High Resolution Computed Tomography (HRCT) Evaluation of Temporal Bone Infectious Pathologies - A Study from a Tertiary Care Hospital, Valsad, Gujarat

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ABSTRACT

BACKGROUND

The complicated middle and inner ear anatomy challenge the diagnostic ease in radiological evaluation of the temporal bone. Their tiny dimension and close neighbouring of the structures limited the successful imaging facilities for long periods of time. Conventional radiological procedures have been inadequate for diagnostic imaging but recently multidirectional tomography and high-resolution computed tomography (HRCT) has gained importance. Inflammatory and infectious diseases of the temporal bone are a major indication to perform high-resolution CT. Such studies allow one to evaluate the extent of the disease in the soft tissues and in the bony structures of the temporal bone. The purpose of this study was to evaluate temporal bone infectious pathologies using high resolution computed tomography (HRCT).

METHODS

The study is completely observational & retrospective type of study. HRCT of temporal bone was carried out on 50 cases with SIEMENS SOMATOM emotion 16 slice CT scan machine, GMERS Medical College & Hospital, Valsad, Gujarat depending upon the availability from February 2019 to January 2020 including all age groups, both sexes with suspicion of temporal bone infective pathologies based on sign and symptoms.

RESULTS

Out of 50 patients, 38 patients were diagnosed with chronic suppurative otitis media (CSOM) and 12 patients were diagnosed with acute suppurative otitis media (ASOM), of which 65 % of CSOM showed cholesteatoma formation. All the patients with ASOM showed air-fluid levels. Male to female ratio was nearly 1.77 : 1. Out of which, 52 % were paediatric patients. Common symptoms were ear, discharge, headache and deafness. Most commonly affected site was right side. There were 6 extra cranial and 2 intracranial complications seen.

CONCLUSIONS

Due to the ability to delineate the bony and soft tissue anatomy with high accuracy, high-resolution CT is the imaging modality of choice for topographic evaluation of temporal infective pathologies and their extracranial and intracranial complications.

KEYWORDS

ASOM, CSOM, Cholesteatoma, Air Fluid Level, Pneumatization, Ossicles, Middle Ear, Inner Ear, Complications

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BACKGROUND

The complicated middle and inner ear anatomy challenge the diagnostic ease in radiological evaluation of the temporal bone. Their tiny dimension and close neighbouring of the structures limited the successful imaging facilities for long periods of time. Conventional radiological procedures have been inadequate for diagnostic imaging, but recently multidirectional tomography and high-resolution tomography has gained importance. The ability of high-resolution computed tomography to predict accurately the status of the structures of the temporal bone represents a major advance in delineating pathology prior to surgical exploration of ears with cholesteatoma.

HRCT has the advantage of excellent topographic visualization, devoid of artefacts from superimposition of structures which helps in accurate assessment of pathology prior to surgical exploration regarding location, extent, and complication of the disease.

Thin section high resolution tomography with modern equipment gives excellent fine details in addition to its capability to identify soft tissue lesions located in middle ear, inner ear, and mastoid. Due to these advantages, HRCT has completely replaced multidirectional tomography in evaluation of temporal bone infectious pathologies.[1,2]

Comparing HRCT and magnetic resonance imaging (MRI), CT is more useful in evaluation of osseous labyrinth. CT has superiority over MRI to provide more useful information in the diagnosis of middle ear and mastoid diseases.

As stated by Fritz et al. radiation exposure to skin and eye is considerably less in HRCT compared to multidirectional CT.[1]

According to results comparing HRCT and MRI, CT is more useful in evaluation of osseous labyrinth. In the diagnosis of middle ear and mastoid diseases, CT has superiority over MRI to provide more useful information.[3]

Advent of HRCT and improvements in radiological technique has definitely improved study of the temporal bone in patients with CSOM, which includes evaluation of the extent and sites of involvement and inter-relationships of the tympano-mastoid compartment with adjacent neurovascular structures.

