatial resolution, HRCT has emerged as the modality of choice in diagnosing, surgical decisions, and further follow-up of patients.

Aims and Objectives: The present study aimed to study the radiological findings in the temporal bone in patients with CSOM, to look at the extent and sites of involvement in the middle ear and mastoid air cells, and to look for the complications of CSOM (if any).

Materials and methods: 150 patients referred for HRCT evaluation to the Radiology department over 1 year were enrolled in the study. HRCT evaluation of the study participants was done as per the set temporal bone protocol. The contrast was administered only in those patients where there was suspicion of intracranial complications. The HRCT images were evaluated for the presence or absence of abnormal soft tissue density, the status of the ossicles & the integrity of the ossicular chain, the integrity of the bony landmarks including the scutum, tegmen, mastoid cotes, & sigmoid sinus plate. Assessment of the mastoid pneumatisation was done in all cases.

Results: The mean age in our study population was 24.81 years. The majority of the patients belonged to the age group of 21-30 years. In our study, males were affected more frequently than females. The most common presenting complaints were ear discharge, decreased hearing, and ear aches. On HRCT evaluation, abnormal soft tissue density was seen in 100 cases(66.67%), with involvement of mastoid antrum and aditus ad antrum in all cases, followed by epitympanum, mesotympanum, and hypotympanum in that order. Ossicular erosions were seen in 89 cases(59.33%), with incus being the most frequently involved ossicle, followed by stapes malleus in that order. Scutum erosions were seen in 70 cases (46.67%) and erosions of the tegmen were seen in 38 cases (25.33%). Facial canal dehiscence/erosions were seen in 20 cases (13.33%). Mastoid cortex & sinus plate erosions were seen in 3 cases each (2%). Labrynthine fistula & extratemporal complications were noted in 2 patients each (1.33%).

Conclusions: HRCT of the temporal bone is an efficacious modality for the accurate delineation of the anatomy and pathological involvement of the temporal bone. It is a unique method to detect early cholesteotoma & also to detect cholesteotoma in hidden areas. HRCT is useful for diagnosis, surgical planning & management of temporal bone pathologies.

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Introduction:

Chronic Suppurative otitis media is a chronic inflammation of the middle ear cleft of more than two-week duration. Clinically it is characterized by discharging ear, decreased hearing, fever, and nostalgia. Chronic suppurative otitis media is the leading cause of the chronic aural discharge. As per WHO estimates, it affects 65-330 million individuals globally with its prevalence ranging from as low as 1% in the developed world to as high as 30-45% in underdeveloped countries. Among them,50% of the patients have a hearing impairment

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Keywords
HRCT, Chronic Suppurative otitis media, diagnosis

and 28000 deaths are attributed to the complications of otitis media per year.[1]The diagnosis is mostly on clinical examination with an otoscope or otoendoscope. However, given the location of the tympanomastoid compartment, being separated from the middle cranial fossa and posterior cranial fossa by a thin bony partition, both short and long-term sequelae of otitis media may be devastating. If recognized early and treated appropriately, these complications can be avoided.[2]As the such radiological examination of the temporal bone provides crucial information to the clinician which guides both the medical and surgical management of patients with middle ear disease.

HRCT and MRI are the two most important imaging modalities in the evaluation of patients with chronic ear discharge. Conventional techniques of temporal bone imaging like the X-ray(Schuller's view,Stenvers, Townes, and submentrovertical projections) have been replaced by HRCT. It confirms the otoscopic findings to a greater extent, clears many clinical doubts, and helps in determining when surgery will be necessary and also in planning the approach for surgery. With its excellent submillimetric resolution, HRCT has emerged as the imaging modality of choice for the evaluation of middle ear pathologies. Being a highly sensitive tool, if normal, it virtually excludes any middle ear pathology.[3,4] It is the best modality to look for the integrity of the ossicles and the bony confines of the middle ear. HRCT can detect exposed dura, semicircular canal dehiscence, and facial canal dehiscence. It can effectively assess anatomical pitfalls like a high-riding jugular bulb. Having preoperative knowledge of anatomy and anomalies is crucial to prevent post-operative morbidity among patients who require surgery for middle ear disorders.

Due to its superior contrast resolution, MRI serves as a problem-solving tool in indeterminate, complicated CSOM cases to look for the involvement of facial nerve canal, inner ear structures, and intracranial complications. It is the most useful modality for distinguishing residual or recurrent cholesteotoma from the granulation tissue or post-operative scar formation.[4,5,6]

The present study aims to study the radiological findings in the temporal bone in patients with CSOM, to assess the severity of the pathological changes in CSOM patients, to look at the extent and sites of involvement of the middle ear and mastoid air cells, and to look for the complications of CSOM (if any).

