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Role of HRCT Multiplanar Temporal bone Non-traumatic lesions of Temporal bone, Comparative analysis with post-operative findings and histopathology report, wherever applicable.

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Abstract:Background:*HRCT Temporal bone remains mainstayévaluation of various pathologies involving the Temporal bone . It plays a vital role in diagnosis ,understanding the pathology , behavior of the disease and planning the best course of treatment , may it be medical or surgical line. Prognostication of complications are best done by this imaging modality .*
Materials and Methods*: In this prospective randomised controlled study, 52 patients of clinically fresh non operated case of non traumatic temporal bone (External , inner , middle ear pathologies) were selected . Multiplanar HRCT temporal bone study was done at Subbiah institute of medical sciences Shimoga , few under anaesthesia support . Past history of trauma or surgery were main exclusion criteria . The cases were categories under headings of Congenital , Infections , Tumours. Operative correlation , histopathological correlation were done in relevant cases . The study was done over 18 months interval . Total of 38 infection , 8 tumours and 1 osteopetrosis cases were evaluated . 31 male , 21 female patients were part of the sample with mean age of 25 years . Role of imaging towards sensitivity and specificity of pick up and evaluation of conditions , its correlation with operative and HPR findings were clubbed . Finally structured understanding the imaging differences between CSOM , Cholesteatoma was attempted*
Results*: Infection , neoplasm followed by Congenital conditions were noted in order of frequency . There is concomitant associations in the form of infections superadded to congenital /tumour conditions. Operative correlation correlated well with both intra temporal and extra temporal complications of various infections ,tumours. points of differentiation of CSOM , Cholesteatoma well correlated with HPR. Anaesthesia support remained mainstay in paediatric population and complicated cases*
Conclusion:*HRCT Temporal multiplanar imaging remains excellent tool in Diagnosis , Evaluation of complications of various non traumatic intra and extra temporal assessment of Temporal bone pathologies*
Key Word*: HRCT; Temporal ,CSOM, Cholesteatoma, Multiplanar , HPR*

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I. Introduction

Temporal bone is an unique bone housing the complex structures of ear, having intrinsic variable attenuation due to interspersed minute anatomical structures and pneumatization, thus giving the advantage of possibility of high resolution imaging.The temporal bone with its high inherent radiation attenuation contrast due to presence of both, most dense bone in body and air filled space, the utility of CT images with special high spatial resolution bone algorithm, gives good details.HRCT, a modification of routine CT, utilizes thin sections (0.6 to 1.5 mm) with special bone algorithm. The technique has relative low radiation dose compared to many other types of CT examinations and utility of contrast is not essential for evaluation of pathology isolated to bone / air space.The advent of multidetector CT, least pixel sized reformation, availability of wide range of HU windowing, has allowed excellent imaging evaluation of the Temporal bone pathologies.Multiplanar CT reformations can display complex anatomy in variable views using MIP and MPR reformations.

II. Material And Methods

This prospective comparative study was carried out on patients of Department of Radiodiagnosis and ENT atSubbaiah Institute of Medical sciences and Hospital , Shimoga. A total 52 adult subjects (both male and females), were part of this study

Study Design: Prospective Evaluation with Operative and HPR correlation

Study Location: This was a tertiary care teaching hospital based study done in Department of Radiodiagnosis and ENT at Subbaiah Institute of Medical sciences and Hospital , Shimoga ,

Study Duration:20months

Sample size: 52 patients.
Subjects & selection method: The study population was drawn from OPD patients presented at Department of ENT and referred for Imaging to Department of Radiodiagnosis at Subbaiah Institute of Medical Sciences Shimoga

Inclusion criteria:
1. Patients are examined by ENT specialists at Subbaiah Institute of Medical sciences and referred for Temporal bone imaging.
2. Patients to be operated (or) biopsy sampling done after evaluation by HRCT Temporal bone, except in absolute contraindications / lack of feasibility.