Pre-operative HRCT scanning is quite necessary in cases of intracranial complications due to chronic suppurative otitis media. Other reasonable uses of CT scanning include preoperative facial paralysis, vertigo with positive fistula test and when revision mastoidectomy is contemplated in the absence of details of the previous procedure. Its ability to determine the extent of soft tissue involvement of the antrum, middle ear and especially the posterior tympanic spaces may assist the surgeon in deciding between a canal wall up versus an open procedure.

CT has revolutionized the scene of the imaging of the temporal bone because it is with this modality, the axial, coronal & sagittal sections could be obtained and reconstructions in virtually any plane are possible. The wider differences in the density of the middle ear structures produce an inherent image contrast on CT, although soft tissue characterization is much more limited than with MR imaging.

As HRCT can detect and delineate both soft tissue & bony abnormality it should be preferred as the initial line of investigation.

Aims & Objectives

- To study the characteristics and nature of infectious pathologies of temporal bone by HRCT
- To study the involvement of adjacent structures and complications.
- To determine the fine and precise anatomical details of the involved part.

METHODS

The study is completely observational & retrospective type of study conducted on 50 cases on SIEMENS SOMATOM emotion 16 slice CT scan machine depending upon the availability within the study period from February 2019 to January 2020.

Participant Recruitment Procedure

All the patients referred to the department of radiodiagnosis with clinically suspected temporal bone infectious pathology were recruited for HRCT investigation.

- All the scans with positive HRCT findings were clinically correlated with their symptoms.

Inclusion Criteria

- All age groups.
- Both sexes.
- All patients with clinically suspicion of temporal bone infectious pathologies.

Exclusion Criteria

- Those patients who have contraindications for HRCT investigation.
- Uncooperative patients.

Statistical Analysis

Out of 50 patients, 38 patients were diagnosed with chronic suppurative otitis media (CSOM) and 12 patients were diagnosed with acute otitis media, of which 65 % of CSOM showed cholesteatoma formation, 21 % showed granulation tissue with collection and 15 % showed only granulation tissue with no e/o mastoiditis or ossicular chain involvement. All the patients with ASOM showed air-fluid levels. Male to female ratio was nearly 1.77: 1. Out of which, 52 % were paediatric patients. Common symptoms were ear, discharge, headache, and deafness. Most commonly affected site was right side. There were 6 extra cranial and 2 intracranial complications seen.

RESULTS

Age Group (in Years)	Numbers (n)	Percentage (%)
0 - 9	26	52
10 - 19	8	16
20 - 29	6	12
30 - 39	3	6
40 - 49	3	6
50 - 59	2	4
60 - 69	1	2
> 70	1	2
Total	**50**	**100**

Table 1. Age Distribution

The age of patients in this study group ranged from 4 years to 70 years. Maximum number of cases were observed in the age group 0 to 9 years (52 %), followed by 10 to 19 years (16 %). In this study, 32 patients (64 %) were males and 18 patients (36 %) were females with male to female ratio of 1.77: 1.

Sex	Number (n = 50)	(%)	Ratio (Male : Female)
Male	32	64	1.77 : 1
Female	18	36	
Total	**50**	**100**	

Table 2. Sex Distribution

Clinical Findings	Number (n = 50)	Percentage (%)
Ear discharge	47	94
Deafness	40	80
Earache	37	74
Swelling behind ear	17	34
Fever	6	12
Headache	4	8
FND / Seizure	1	2
Deviation of angle of mouth	1	2
H/o operation	2	4

Table 3. Clinical Presentation

The commonest symptoms in this series were ear discharge (94 %). The other symptoms in order of descending frequency are – deafness (80 %), earache (74 %), swelling behind the ear (34 %), fever (12 %), headache (8 %), functional neurological disorder (FND)/seizure (2 %) and deviation of angle of mouth (2 %).