Materials and Methods

The present study was conducted on 150 patients who were clinically diagnosed with chronic suppurative otitis media and were referred to the Radiology department of a tertiary care hospital, between June 2021 to June 2022 over a one year period. This was a prospective observational study with descriptive statistics. The study was performed after ethical clearance & informed consent.

Inclusion criteria:

All patients with chronic middle ear infections who were referred to the radiology department for HRCT evaluation.

Exclusion criteria:

Pregnant females, patients with a cochlear implant, those who had undergone previous temporal bone surgeries, patients with a history of previous skull base trauma, and patients are known to have temporal bone neoplastic pathology were excluded from the study.

All the CT scans were performed at our institute on a 128-slice Philips Incisive CT scanner. Non-contrast HRCT of the temporal bone was performed parallel to the orbito-meatal line by a spiral technique using the multislice CT scanner. Contiguous axial and coronal thin slices of both temporal bones were reconstructed using a high-resolution matrix and bone algorithm. Soft tissue windowing and sagittal reformatting were done wherever required. Intravenous contrast was given in patients with suspected intracranial complications. CT images were analyzed for the presence of soft tissue attenuation in middle ear clefts, ossicular erosions, erosions of the scutum, tegmen, and semicircular canals, facial canal erosions or dehiscence, mastoid cortex erosions, dural exposure & intracranial complications.

Data analysis:

The data was entered in Microsoft excel & analyzed with SPSS 23.0 software. Continuous variables like age were expressed as mean and standard deviation or median with the interquartile range depending on the normality distribution. Categorical variables like sex and temporal bone findings were expressed as proportions and percentages.

Results

Table 1: Distribution of age among the study participants.

Age Group (Years)	**Number (n=150)**	**Percentage**
<10	10	6.67%
11-20	37	24.67%
21-30	49	32.67%
31-40	28	18.67%
41-50	16	10.67%
51-60	6	4.00%
>60	4	2.67%
total	150	100.00%

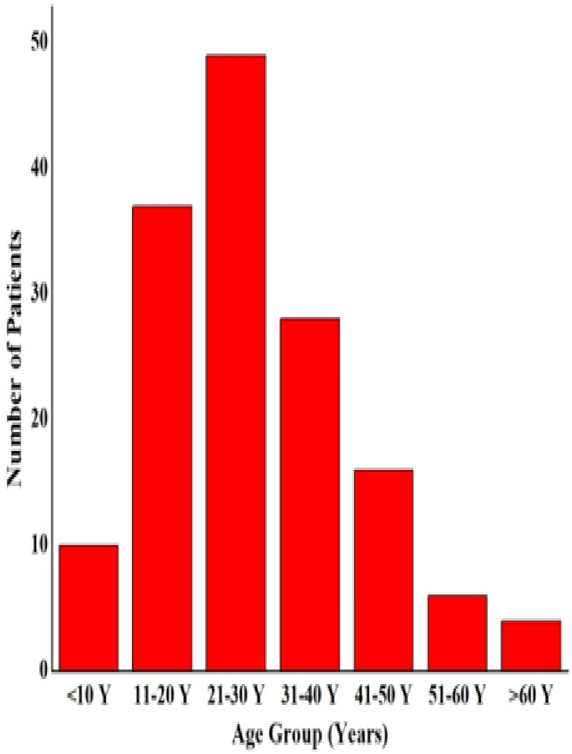


Fig 1: Graphical representation of the distribution of age among the study participants.

Table 2: Distribution of gender among the study participants.

Gender	Number (n=150)	Percentage
Male	88	58.67%
Female	62	41.33%
Total	150	100.00%

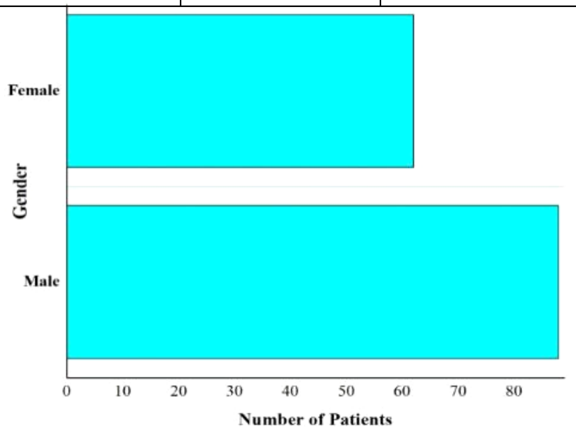


Fig 2: Graphical representation of the distribution of gender among the study participants.

Table 3: Distribution concerning the side of the affected ear.

Size	Number (n=150)	Percentage
Left	76	50.67%
Right	66	44.00%
Bilateral	8	5.33%

Table 4: Distribution of presenting symptoms/complaints among the study participants.