Exclusion criteria:
1. History of Trauma to the Temporal bone (side) being imaged.
2. Previous surgical intervention involving the side of Temporal bone being imaged.

Procedure methodology

After written informed consent was obtained, a well-designed questionnaire was used to collect the data of the recruited patients retrospectively. All the HRCT scans were performed at our institute, Department of Radiodiagnosis, Subbaiah Institute of Medical Sciences ,Shimoga, on GE Revolution ACT 16 slice Spiral CT with least slice thickness of 0.6mm.At 130 kV and 140 effective mAs, the noise level is low with better bone penetration / minimal beam hardening. At the same time better soft tissue differentiation is possible. 0.56 seconds scan time allows less probability of motion artifacts and 0.6mm slices gives best Axial and reformatted MPR images

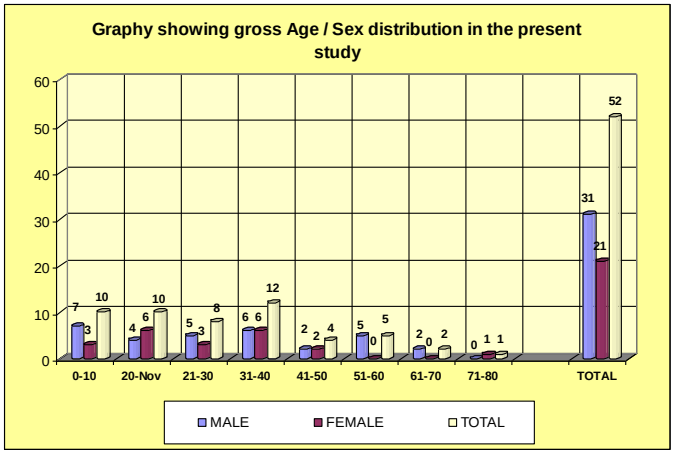
Spiral	**Inner Ear**	**2nd reconstruction**
kV	130	
Effective mAs	70	
Slice collimation	1mm	
Slice width	2mm	0.6mm
Feed / rotation	1.7mm	
Rotation time	1.5mm	
Kernel	H 90s.	H 90s.
Increment	1.5mm	0.8
CT D Ivol	15.94 mGy.	

The clinical cases were mandatorily correlated with HPR report , principally post operative and occasional by biopsy . Imaging conclusions, clinical diagnosis , operative findings and HPR were correlated .

Statistical analysis
All Data were expressed in percentage and Chisquare test applied wherever applicable .Data was analyzed using SPSS version 20 (SPSS Inc., Chicago, IL).. The level $P < 0.05$ was considered as the cutoff value or significance.

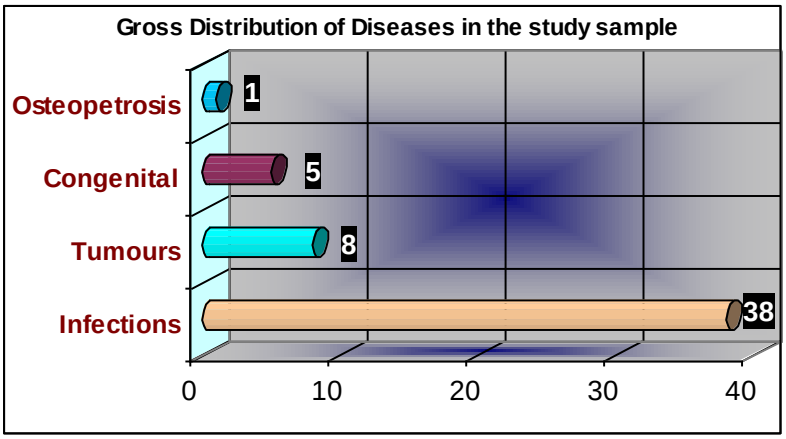
III. Result

The total sample size = 52 cases.The age range = 1week old baby to 74 years.



The median of the age of presentation = 25 years.