HRCT Diagnosis	Total Number (n = 12)	(%)
Fluid level in mastoid	12	100
Septal erosion	6	50
Pneumatization:		
Sclerotic	0	0
Normal	8	100
Diploic	0	0

Table 4. HRCT Findings in ASOM

In our study, we found 12 patients with ASOM. All of 12 cases showed air-fluid level in mastoid air cells and the other one showed erosion of septa between mastoid air cells and fluid levels in mastoid air cells.

HRCT Diagnosis	Total Number (n = 38)	(%)
Cholesteatoma	25	65.78
Granulation tissue with collection	8	21.05
Granulation tissue	6	15.78

Table 5. HRCT Findings in CSOM

Study showed 25 cases of cholesteatoma (65.78 %) followed by granulation tissue with collection in 8 cases (21.05 %) and granulation tissue alone in 6 cases (15.78%).

HRCT Findings	Total Number (n = 25)	Percentage (%)
Soft-tissue density in middle ear and mastoid	25	100.00
Pneumatization:		
Sclerotic	25	100.00
Diploic	0	0.00
Ossicular involvement	21	84
Widening of auditus	21	84
Erosion of scutum	20	80
Erosion of sigmoid sinus plate	8	21.05
Lateral semicircular canal	7	18.42
Erosion of tegmen tympani	2	5.26
Erosion of cortical wall of mastoid	8	21.05

Table 6. HRCT Findings in Cholesteatoma

Most common finding in cholesteatoma was soft tissue density in middle ear and mastoid and sclerosis of mastoid air cells in all 25 cases (100 %). Other findings were involvement of ossicular chain in 21 cases (84 %), widening of auditus in 21 cases (84 %), erosion of scutum in 20 cases (80 %), erosion of sigmoid sinus plate in 8 cases (21.05 %), erosion of lateral cortical wall of mastoid in 8 cases (21.05 %), involvement of lateral semicircular canal in 7 cases (18.42 %) and erosion of tegmen tympani in 2 cases (5.26 %).

Location and Extension	Number (n)	(%)
Attic / Epitympanum	5	20
Attico-antrum + Mesotympanic	4	16
Holotympanic extending to the mastoid antrum (Extensive)	16	64
TOTAL	25	100.00

Table 7. Location And Extension of Cholesteatoma

In our study, out of 25 cases of cholesteatoma, highest number of cases were seen in the holotympanic group, 16 cases (64 %), followed by the attico-antral + holotympanic group in 5 cases (20 %) and attic/epitympanic cholesteatoma was seen in 4 cases (16 %).

HRCT Findings	Number (n = 8)	Percentage (%)
Extracranial:		
Mastoid abscess / Fistula /Bezold's abscess	5	62.5
Facial nerve palsy / facial canal erosion	1	12.5
CSF otorrhea	0	0.00
Intracranial:		
Meningitis	1	12.5
Subdural empyema	1	12.5

Table 8. Distribution of Complications

There were 6 extra cranial and 2 intracranial complications seen. Out of 6 extra cranial complications, highest were mastoid abscess / fistula / Bezold's abscess 5 cases (62.5 %), followed by facial nerve palsy / facial canal erosion.

Out of the 2 intracranial complications, 1 cases of meningitis (12.5 %) and 1 was subdural empyema (12.5 %).

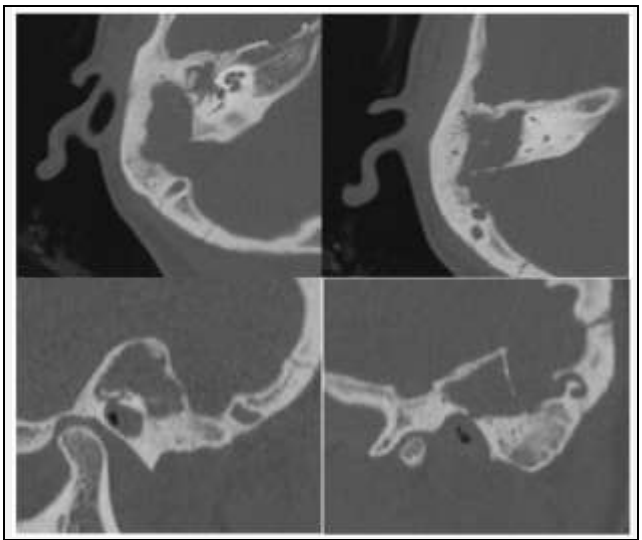

Figure 1. Chronic Suppurative Otitis Media. High Resolution CT Axial and Coronal Scan of Right Side Shows Soft Tissue Density Material Occupying Right Middle Ear Cavity with Loss of Ossicular Chain, Mastoid Air Cells and Sigmoid Sinus Plate.