	Chief Complaints	Number (n=150)	Percentage
i	Ear Discharge	134	89.00%
ii	Decreased Hearing	121	80.67%
iii	Earache	55	36.67%
iv	Headache	15	10.00%
v	Vertigo/Giddiness	8	5.33%
vi	Tinnitus	5	3.33%
vii	Bloodstained discharge	6	4.00%
viii	Fleshy mass in the ear	3	2.00%
ix	Facial Paralysis	1	0.67%

Almost all the patients presented with multiple symptoms. The most common presenting symptoms were discharged from the ear and hearing impairment.

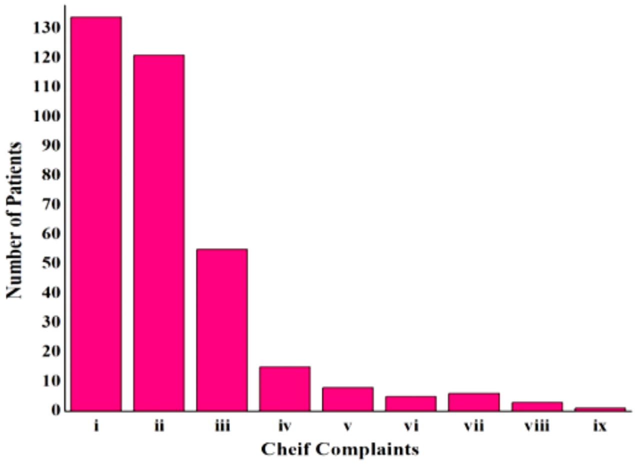


Fig 3: Graphical representation of the distribution of presenting symptoms/complaints among the study participants.

Distribution of the impression of CSOM type based on HRCT findings.

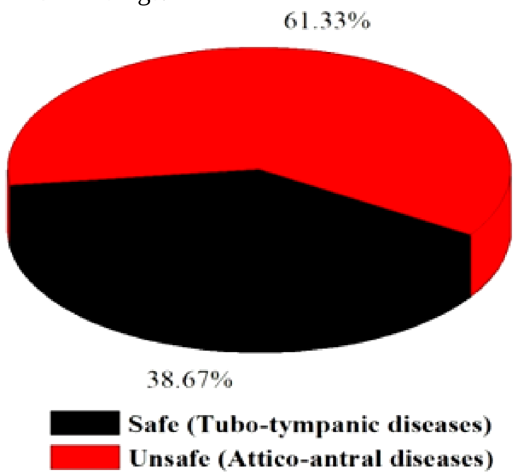


Fig 4: Graphical representation of the impression of CSOM type.

Table 5: Distribution of findings on HRCT evaluation.

Findings on HRCT	Present	Absent
Abnormal soft tissue mass	100(66.67%)	50(33.33%)
Ossicular involvement (erosions/displacement)	89(59.33%)	61(40.67%)
Scutum erosions	70(46.67%)	80(53.33%)
Tegmen erosions	38(25.33%)	112(74.67%)
Semicircular canal erosions	2(1.33%)	148(98.67%)
Facial canal erosions/ dehiscence	20(13.33%)	130(86.67%)
Mastoid cortex erosions	3(2%)	147(98%)
Sinus plate erosions	3(2%)	147(98%)
Aural polyp	3(2%)	147(98%)
Extra temporal complications	2(1.33%)	148(98.67%)

Table 6: Distribution of site and extent of involvement of middle ear and mastoid in patients with abnormal soft tissue density (n=100).

Site	Number	Percentage
Epitympanum	98	98.00%
Mesotympanum	50	50.00%
Hypo tympanum	18	18.00%
Mastoid Antrum	100	100.00%
Aditus-ad-antrum	100	100.00%

Table 7: Distribution of the HRCT findings of Temporal bone concerning the status of mastoid pneumatisation.

Status of mastoid pneumatisation	Number (n=150)	Percentage
Loss of pneumatisation	91	60.67%
Mastoid air cell opacification	14	9.33%
Coalescent mastoiditis	3	2%
Well pneumatised mastoid bone	42	28%

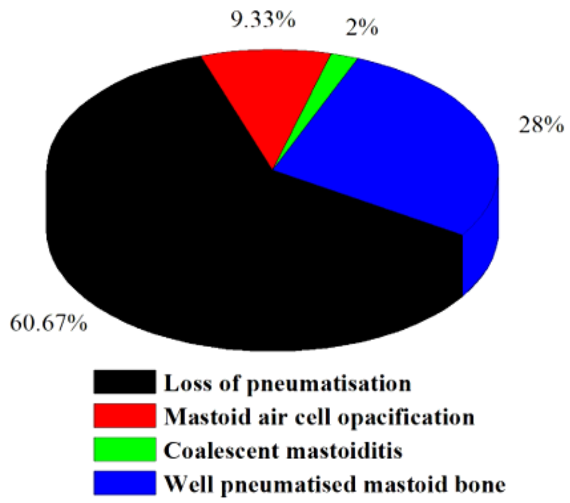


Fig 5: Graphical representation ofthe status of mastoid pneumatization. The pattern of involvement of ossicular erosions