- The arithmetic mean of age = 29.3 years considering the ungrouped data.
- The Male : Female ratio of the study sample is 3 : 2



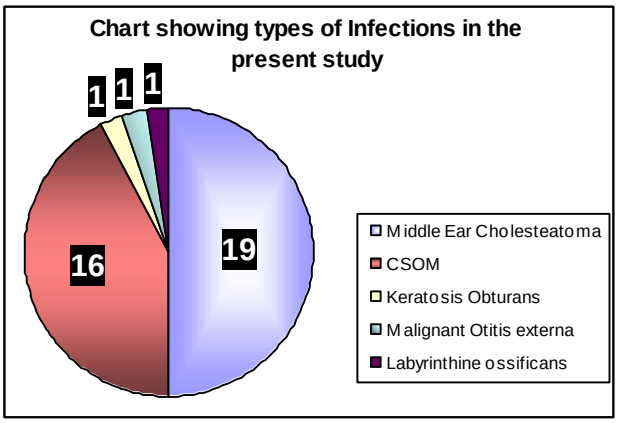


TABLE 3 : DISTRIBUTION OF INFECTIONS OF MIDDLE EAR CLEFT

Condition	No.
Cholesteatoma	19
Suppurative Oto - Mastoiditis i) Chronic inflammatory granulation ii) Cholesterol granuloma	 14 02

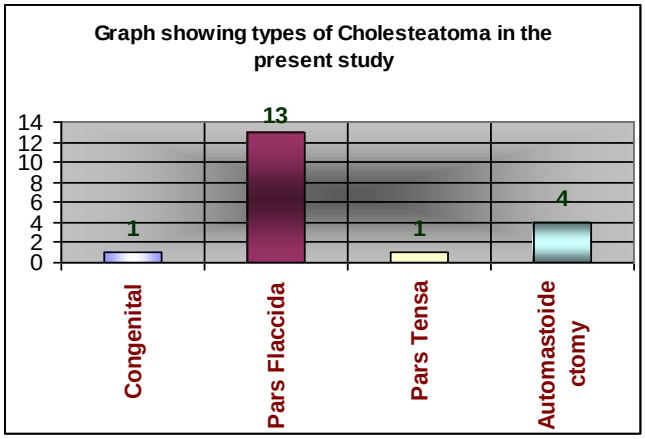


TABLE 4 : AGE / SEX DISTRIBUTION OF CHOLESTEATOMA.

Age	Male	Female	Total	Percentage (%)
0-10	4	1	5	26.3
11-20	2	2	4	21
21-30	1	1	2	10.5
31-40	2	3	5	26.3
41-50	0	2	2	10.5
51-60	1	0	1	5.2
61-70	0	0	0	00
71-80	0	0	0	00
Total : -	**10**	**9**	**19**	
%	**52.6**	**47.4**		

TABLE 6 :SEX DISTRIBUTION OF SPECIFIC NEOPLASMS.

	MALE	FEMALE	TOTAL	%
Osteoma	0	2	2	25
FIBROUS DYSPALSIA	1	0	1	12.5
SquamousCell Carcinoma	1	1	2	25
Chondrosarcoma	0	1	1	12.5
Ac. Schwannoma	1	0	1	12.5
Jugular fossa paraganglioma	0	1	1	12.5
Total	**3**	**5**	**8**	
%	**37.5**	**62.5**		

TABLE 7: GROSS AGE/SEX DISTRIBUTION OF NEOPLASM.