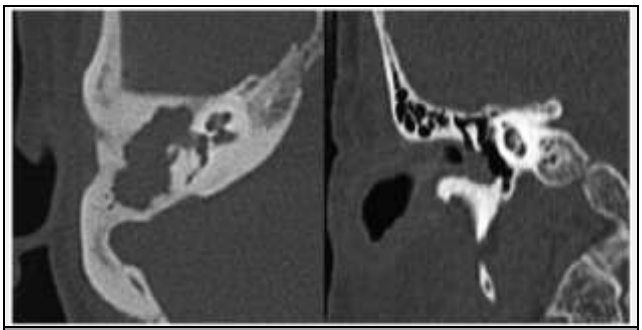

Figure 2. Chronic Suppurative Otitis Media. High Resolution CT Axial Image (A) Showing Soft tissue Density Material Occupying Right Middle Ear Cavity with Erosion of Ossicles and Destruction of Mastoid Air Cells in the Right Image and Coronal Image of Another Patient Shows Soft Tissue Density Material Occupying Middle Ear Cavity with Erosion of Scutum with Sparing of Ossicles

DISCUSSION

Age Incidence

The patients in this series belonged to the age groups from the first to the eighth decade. It was found that the greatest incidence was in the 0 - 9 years age group followed by 10 - 19 years age group. Poorey, V.K et al. (2000) observed in their study series that majority of the patients with CSOM belonged to the age group of 0 - 10 years (47 %) which supports our study with highest 52 % CSOM cases.[1]

It was supported by Vaidya Krista, who said that CSOM was most common in the 1 - 10 years age group, which decreases with increasing age.[4] Sitashree Sethy et al. in their study found maximum population of CSOM patients belonged to 2 - 11 year age group.[2] Adeyi Adoga et al. (2008) found highest number of cases in 1 - 5 year age group.[3] The youngest patient in this study was 4 years and 4 months old. The oldest patient in our study was 70 years old.

Sex Incidence

In the present study, male predominance has been noted. This is in agreement with Adeyi Adoga et al. (2010) observation that chronic suppurative otitis media is more common in males.[3]

Dr. Seepana Muralidhara Rao et al. in their study found male female ratio to be almost 2 : 1.[5]

Asghar Ullah Khan et al. found the male incidence to be more than female with a male to female ratio to be almost 1.35 : 1. Thus it supports our study where we found a ratio of 1.77 : 1 of male & female ratio.[6]

Duration of Symptoms

In this study the term "chronic" has been used when the duration of ear discharge from a case of otitis media was 6 weeks or more and the term acute has been used when the duration was less than 6 weeks.[7]

Modes of Presentation

The commonest presenting symptom found on 47 of our patients was ear discharge either unilateral or bilateral and varying degrees of hearing impairment. Sushant Tyagi et al. in their study of chronic suppurative otitis media found commonest presenting symptoms as chronic otorrhea.[8] In a study Dr. V. Anil Kumar et al. found maximum incidence of otorrhea (60%) in CSOM cases.[9] David S Haynes et al. stated that history of intermittent otorrhea is most common presenting symptom in CSOM.[9]

Besides chronic discharge, most patients of CSOM present with mixed hearing loss, less frequently with sensorineural hearing loss or with a dead ear. In our study, a total of 17 (34 %) cases presented with swelling behind the ear.

