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A Correlative Study of Pre-Operative High Resolution Computed Tomography Temporal Bone Findings with Intra-Operative Findings in Tympanomastoid Surgery in Cases of Chronic Otitis Media

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Abstract

Background: Chronic Otitis Media (COM) is the term used to describe any chronic inflammatory pathology of the middle ear cleft without reference to etiology or pathogenesis. High resolution computed tomography (HRCT) the temporal bone provide significant advantages in differentiating between the bone and soft tissue in high contrast images. In this research paper, we have studied the pre-operative HRCT effectiveness in identifying the abnormalities and its aid in tympanomastoid surgery. **Methodology:** This was a cross sectional study conducted in department of ENT, Indira Gandhi Government General Hospital and Postgraduate Institute, Puducherry from January 2019 to June 2020 with Sample size of 35. Patient diagnosis was made and pre-operative HRCT temporal bone done. Patient was then taken up for surgery and Intra-operative findings noted. **Conclusion:** In this study which included 35 patients of Chronic Otitis Media attending a tertiary care hospital, the following conclusions made. The mean age of presentation is 36.5 years. Visualization of Tympanic membrane is poor as it was tough to differentiate between Retraction and perforation. The involvement of middle ear identification in HRCT is satisfactory. The ossicles were visualized, even when surrounded soft tissue density. However they cannot be reliable on the scans. The visualization of bony structures (tegmen, LSCC) were high except for the facial canal. This may be misleading due to errors in reconstruction. HRCT couldn't differentiate between various soft tissue densities.

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Introduction

Chronic Otitis Media (COM) is the term used to describe any chronic inflammatory pathology of the middle ear cleft without reference to etiology or pathogenesis. Pathologically COM is of two types - **Mucosal type** and The **Squamous type**. The Mucosal type of COM is often associated with destruction of the ossicular chain and prominent granulation tissue. The Squamous type of COM has the potential for intracranial and extracranial extension.(1)

The primary objective of any surgery in inflammatory middle ear disease is to obtain a dry ear and second objective is to restore the functional capacity of the ear,(2) and both of these are better facilitated by the aid of a radiological preoperative assessment. Hence it becomes very

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important to know the location and extent of disease before proceeding to surgical management.[3]

Temporal bone is a complex structure which contains organs for hearing and balance. Large vessels and nerves pass through temporal bone. Because of its complex anatomic structure and functional properties temporal bone is one of the most challenging organs for radiologists to detect diagnostic findings. [4] Anatomical variation of the temporal bone is a significant source of concern in otologic and neuro-otologic surgery, and facial canal dehiscence is one the most commonly seen variations. In ear surgery, the preoperative assessment of the facial canal, lateral semicircular canal, and Dural plate structures is important to avoid many complications. In patients requiring surgery, temporal bone computed tomography is used to assess the disease and to develop the treatment strategy. [5,6]

High resolution computed tomography (HRCT) is a type of assessment in which thin sections and high-resolution reconstructive algorithms are used. These thin slices of the temporal bone provide significant advantages in terms of delivering a lower radiation dose and differentiating between the bone and soft tissue in high contrast images. [7]

In HRCT temporal bone, hallmarks of Cholesteatoma are soft tissue mass like opacity in middle ear cleft associated with erosion of ossicles, smooth bony erosions and surrounding structures. [7,8] However, HRCT cannot differentiate cholesteatoma from granulation tissue and other soft tissue masses if not associated with bony erosions. [9] Few authors feel routine HRCT is unnecessary financial burden on the patient. Therefore, routine scanning prior to all surgery of cholesteatoma can only be justified if it can be shown to influence clinical management. [10]

Aims And Objectives

1) To compare the findings of High-resolution computed tomography with intra-operative findings in tympanomastoid surgery in cases of chronic otitis media

2) To evaluate the role of High-resolution computed tomography temporal bone in Diagnosing the disease, Disease extension into middle ear cleft and beyond, Complications of the disease and Planning for tympanomastoid surgery.