Age	Male	Female	Total	Percentage (%)
0-10	0	0	0	00
11-20	0	0	0	0
21-30	1	2	3	37.5
31-40	2	2	4	50
41-50	0	0	0	0
51-60	0	0	0	0
61-70	0	0	0	0
71-80	0	1	1	12.5
Total : -	**3**	**5**	**8**	
%	**37.5**	**62.5**		

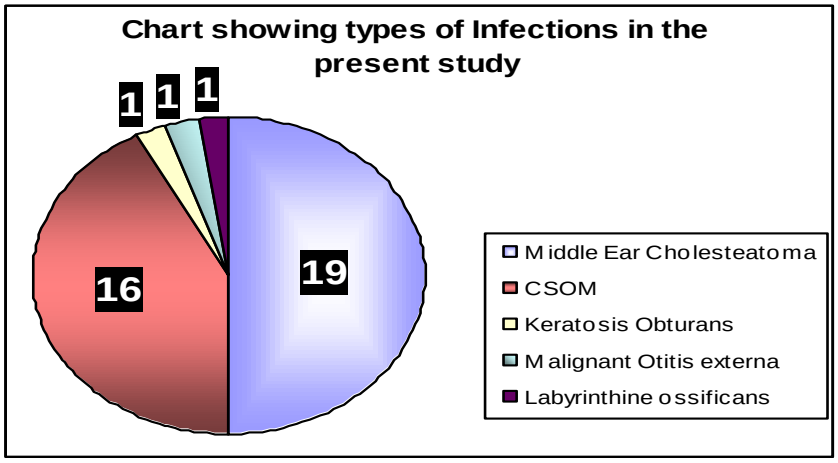
TABLE 8 : AGE / SEX DISTRIBUTION OF CONGENITAL ANAMOLIES OF TEMPORAL BONE

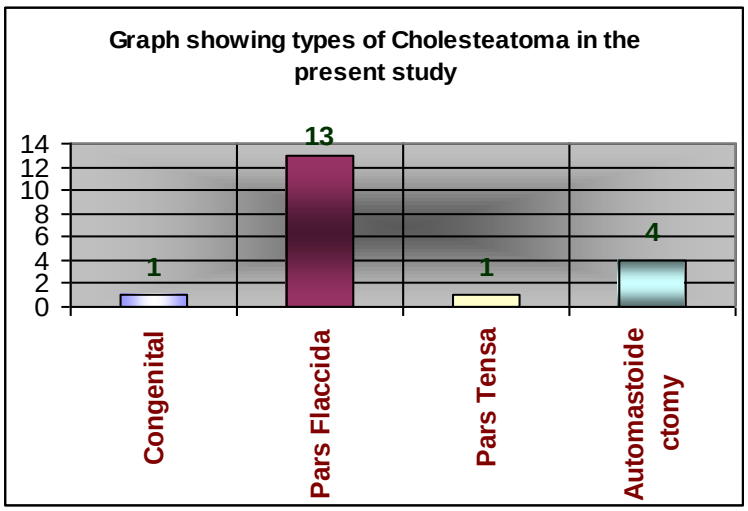
MALE						FEMALE						%
Pinna / EAC / ME			Inner Ear			Pinna / EAC / ME			Inner Ear			
Rt.	Lt.	Bil	Rt.	Lt.	Bil	Rt.	Lt.	Bil	Rt.	Lt.	Bil	
1							2					33.3

1						1		1			1	66.6
2			**0**			**3**			**1**			
33.3						66.7						

TABLE 9 : DISTRIBUTION OF FEATURES OF EXTERNAL / MIDDLE EAR ANOMALIES.

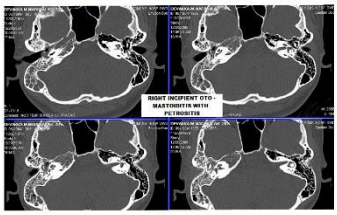
Feature	Right	Left	Bilateral
Pinna	- Acrotia / dysmorphic…...3 - Normal……0	0 0	1 0
EAC	- Dysgenetic ……0 - Atretic ……...3	0 0	1 0
Middle ear	- Dysgenetic.....3 - Normal ……..…0	0 0	1 0
Ossicles	- Dysmorphic……...3 - Absent ……...0	0 0	1 0
Oval Window	- Atretic……0 - Normal……...3	0 0	1 0
Facial Nerve course	- Aberrant ……...1 - Normal ……..2	0 0	1 0
Inner ear	- Normal……3 - Abnormal……...0	0 0	1 0
Total :	**3**	**0**	**1**