This supplement the view of S Devi Prasad et al. who found swelling behind ear in 48.3 % cases.[10] David S Haynes et al. found headache to be the commonest presenting feature in CSOM associated with intracranial complications.[11]

HRCT Findings

In our study, we came across 12 cases of acute otitis media. HRCT findings reveal fluid levels in 12 cases (100 %) and erosion of mastoid septae seen in 6 cases (50 %) along with fluid levels. William R. Nemzek and Joel D. Swartz stated that the fluid level in the mastoid air cells is the commonest HRCT finding in acute otitis media.[7] In our study also, most common finding in ASOM was fluid level followed by septal erosion. So, our study stands with the study made by William R. Nemzek and Joel D. Swartz.[7]

High Resolution Computed Tomography in CSOM

The findings of HRCT scan in the 38 cases of CSOM in our study were evaluated properly so that a definite diagnosis can be given. As mentioned earlier we had fixed parameters of evaluation as:

- Soft tissue density in middle ear.
- Extent of the soft tissue density.
- Any dependent density in middle ear.
- Status of the Prussak's space.
- Presence of bony erosions - scutum, tegmen tympani, sigmoid sinus plate
- State of ossicular chain integrity.
- Involvement of semicircular canal.
- Evidence of sclerosis of mastoid air cells
- Any soft tissue density in mastoid.
- Pneumatization of mastoid.
- Condition of the lateral cortical wall of mastoid.
- Widening of aditus-and -antrum.

Among the 38 cases of CSOM studied, cholesteatoma was diagnosed in 25 cases (65.78 %), only granulation tissue in 6 cases (15.78 %) and granulation tissue with collection in middle ear in 8 cases (21.05 %). Bates & Anslow (1986) found granulation tissue in 20 % cases in their study of 50 cases of CSOM.[12] In our study, granulation tissue was diagnosed on the basis of presence of non-dependent soft tissue density and in the absence of bone erosion, as stated by Swartz & Goodman (1983).[13] So in our study, the diagnosis of granulation tissue was made on basis of presence of non-dependent density in middle ear without any erosive changes as stated by the above authors. Out of 38 cases of cholesteatoma, soft tissue density in middle ear and mastoid were present in all cases (100 %). Sclerosis of mastoid air cells were also seen in 100 % cases, ossicular chain involves in 33 cases (86.84 %), erosion of tegmen tympani in 2 cases (5.26 %), erosion of lateral cortical wall of mastoid in 8 cases (21.05 %). Erosion of sinus plate in 8 cases (21.05 %) and semicircular canal was noted in 7 cases (18.42 %). Mohammed A. Gomaa et al. found in their study that 96.43 % of cholesteatoma cases had ossicular chain involvement.[14] S. Devi Prasad et al. in 2015 found involvement of lateral semicircular canal in 8 (13.33 %) out of 60 cases of CSOM.[10] However, in our study, we found 7 (18.42 %). Ginni Datta et al. in 2014, found that sinus plate was eroded in 3 (12 %) cases of unsafe CSOM on CT. In our study, the value was 21.05 %.[15]

Pneumatization

The HRCT scan provided perfect views of the air cell system within the temporal bone. This was evident in both scan planes. In our series, we found non-pneumatization to be the commonest findings being present in all cases of cholesteatomas. Mohammed A. Gomaa found in their study that sclerosis of mastoid was present in 93.8 % of cholesteatoma which support our study.[14] Cholesteatoma is more commonly found in poorly pneumatised sclerotic bones.

Early Signs of Cholesteatoma

According to Mehrdad Rogha, first sign of aural cholesteatoma is erosion of the scutum which is also present in attic type of cholesteatoma. Their study demonstrated good correlation between temporal bone HRCT scans with surgical findings, particularly in sigmoid plate erosion & aditus widening.[16] Mafee et al. and David et al. described the criteria indicating cholesteatoma as "blunting" of the scutum's normally sharp tip which is often the earliest sign of attic cholesteatoma. Widening of the aditus is often an important imaging diagnostic finding in cholesteatoma.[7]