Methods

This is a cross sectional study conducted in department of ENT, Indira Gandhi Government General Hospital and Postgraduate Institute, Puducherry from January 2019 to June 2020. As per the study conducted by Santhoshikumari M et al in South Indian Population, Sample size was calculated as 34 using OpenEpi (Version 3.01) software.[11]

Inclusion Criteria

1. Patients with chronic otitis media squamosal type who give consent for tympanomastoid surgery of age group (7-60) and both the sexes
2. Patients undergoing revision tympanomastoid surgery for recurrence of disease of age group (7-60) and both the sexes

Exclusion Criteria

Patients with malignancies of the ear, with conductive hearing loss due to otosclerosis, Patients with diseases of the external and inner ear, Patients not willing for tympanomastoid surgery, associated co-morbidities and systemic diseases, with electric devices at the skull base (Cochlear implants), history of trauma to the temporal bone

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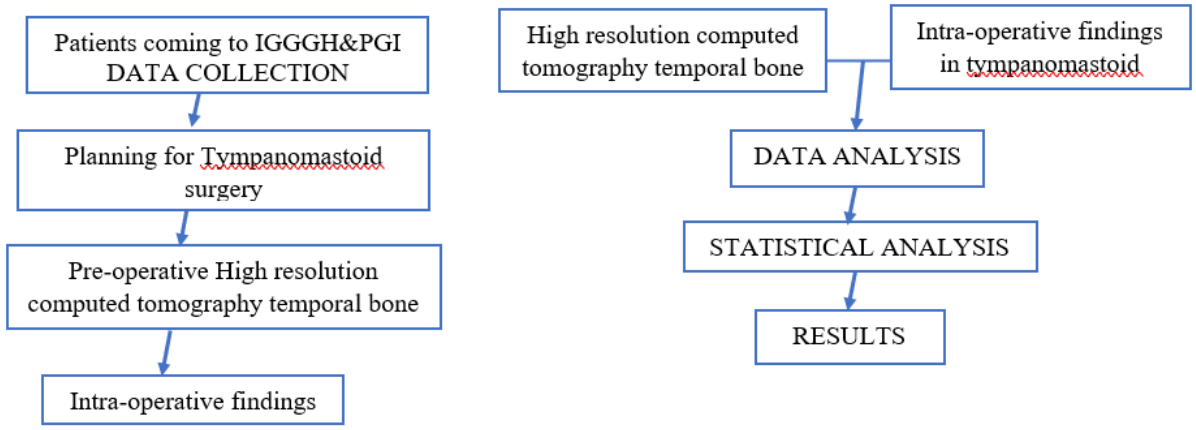

Results

Table 1: HRCT findings and Intraoperative findings of Tympanic membrane

Interpretation	Number of patients (HRCT)	Number of patients (IO)
Perforation	25	28
Retraction	9	7
Not visualized	1	0

Table 2: HRCT findings and Intraoperative findings of Scutum

Interpretation	Number of patients (HRCT)	Number of patients (IO)
Eroded	9	9
Not eroded	26	26

Table 3: HRCT findings and Intraoperative findings in Ossicles

	Interpretation	Number of patients (HRCT)	Number of patients (IO)
Ossicle – Maleus	Intact	17	17
	Partially eroded	2	5
	Eroded	16	13
Ossicle – Incus	Intact	22	21
	Partially eroded	0	2
	Eroded	13	12
Ossicle – Stapes	Intact	25	26
	Partially eroded	0	3
	Eroded	10	6

Table 4: HRCT findings and Intraoperative findings in Tegmen Tympani

Interpretation	Number of patients (HRCT)	Number of patients (IO)
Intact	34	34
Eroded	1	1

Table 5: HRCT findings and Intraoperative findings of Sinus tympani

Interpretation	Number of patients (HRCT)	Number of patients (IO)
Involved	26	26
Not involved	9	9

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Table 6: HRCT findings and Intraoperative findings of Inner Ear

Interpretation	Number of patients (HRCT)	Number of patients (IO)
Involved	2	3
Normal	33	32