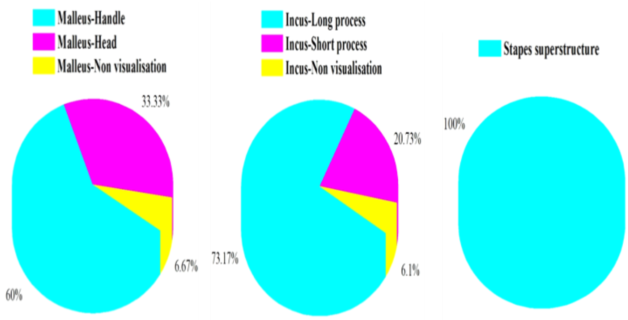


Fig 6: Graphical representation showing pattern of involvement in individual ossicles.

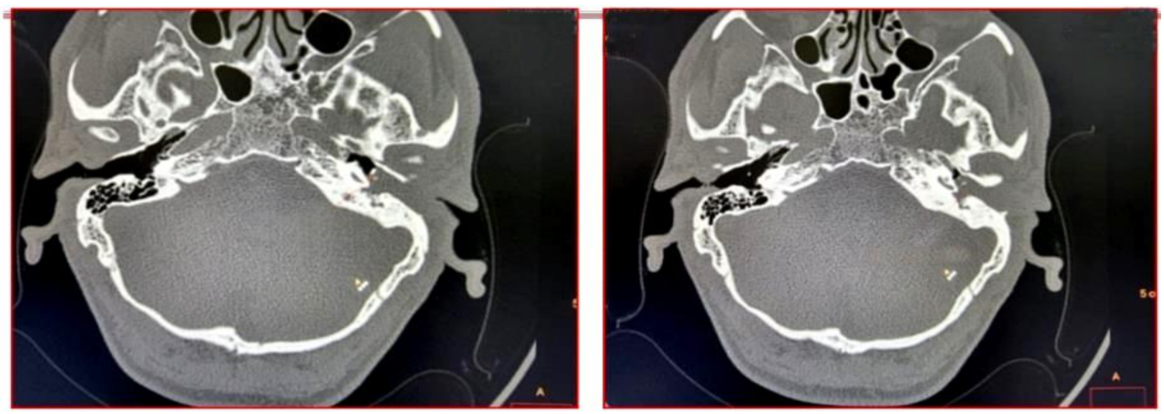
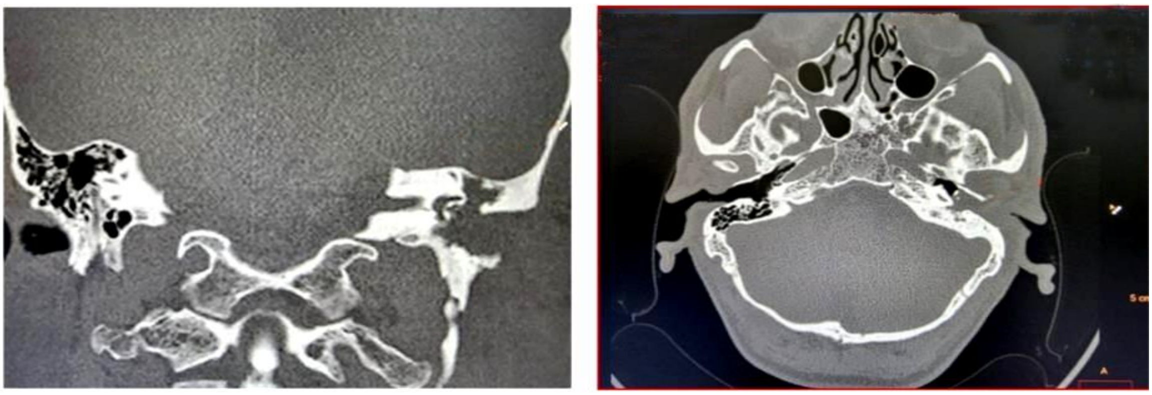


Image 1: Abnormal Soft tissue density in the left middle ear cavity with associated ossicular erosions.



a b

Image 2: (a) Abnormal soft tissue density in the middle ear cavity with erosions involving the tegmen tympani. **(**b) Soft tissue density in the left EAC in the same patient is consistent with an aural polyp.

a b

Image 3: (a) Focal erosions in the tegmen in a CSOM patient with abnormal soft tissue density in the epitympanum. (b) Loss of the normal ice-cream cone configuration of the middle ear ossicles in the same patient.