Cholesteatomas are diagnosed at HRCT by the presence of a non-dependent, homogenous, soft tissue mass in a location appropriate to the etiopathology of the locations. If no bony erosions present, then differentiation of cholesteatoma from granulation tissue is difficult.[7]

Mafee (1988) tried to differentiate cholesteatomas from granulation tissue on basis of CT density, but the difference was only subtle & that's why was difficult for diagnosis.[17]

Swartz, Goodman and Russel (1983) stated that cholesteatomas, granulation tissue and middle ear effusion share same CT density (45 - 65 HU). Hence, they advised to rely on secondary findings like ossicular destruction to differentiate them.[18] This was supported by Barath K et al. (2011).[19]

Mention must be made of the collections within the tegmen tympani. Axial HRCT sections provide an excellent opportunity to become familiar with this enigmatic region. This air-filled depression is important as it is not pneumatised by the mastoid air cell system and cholesteatoma tends to fill them. This area is beyond the visualization of the otological surgeon during routine end-aural approach and preoperative knowledge of cholesteatoma in these areas is obvious importance. In our study, cholesteatoma involving tegmen tympani was seen in 2 cases.

Involvement of Sinus Plate

In our present study, 21.05 % of cholesteatoma cases showed erosion of sinus plate. According to Abhijeet Kr. Sinha (2014), the association of bone erosion is highly suggestive of cholesteatoma. Further it is important as the sigmoid sinus can be involved and dreaded complications like sigmoid sinus thrombosis can occur.[20]

Location & Extent of Cholesteatoma

In the present study, 25 cases of cholesteatoma were diagnosed, extensive cholesteatoma i.e., holotympanic which extends up to the mastoid antrum shows highest number of 16 cases (16 %), attic/epitympanic cholesteatomas seen in 5 cases (20 %) & the group including attico-antrum and mesotympanum involves 4 cases (16 %). According to Becker & Woloshin (1962), 20 % of cholesteatoma may remain entirely attic in site.[21] Mohammed A. gomaa et al. (2010) in their study of Correlation between high resolution computed tomography and surgical finding, described highest number of distributions of cholesteatoma in the holotympanic group.[14]

Distribution of Complications

S Devi Prasad et al. & Thapa N et al. found highest number of cases in the mastoid abscess/fistula/Bezold's abscess group.[10,22] In our study also, it shows highest number of 5 (62.5 %) cases were in this subgroup. In the extracranial complication group, 1 case of facial nerve palsy (12.5 %) were seen. Thapa N et al. found 8.33 % cases of facial nerve palsy in his study group.[22] S Devi Prasad et al. also found facial nerve palsy showing second highest incidence rate in the extracranial complications group.[10] Other complications found in our study were 1 case of meningitis (12.5 %) and 1 case of subdural empyema (12.5 %).

CONCLUSIONS

A large number of structures like tympanic membrane, the ossicles and part of the facial canal etc. which were previously not visualized or poorly visualized by other means can now be seen by HRCT.

For maximum resolution, scanning the patient directly in the two projections is advantageous. If two projections are not available, reformatted images can be obtained. There is possibility of some loss of resolution in the reformatted images.

There are many clinical implications of HRCT. It provides precise technique for the evaluation of the soft-tissue masses within the air-filled middle ear and mastoid. It helps in defining the extent of erosion or destruction of the walls of the middle ear, the capsule of semicircular canal (SSC), and the ossicular chain which is very important in the evaluation of cholesteatomas and other middle ear lesions. HRCT scanning serves as a road map to assist the surgeon during cholesteatoma surgery.

It is also very helpful in evaluating various dreaded extra and intracranial complications due to CSOM along with post-operative complications from mastoidectomy.

HRCT can accurately demonstrate the extent of various middle ear diseases & provide a roadmap to the otorhinolaryngologist and neurosurgeons for operative interventions. With more prevalent use of HRCT, better patient management is possible & thus disease recurrence, morbidity as well as mortality related to the suppurative disease of the middle ear and the mastoid etc. are also controlled.

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