Table 7: HRCT findings and Intraoperative findings of Mastoid cells

Interpretation	Number of patients (HRCT)	Number of patients (IO)
Normal	1	1
Sclerosed	12	1
Coalesced	13	16
Soft tissue mass	9	17

Table 8: HRCT findings and Intraoperative findings of Facial canal

Interpretation	Number of patients (HRCT)	Number of patients (IO)
Normal	26	33
Eroded	9	2

Table 9: HRCT scan findings compared with Intra-operative findings

	HRCT	Accuracy (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Kappa	P value
1	TM	91.4	89.3	100	100	70	0.769	< 0.005
2	Epitympanum	74.3	100	55	62.5	100	0.51	> 0.01
3	Mesotympanum	71.4	85.7	61.9	60	86.7	0.4	0.005
4	Hypotympanum	82.8	100	53.8	78.6	10	0.6	0.005
5	Scutum	80	88	60	84.6	66.7	0.5	0.003
6	Aditus	100	100	100	100	100	1	0.0001
7	Prussak's space	97	95.8	100	100	91.7	0.9	0.0001
8	Malleus	77	76.5	77.8	76.5	77.8	0.5	0.001
9	Incus	88.6	90.5	85.7	90.5	85.7	1	0.0001
10	Stapes	97	96.2	100	100	90	0.9	0.0001
11	Tegmen	100	100	100	100	100	1	0.000
12	Sinus tympani	100	100	100	100	100	1	0.000
13	Pyramidal eminence	89	67	81	66	93	0.6	0.66
14	Inner ear	100	100	100	100	100	1	0.000
15	Mastoid cells	100	100	100	100	100	1	0.000
16	Facial canal	80	78.8	100	100	22.2	0.3	0.01

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Discussion

Table 10: Comparison of HRCT vs Intra-operative finding in relation to Tympanic membrane involvement with various studies

Study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	P Value
Suat Keskin et al [12]	84.6	88.3	68.7	95	
Mariam Aljehani et al [13]	100	21.2	54	100	0.075
Our study	89.3	100	100	70	<0.005

The sensitivity and specificity of the my study is comparable to that study conducted by Suat Keskin et al [12]. The tympanic membrane has a weak relation in differentiating between retraction and perforation.

Table 11: Comparison of HRCT vs Intra-operative finding in relation to Scutum involvement with various studies

Study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	P Value
Suat Keskin et al [12]	80	90.4	84.8	73.7	
Mehrdad Rogha et al [14]	96.4	87.5	96.42	87.5	>0.0001
Sandeep Sreedhar et al [15]	100	94.7			
Chakenkahalli P. Nanjaraj et al [16]	100	100			
Vanita Sarin et al [17]	86.21	63.64	86.21	63.64	1.000
Pradeep Poswal et al [18]	83.67	71.43	87.23	75.22	<0.0001
Prem kumar Chidambaram [19]	100	92	91	100	
V Tamilarasan et al [20]	98	100			
Pamod V et al [21]	95	100			
Lham Dorjee et al [22]	100	100			
Our study	82.8	100	53.8	78.6	0.005

Scutum erosion in HRCT has 100% specificity in my study which is compared with the latest studies conducted by V.Tamilarasan et al[20], Pramod V et al[21], Lham Dorjee[22]. Sensitivity is almost similar to majority of the studies.

Table 12: Comparison of HRCT vs Intra-operative finding in relation to Ossicle - Malleus involvement with various studies

Study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	P Value
Suat Keskin et al [12]	81.3	46.1	83.3	42.8	
Mehrdad Rogha et al [14]	82.4	78.9	77.77	83.33	>0.0001
Ranga Reddy Sirigiri [23]	81	100			
Garg Payal et al [24]	90.9	89.47	83.33	94.44	
Sandeep Sreedhar et al [15]	100	80			
Chakenkahalli P. Nanjaraj et al [16]	100	100			
R.G. Aiyer Abhishek [25]	100	100			
Chintan Shah et al [26]	81.3	94.1			
Sonika Kanotra et al [27]	90	100	100	84.21	
Vanita Sarin et al [17]	85	90	89.47	85.11	