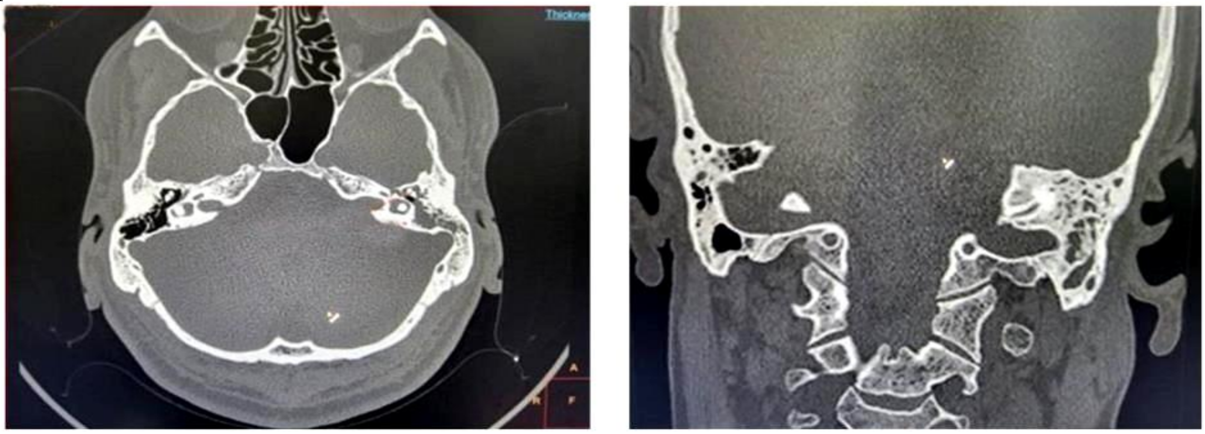


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Image 4: (a) Ossicular displacement with maintained integrity. (b) Mastoid air cell opacification with associated mastoid sclerosis.

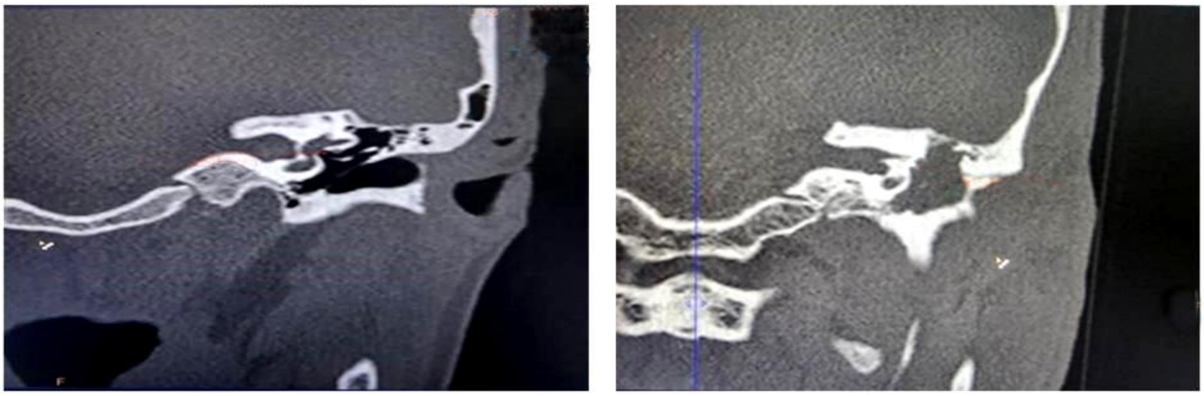

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Image 5: (a) Facial canal dehiscence (FCD)in a normal middle ear cavity.(b)Another patient with abnormal soft tissue in the middle ear & mastoid antrum & associated FCD.