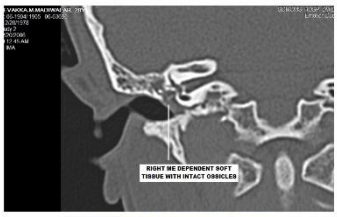




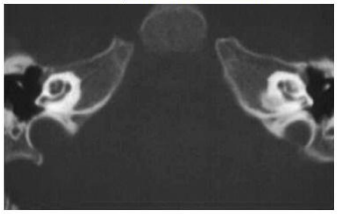
IV. Image gallery

INCIPIENT OTOMASTOIDITIS WITH PETROSITIS

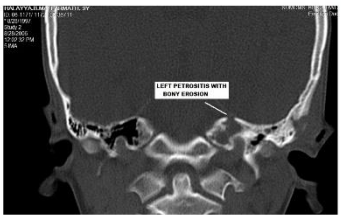


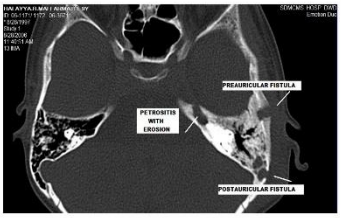


Labyrinthine ossificans

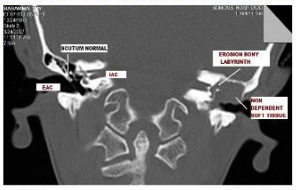


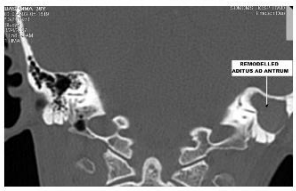
LEFT PETROSITIS WITH CORTICAL EROSION, AND MASTOID PRE & POST AURICULAR ABSCSS



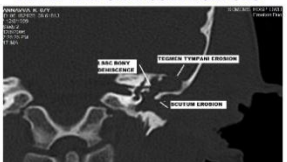


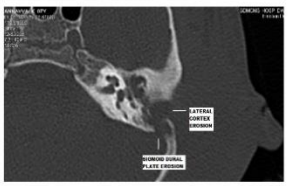
ACQUIRED PARS FLACCIDA CHOLESTEATOMA

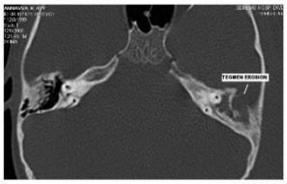




CHOLESTEATOMA WITH INTRA & EXTRA-TEMPORAL COMPLICATIONS

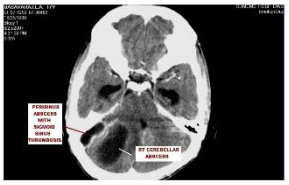


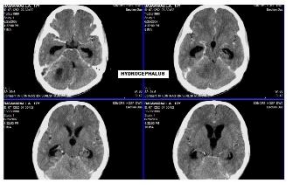


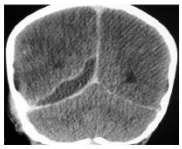


CSOM WITH SINUS DURAL PLATE EROSION

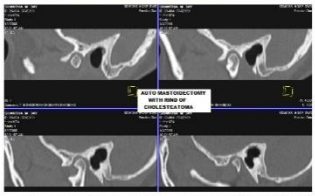
SIGMOID SINUS THROMBOSIS, PERISINUS, SUBDURAL ABSCESS & CEREBELLAR ABSCESS

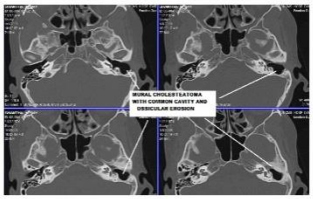




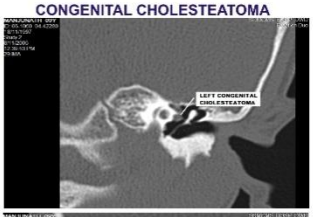


AUTOMASTOIDECTOMY

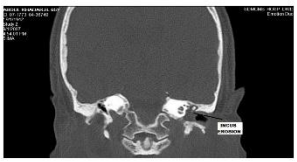


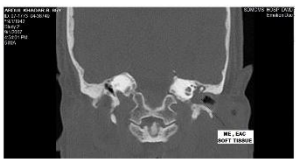


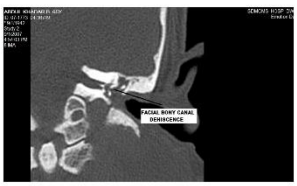
CONGENITAL CHOLESTEATOMA



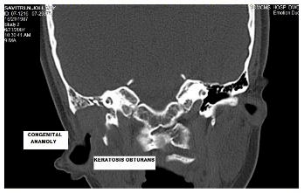
MALIGNANT OTITIS EXTERNA

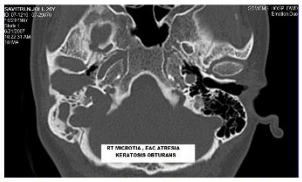




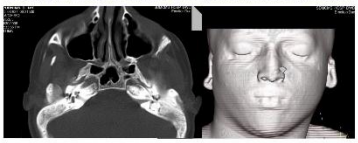