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Pradeep Poswal et al [18]	81.08	69.07	75	76.67	
Prem kumar Chidambaram et al [19]	94	90	92	92	
Mariam Aljehani et al [28]	78	96	95	21	0.348
V Tamilarasan et al [20]	98	100			
Prabhu Khavasi et al [29]	100	65			
Pramod V et al [21]	60	85.7			
Our study	76.5	77.8	76.5	77.8	0.01

Out of 16 patients with Malleus erosion in HRCT, only 13 had full erosion intra-operatively, while rest are only partially eroded. The sensitivity of HRCT in detecting malleus erosion is comparable to that of study conducted by Mariam Ajhani et al[28].

Table 13: Comparison of HRCT vs Intra-operative finding in relation to Ossicle - Incus involvement with various studies

Study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	P Value
Suat Keskin et al [12]	81.3	46.1	83.3	42.8	
Mehrdad Rogha et al [14]	90.6	50	93.54	40	0.027
Ranga Reddy Sirigiri [23]	82	87			
Garg Payal et al [24]	65.21	71.42	88.23	38.46	
Sandeep Sreedhar et al [15]	95.5	66.7			
Chakenkahalli P. Nanjaraj et al [16]	85.71	100			
R.G. Aiyer Abhishek [25]	100	100			
Chintan Shah et al [26]	90	66.7			
Sonika Kanotra et al [18]	95.74		100		
Vanita Sarin et al [17]	80.65	66.67	89.29	50	
Pradeep Poswal et al [18]	85	60	92.73	40	
Prem kumar Chidambaram et al [19]	99	87	97	93	
Mariam Aljehani et al [13]	100	100	100	100	0.001
V Tamilarasan et al [20]	85.7	100			
Prabhu Khavasi et al [29]	100	100			
Pramod V et al [21]	83.3	100			
My study	90.5	85.7	90.5	85.7	0.0001

Incus involvement has a better chance identifying HRCT than Malleus. But specificity is low compared to other recent studies of Mariam Aljehani et al [13], V Tamilarasan et al [20], Prabhu Khavasi et al [29], Pramod V et al [21].

Table 14: Comparison of HRCT vs Intra-operative finding in relation to Ossicle - Stapes involvement with various studies

Study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	P Value
Suat Keskin et al [12]	81.3	46.1	83.3	42.8	
Mehrdad Rogha et al [14]	61.9	66.7	72.22	55.55	0.091
Garg Payal et al [24]	40	26.67	35.29	30.76	
Sandeep Sreedhar et al [15]	83.3	61.5			

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Chakenkahalli P. Nanjaraj et al [16]	75	100			
R.G. Aiyer Abhishek [25]	80	80			
Chintan Shah et al [26]	80	95.7			
Sonika Kanotra et al [27]	90	100	100	97.36	
Vanita Sarin et al [17]	53.3	60	44.44	68.18	
Pradeep Poswal et al [18]	85.71	65.71	71.43	82.14	
Prem kumar Chidambaram et al [19]	65	85	56	89	
Mariam Aljehani et al [13]	100	100	100	100	0.002
V Tamilarasan et al [20]	75	100			
Prabhu Khavasi et al [29]	100	53			
Pramod V et al [21]	72.3	83.3			
Our study	96.2	100	100	90	0.0001

HRCT values of identifying stapes involvement has improved significantly in newer studies than the older studies. HRCT has very good sensitivity and specificity in identifying the stapes involvement.

Table 15: Comparison of HRCT vs Intra-operative finding in relation to Tegmen involvement with various studies

Study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	P Value
Suat Keskin et al [12]	0	97.7	0	80	
Mehrdad Rogha et al [14]	75	96.9	60	96.77	> 0.0001
Garg Payal et al [24]	54.54	73.68	54.54	73.68	
Sandeep Sreedhar et al [15]	100	91.7			
Chakenkahalli P. Nanjaraj et al [16]	0	100			
Sonika Kanotra et al [27]	100	95.45	60	95.23	0.7116
Vanita Sarin et al [17]	33.33	86.49	16.67	94.12	0.257
Pradeep Poswal et al [18]	90.91	89.83	62.50	98.15	<0.0001
Prem kumar Chidambaram et al [19]	87	99	92	97	
V Tamilarasan et al [20]	0	100			
Pramod V et al [21]	100	100			
Our study	100	100	100	100	0.000

There was a partial erosion in tegmen in only one of the case in my study which was detected in HRCT has well. So it showed high sensitivity and specificity when compared to other studies.