a b

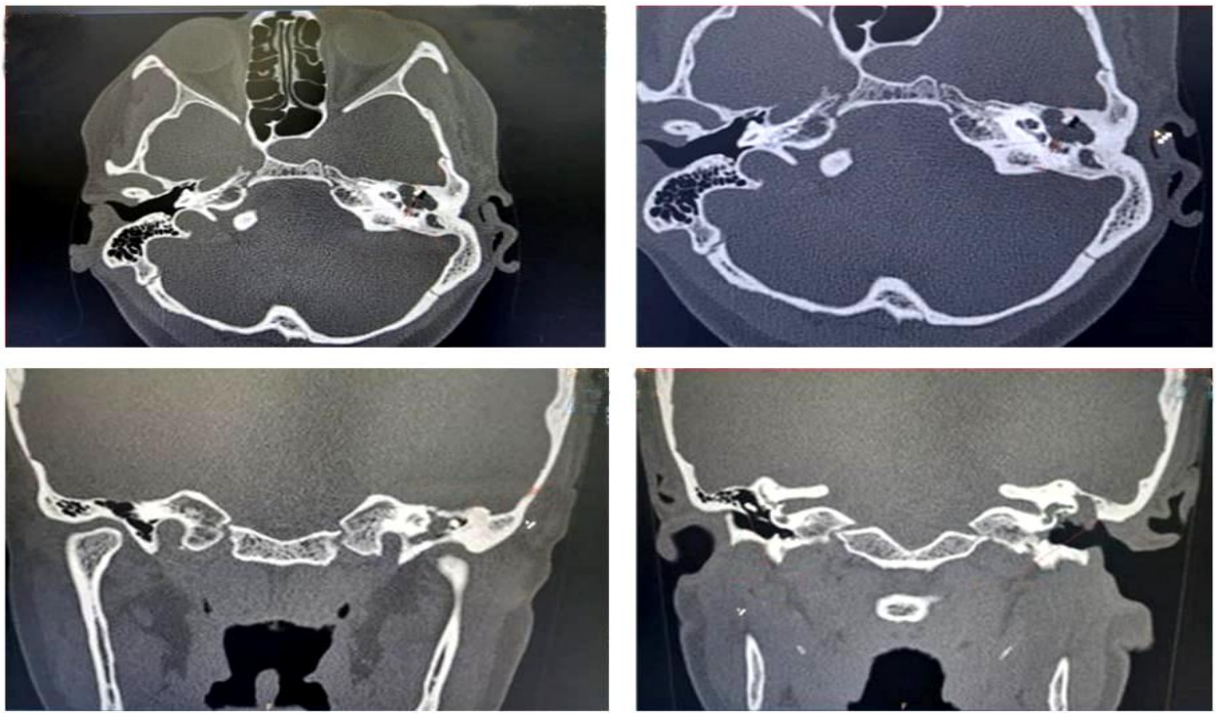
Image 6: (a) CSOM on the right side with erosions of the long process of the incus. (b) CSOM on the left side of the same patient with normal incus.

a b

Image 7: (a) Bilateral chronic sclerosing mastoiditis. (b)Mastoid air cell opacification on the left side.

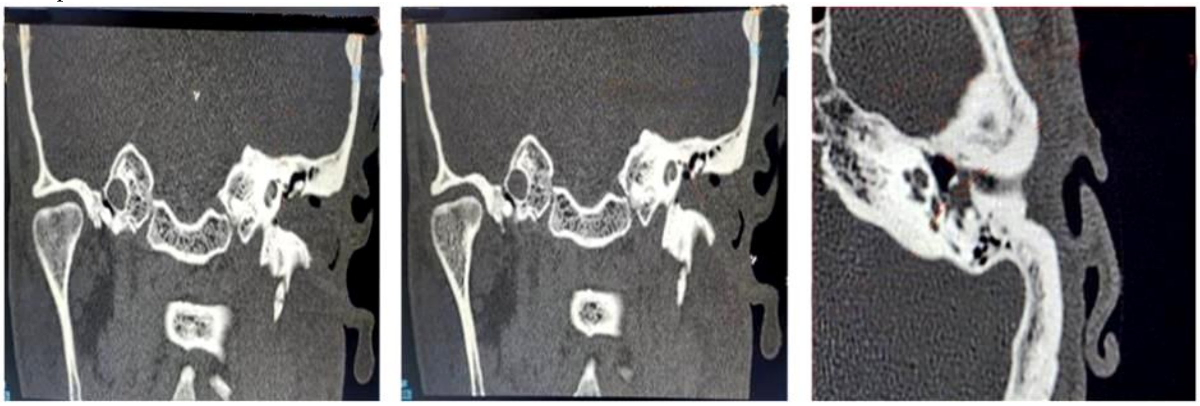
Image 8: Abnormal soft tissue in epitympanum & mastoid antrum with blunt scutum.

a **b**



c **d**

Image 9: (a and b) Abnormal soft tissue in the left middle ear cavity with displacement & erosions of the middle ear ossicles. Articulation between the incus & the malleus is maintained. (c) Coronal HRCT of the same patient as above demonstrates abnormal anterior displacement of the ossicles. (d) Coronal HRCT image in the same patient at the level of scutum demonstrates scutum erosions.



a **b** **c**

Image 10: (a) Abnormal soft tissue density in left mesotympanum. (b) Abnormal soft tissue density filling the left external auditory canal. (c)Erosions involve the long process of incus, with a normal appearing handle of malleus & stapes superstructure.