CONGENITAL E.A.C., MIDDLE EAR ANOMALIES WITH KERATOSIS OBTURANS

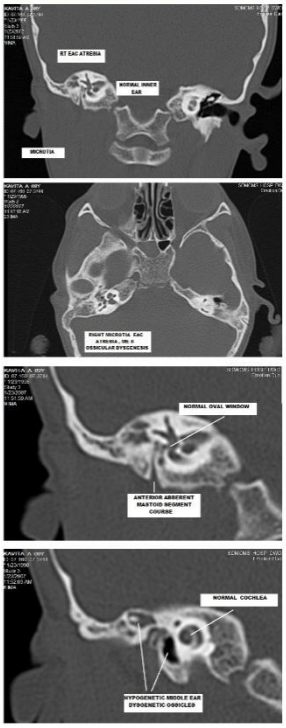




BILATERAL, E.A.C., MIDDLE EAR ANOMALIES WITH ABERRANT FACIAL NERVE WITH OVAL WINDOW ATRESIA

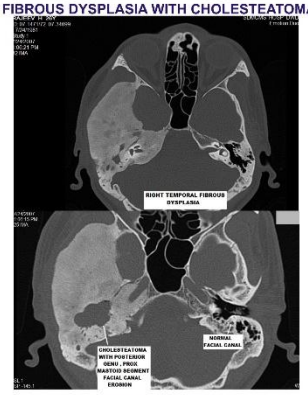


E.A.C. ATRESIA WITH DYSPLASTIC MIDDLE EAR



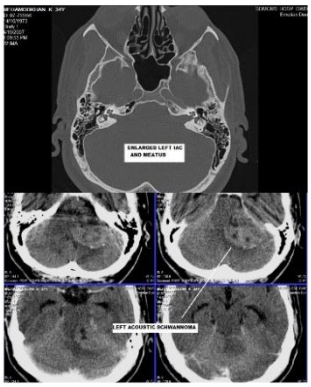
OSTEOMA

FIBROUS DYSPLASIA WITH CHOLESTEATOMA

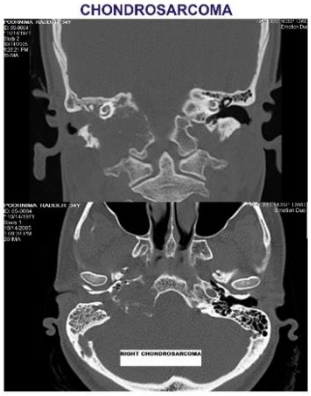


OSTEOPETROSIS

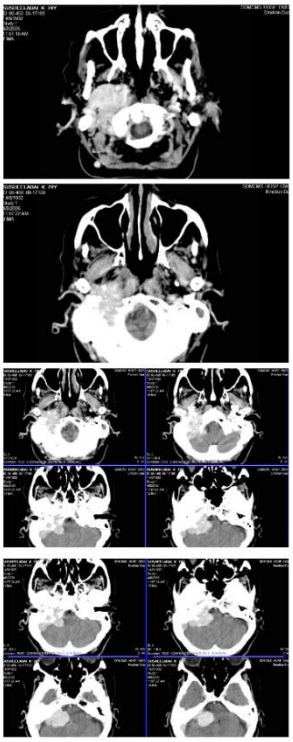
ACOUSTIC SCHWANNOMA

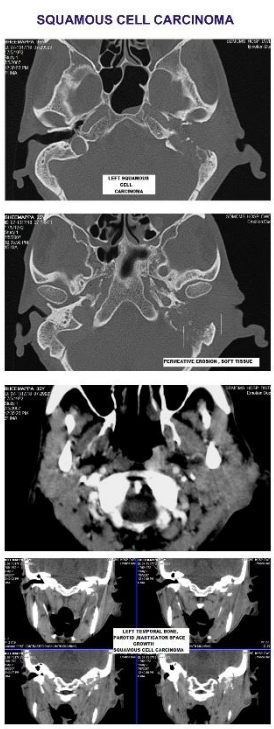


CHONDROSARCOMA



RT. JUGULO-TYMPANICUM TYPE OF PARAGANGLIOMA





V. Discussion

HRCT Temporal bone in the present study has given excellent topographic visualization of anatomy and pathology with accurate assessment of pathology prior to surgical exploration, regarding the location, extent and complications of the disease. Broadly 4 categories of patients were part of this study –**Infections** : The most common 38/52 cases (including one case with associated congenital anomaly. **Tumours** : The 2nd most common category with 8/52 cases.**Congenital anomalies** – 6 cases (including one case with infection)Miscellaneous – **Osteopetrosis** (1 case). The age group with maximum presentation was 11-20 years (9/28 = 23.7%) which was comparable with Gupta et al, study of 1998 (30%)The Male : Female ratio 