Table 16: Comparison of HRCT vs Intra-operative finding in relation to Inner ear (Lateral Semicircular Canal) involvement with various studies

Study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	P Value
Suat Keskin et al [12]	45.4	95.5	71.4	87.7	
Mehrdad Rogha et al [14]	75	87.5	42.85	96.55	>0.003
Ranga Reddy Sirigiri [23]	100	94			

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Garg Payal et al [24]	66.67	83.33	50	90.9	
Sandeep Sreedhar et al [15]	25	100			
Chintan Shah et al [26]	85.7	96.1			
Sonika Kanotra et al [27]	66.66	95.74	100	97.77	1.0
Vanita Sarin et al [17]	50	92.11	25	97.22	0.317
Gulay Madan et al [30]	71	96	71	96	
Pradeep Poswal et al [31]	72.73	96.61	80	95	<0.0001
Prem kumar Chidambaram et al [19]	100	98	60	100	
V Tamilarasan et al [20]	90	100			
Prabhu Khavasi et al [29]	33	48			
Pramod V et al [21]	80	100			
Our study	100	100	100	100	0.000

Lateral semicircular canal involvement had 100% specificity and sensitivity in my study which is nearly similar to study conducted by Prem kumar Chidambaram et al [19] and V Tamilarasan et al [20]. Since my study had only involvement of LSCC, the power of identification of involvement of rest of the inner ear structures couldn't be given.

Table 17: Comparison of HRCT vs Intra-operative finding in relation to Sinus tympani involvement with various studies

Study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	P Value
Garg Payal et al [24]	66.67	92.6	50	96.15	
Sandeep Sreedhar et al [15]	71.4	66.7			
Chakenkahalli P. Nanjaraj et al [16]	75	100			
Pramod V et al [21]	66.6				
Our study	100	100	100	100	0.000

Out of the 9 cases seen in HRCT, all had involvement in intra-operative as well. The specificity of my study is that of the same as study conducted by Chakenkahalli P. Nanjaraj et al [16].

Table 18: Comparison of HRCT vs Intra-operative finding in relation to Mastoid involvement with various studies

Study	Sensitivity	Specificity	PPV	NPV	P Value
Suat Keskin et al [12]	40	97.8	80	88.2	
Mehrdad Rogha et al [14]	76.9	82.6	71.42	86.36	>0.0001
Ranga Reddy Sirigiri [23]	86	100			
Sandeep Sreedhar [15]	100	100			
Chakenkahalli P. Nanjaraj et al [16]	88.8	100			
Chintan Shah et al [26]	100	100			
Sonika Kanotra et al [27]	94	100	100	60	0.157
Prem kumar Chidambaram et al [19]	100	100			
V Tamilarasan et al [20]	100	100			
Pramod V et al [21]	95	100			
Our study	100	100	100	100	0.000

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Even though the sensitivity and specificity of mastoid involvement is high in my study which is comparable to rest of the recently conducted study, HRCT couldn't distinguish between granulation or cholesteatoma in the mastoid. Both were reported as a soft tissue density in HRCT,

Table 19: Comparison of HRCT vs Intra-operative finding in relation to Facial canal involvement with various studies