Discussion

Imaging techniques in the medical field have undergone tremendous changes ever since the first discovery of the X-ray by Sir William Roentgen on 8th November 1895.With the advent of HRCT with a submillimetric resolution, HRCT has emerged as the modality of choice for patients with CSOM. Although not a routine investigation in all CSOM patients, HRCT is especially useful for patients where the clinical examination is confounded due to one reason or the other or when there is a clinical suspicion of an unsafe type of CSOM (Atticoantral type).From an imaging perspective, the atticoantral CSOM can be further classified into the cholesteotomatous& non-cholesteotomatous types. Classical HRCT findings in atticoantral CSOM with cholesteotoma include a non-dependent abnormal soft tissue density, with erosion and blunting of scutum/lateral attic wall, widening of the aditus-ad-antrum, displacement of the ossicular chain and destruction of the ear ossicles. HRCT of the temporal bone has revolutionized the pre-operative assessment of the disease by picking up the anatomical variations in the temporal bone, delineating the extent of the disease, erosion of the ossicles, erosion of the dura, facial canal, etc, thereby allowing better pre-operative planning of surgery.

This prospective study was undertaken to study the imaging features of CSOM patients referred for HRCT to the radiology department.

We studied a total of 150 patients with a clinical diagnosis of CSOM. In this study, the mean age of the patients was 24.81 years. Thukral et al found that the mean age of the patients was 27.95 years which was similar to our study. A maximum number of patients in our study belonged to the age group of 21-30 years (32.67%) followed by the 11-20 year age group (24.66%). A minimum number of patients belonged to the age group of more than 60 (2.66%).

In our study, the males were more commonly affected than females. These results were following studies by Sharma et al, Dhulipalla et al, Chatterjee et al &Kanotra et al [7, 8,9,10]. In all these studies, males were affected more frequently than females (60%, 58%, 68.86% & 57.44% respectively).

In our study, the left side ear was affected more commonly than the right side with bilateral involvement in eight cases.

The majority of our patients had the presenting complaints of ear discharge (89%) followed by decreased hearing (80.66%), earache (36.67%), headache (10%), vertigo/giddiness (5.33%), blood-stained discharge (4%), tinnitus (3.33%), fleshy mass in the ear (2%) & facial paralysis (0.67%). Our results were comparable with Jadia et al [11] who in their study observed that otorrhea/ear discharge was the most common presenting feature (100%) followed by hearing loss (98.1%) with facial weakness being the least common(1.92%). Similarly, Tamilarasan etal [12] reported that the symptoms in their study population were Otorrhoea (91.95%), Hearing loss (59.77%), otalgia (29.89%), nausea & vomiting (11.49%), headache (10.34%), tinnitus (9.20%) & facial weakness (5.75%).

HRCT evaluation of the temporal bone revealed the presence of abnormal soft tissue mass in 100 patients (66.67%). The presence of a non-dependent soft tissue mass in the middle ear cavity is highly suggestive of cholesteotoma. Payal et al [13] observed the presence of soft tissue mass in 86.67% of the patients. Similarly, Chatterjee etal found the presence of soft tissue mass in 100% of the patients [9].This variation in our results was likely because our study was not limited to the unsafe type of CSOM rather it included all patients of CSOM referred for HRCT evaluation.

Regarding the site of involvement of this abnormal soft tissue mass, epitympanum was involved in 98% of the cases; mesotympanum was involved in 50% of the cases followed by hypotympanum which was involved in 18% of the cases. The mastoid antrum and aditus and antrum were involved in 100% of the cases which showed an abnormal soft tissue mass. Our observations are comparable to the findings by Jadia etal [11]who found the extension in epitympanum in 100% of cases followed by mesotympanum in 78.85% and hypotympanum in 55.57%. In their study, antrum was involved in 84% of the cases, and aditus adantrum in 78.85%. Similarly, the most frequently involved sites observed by Sirigri et al [14] were epitympanum in 88% of the cases, mastoidantrum in84% of the cases, aditus ad antrum in 76%, mesotympanum in 44% and hypotympanum in 44%. The order of the involvement was comparable to our study.

Loss of pneumatisation of the mastoid air cells was seen in 91 cases (60.67%), whereas mastoid air cell opacification was noted in 14 patients (9.33%) and findings suggestive of coalescent mastoiditis was noted in 3 cases (2%). The rest of the study participants showed well-pneumatised mastoid bone(28%). These findings were consistent with those of Mandal P et al[15] who reported the presence of mastoiditis in 60% of the cases. Similarly, our findings corroborated with those of Thukral et al [16] who observed mastoiditis in 76% of the cases.