26/12 = 2.1 : 1 is comparable with Loyld et al and Paparella et al, study (2.4 : 1 & 2.3 : 1 respectively) Application of X2 Test for studying the relation between Sex (vs) Infection reveals X2 = 4.414. D.F. = 1, P=0.05.The Calculated Chisquare value is greater than Tab X2 at DF = 1, P=005 : Hence significant.

Important role of HRCT in temporal bone infections are,
Assessment of middle ear cleft 18 abnormality, as it is an unified cleft , which is always abnormal in infections. The spread of infection through nasopharynx , eustachian tube and overall infective process noted in this anatomical unit as a whole, is worthy to be noted.
The infective process then ,needs to be differentiated into aggressive
(cholesteatoma) or non aggressive (CSOM)

11 POINT CRITERIA APPLIED FOR SPECIFICITY EVALUATION OF ROLE OF HRCT TEMPORAL BONE IN EVALUATION OF CHOLESTEATOMA (VS) NON-CHOLESTEATOMA INFECTION.[36 ,37]

CRITERIA	**Cholesteatoma** Positive / No. of cases	**Non-cholesteatomatous infection** Positive / No. of cases
Middle ear cleft soft tissue	19/19	16/16
Expansile soft tissue	18/19	1/16
Non-dependent Soft tissue	18/19	0/16
Loss of hour glass shape of aditus (lateral attic remodeling)	18/19	0/16
Scutum erosion	18/19	1/16
Cog erosion.	12/18	0/16
Ossicle erosion		
Malleus	E- 10/19	E - 2/16 incus
Incus	E- 16/19. 2-NV	
Stapes	E - 14/19	