Our study revealed ossicular erosions in 89 patients (59.33%). These results were comparable with the studies by Chatterjee et al [9] & Gul et al [17] where ossicular erosions were present in 62.28% and 54.57% respectively. Malleus erosions were present in 15 patients (10%), incus erosions were present in 82 patients(54.67%) & stapedial erosions were present in 41 cases (27.33%). However, our study did not match the results of Sharma et al [8] and Bathla et al [18] who reported ossicular erosions in 84 and 73 % of the cases respectively. This was likely due to the general inclusion of CSOM patients referred for HRCT temporal bone. Although both types of CSOM, tubo-tympanic which is considered safe, as well as attico-antral which is considered unsafe, may lead to the erosions of the ossicular chain. This propensity for ossicular destruction is much greater in cases of unsafe CSOM, due to the presence of cholesteotoma and/or granulations.[19]

Among the patients with ossicular erosions, incus was involved in 92% of the cases, followed by stapes in 46% of patients and malleus in 16.85% of the patients. Malleus was found to be the most resistant ossicle & the incus was found to be the most common ossicle to get necrosed in cases of CSOM. These results were comparable with the findings of Tamilarasan et al & Payal etal [12,13].

Regarding the pattern of involvement in individual ossicles, among a total of 15 patients with malleus erosions, the handle of the malleus was involved in 9(60 %) cases followed by the head of the malleus in 5 cases (33.33%) with non-visualization in 1 case (6.67%).These findings were comparable with those of S Varshney et al[20].In their study, the handle of the malleus was the most commonly necrosed part of the malleus.

Similarly out of the 82 patients with incus erosions, the long process was the most frequently involved in 60 patients (73.17%), followed by a short process of incus in 17 cases(20.73%) with non-visualization in 5 cases (6.10%). These findings were comparable with those of Austin et al[2], Kartush et al [22] & Mathur et al [23].

Stapes superstructure erosions were seen in all 41 cases (27.33%) with the involvement of the stapes on HRCT. These findings were comparable with those of S Varshney et al [20] where involvement of the stapes superstructure was noted in 21.33% of the cases of CSOM and the footplate was found intact in all cases.

Erosions of the scutum were seen in 46.67% of the patients enrolled in the study. These results were comparable with the study by Thukral et al [16] where scutum erosions were seen in 42% of the patients. Similarly, Tamilarasan et al [12]identified eroded scutum in 34.48% of the cases. Sharma et al [8] identified erosions in scutum in 84% of the cases and Chatterjee et al found erosions of the scutum in 67.07% of the cases[9]. The higher proportion of erosions in the latter two studies was likely attributed to the fact that the former study included only those patients with unsafe chronic suppurative otitis media and the latter was done in patients who were planned for mastoid exploration & as such were likely to have cholesteotoma.

Regarding the erosions in the tegmen, our study documented the same in 38 patients (25.33%). Our results were comparable to those of Jadia et al [11] who reported the tegmen erosions in 23.1 % of the cases. Similarly, Keskin et al [24] mentioned the tegmen erosions in 19.6% of the study population.

Our study reported labyrinthine fistula (lateral semicircular canal erosions) in 2 patients (1.33%). Our results were comparable with those of Tamilarasan et al [12], Mandal et al [15], and Sharma et al [8] who reported this finding in 3.8%, 4% & 6% respectively. Our study reported a lower rate which may be attributed to the fact that our study was not limited to the unsafe CSOM only. Further, it could be attributed to the fact that patients report to the hospital much earlier in the course of the disease.

Regarding the facial canal dehiscence/erosions, our study reported it in 20 cases (13.33%) whereas an intact facial canal was demonstrated in 130 cases (86.67%). Selesnick and Lynn–Macrae [25] reported that fallopian canal dehiscence was seen in 33% of the patients with cholesteotoma. The accuracy of the CT scan for detecting the FCD is not constant & sometimes it may be impossible to detect it in the thin bony canal of the facial nerve [26,27,28]. The Facial canal dehiscence may be a normal anatomical variant due to a congenital process or may be an associated feature of chronic otitis media, particularly with cholesteotoma. In either case, it is very important to document this finding. It can lead to one of the ominous intra-temporal complications of facial nerve paralysis or can lead to an intra-operative complication of facial nerve trauma.

Similarly, mastoid cortex erosions were seen in 3 cases (2%) and sigmoid sinus plate erosions were seen in 3 cases (2%). We reported only two cases with extratemporal findings, one had an epidural abscess and the other case had skull base osteomyelitis.

Conclusion

HRCT of the temporal bone is an efficacious modality for the accurate delineation of the anatomy and pathological involvement of the temporal bone. It is a unique method to detect early cholesteotom & also to detect cholesteotoma in hidden areas. HRCT is useful for diagnosis, surgical planning & management of temporal bone pathologies.

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