Incudo stapedial junction	NV- 7-19. E- 8/19	
Tegmen tympani/mastoidicum		
Thinned	4-19	0/16
Dehiscent	2/19	
Lateral semicircular canal bony dehiscence	5/19	0/16
Facial bony dehiscence	6/19	1/16
Medial / lateral displaced ossicles	11/15	0/16

E – EROSION , NV – NOT VISUALISED ,

There is a clear picture in the above table,
Pathological middle ear cleft 18(mastoid air cells, antrum, aditus, epitympanum, rest of middle ear and Eustachian tube) was evident in both conditions.
The soft tissue opacity was expansile ,causing scalloped margins in 94.7% of cholesteatoma and only 6.25 % in CSOM. and ,
Non dependent nature of Soft tissue. Loss of Hour glass shape (lateral attic remodeling). Scutum erosion.Ossicular erosion in upto 52 to 84% (malleus and incus respectively) .Labyrinthine fistula Facial bony canal dehiscence.Ossicular displacement---Constituted hallmarks of cholesteatoma
Keratosis obturans , Auto mastoidectomy , Malignant otitis externa constituted part of the infection spectrum .

FEATURES OF A CASE OF KERATOSIS OBTURANS.

Age	Sex	C/F	ST in ME Cleft	- Expansion - Hour glass loss - Bony erosion	Ossicles	EAC ST	EAC B. erosions
20	F	- Otalgia - HOH - Tinnitus. - ED	+	-ve	Incus erosion.	+ with atresia	+

ED – Ear discharge HOH –Hard of hearing ST –soft tissue

Auto mastoidectomy case showed ,

a) Common cavity connecting the external auditory canal , middle ear and the mastoid noted
b) Rind of non dependent soft tissue lining the cavity
c) Absence of ossicular chain indicating complete erosion.
d) 2 cases showing labyrinthine fistula , explaining the tinnitus and vertigo in these patients.
e) No intracranial complications.

FEATURES OF A CASE OF MALIGNANT OTITIS EXTERNA.

Age	Sex	C/F	ST in ME Cleft	- Expansion - Hour glass loss - Bony erosion	Ossicles	EAC ST	EAC Bony erosions
65	M	- ED - Otalgia - FP ST swelling	+	-ve	I	- ST	+

ED –Ear discharge FP –Facial palsy ST –soft tissue

Diagnosis **by HPR – Malignant Otitis extension.** [16]

CONGENITAL INNER EAR ANOMALIES NOTED IN THE CASE.

	Right	Left
Cochlea		
- Modiolus	Absent	Absent
- Turns	Reduced	Reduced
- Apex	Absent	Absent
- Size	Large	Large
Cochlear duct	0.9 mm	1.5 mm
Vestibule	Large	Large
Vestibular duct	1.8mm	0.7mm
IAC	N	N
Middle ear	N	N
Facial nerve course	N	N
Oval window	N	N

FEATURES CASES OF SQUAMOUS CELL CARCINOMA.

Age / Sex	Side	Bone erosion	Involved portions	Clinical presentation
35 years / Male	Left	- Permeative + - Ossicles + - Bony facial canal +	- EAC - Middle ear - Mastoid - Infratemporal fossa - Parotid space - Superficial Masticator space	- Facial palsy - Ear discharge - Otalgia - Parotid swelling - Loss of hearing
40 years / Female	Left	- Permeative + - Ossicles + - Bony facial canal +	- EAC - Middle ear. - Mastoid - Infratemporal fossa - Parotid space - Superficial Masticator space	- Facial palsy - Ear discharge - Otalgia - Parotid swelling - Loss of hearing

Case of Acousticneuroma , Fibrous Dysplasia , Osteoma , Jugulo tympanicum type para ganglioma were part of the study with imaging features , operative correlation and HPR correlating with 100% accuracy

VI. Conclusion

HRCT TEMPORAL BONE outweighs the conventional modalities of investigations and provides higher spatial resolution and better tissue contrast, allowing high sensitivity of pathology pick up and good specificity of diagnosis with the protocol application as used in our study.

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