Study	Sensitivity	Specificity	PPV	NPV	P Value
Suat Keskin et al [12]	66.6	98	80	96.07	
Mehrdad Rogha et al [14]	66.7	75.8	20	75.75	0.116
Ranga Reddy Sirigiri [23]	60	90			
Garg Payal et al [24]	40	95	80	76	
Sandeep Sreedhar [15]	100	91.3			
Chakenkahalli P. Nanjaraj et al [16]	33.3	100			
Chintan Shah et al [26]	75	89.6			
Sonika Kanotra et al [27]	33.3	100	100	91.11	
Vanita Sarin et al [17]	31.58	100	100	61.76	
Gulay Madan et al [30]	52	88	73	75	
Pradeep Poswal et al [18]	75	93.48	85.71	87.76	<0.0001
Prem kumar Chidambaram et al [19]	100	97	50	100	
Mariam Aljehani et al [13]	97.8	77.6	93.9	40	0.077
V Tamilarasan et al [20]	75	88			
Pramod V et al [21]	69.2	80			
Our study	78.8	100	100	22.2	0.01

Minimal involvement of facial canal was reported in 9 cases in HRCT, but intraoperatively only 2 had facial canal involvement. So the negative predictive value is too low for facial canal involvement.

Conclusion

Visualization of Tympanic membrane is poor as it was tough to differentiate between Retraction and perforation. The involvement of middle ear identification in HRCT is satisfactory. The ossicles were visualized, even when surrounded by soft tissue density. However they cannot be reliable on the scans. The visualization of bony structures (tegmen, LSCC) were high except for the facial canal. May be misleading due to errors in reconstruction. HRCT couldn't differentiate between various soft tissue densities. In short, the present study pointed that HRCT is a modality which can accurately image the pathological anatomy and represents a major advance in the diagnostic imaging. It is a very good tool for pre-operative evaluation and gives a road map to surgery. Its accuracy is likely to improve with larger studies.

Recommendations

The following are the recommendations from our study

1.For all the cases of Chronic Otitis media (Both mucosal and squamosal), HRCT is a necessary investigation as it helps in identifying all the important structures of middle and inner ear. Thus preventing failure of surgery and avoiding damage to important structures during surgery.

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2.Thin slice section (0.5-0.6 mm) of HRCT can give a more detailed view of the anatomical structures particularly ossicles and the level of involvement without missing the micro-structures in the ear.
3.Three-dimensional (3D) reconstruction can be used to better depict the complex anatomy.
4.Oblique views must be used routinely for optimal depiction of ossicles and inner ear structures.

References

1. Browning G, Weir I, Kelly G, Swan L. Chronic Otitis Media. In: John C.Watkinson. Scott-Brown's Otorhinolaryngology, Head and Neck Surgery, 8th ed. London. CRC press.2018; 977-1019
2. Jothiramalingam SB, Kumar D, Kumar P, Sasindran V, Kumar N. Atticoantral disease – Revisited. Indian JOtolaryngol Head Neck Surg 2007;59:203-6.
3. Maroldi R, Farina D, Palvarini L, Marconi A, Gadola E, Menni K, *et al.* Computed tomography and magneticresonance imaging of pathologic conditions of the middle ear. Eur J Radiol 2001;40:78-93.
4. Virapogse C, Rothman SLG, Kier EL, Sarwar M. Computer tomographic anatomy of the temporal bone. AJR 1982;139:739-49.
5. Bucak A, Ulu S, Yucedg F, Okur E, Kemal Kahveci O, Said Tekin, M, et al. Facial Canal Dehiscence and Tympano-mastoid Surgery, J Int Adv Otol 2013; 9(3): 319-26.
6. Yu Z, Wang Z, Yang B, Han D, Zhang L. The value of preoperative CT scan of tympanic facial nerve canal in tympanomastoid surgery. Acta Otolayngol 2011; 131(7): 774-8.
7. Abhijeet KS, Mustafa SN, Raushan EA, Kumar G. Role of High resolution computer tomography in cholesteatoma. Int J Sci Study. 2014;2(8):164-8.
8. Sirigeri RR, Dwaraknath K. Correlative study of HRCT in attico-antral diseases. Indian J Otolayngol Head Neck Surg 2011; 63(2):155-8.
9. Baylan MY, Ozmen CA, Gun R, Yorgancilar E, Akkus Z, Topcu I. An evaluation of preoperative computed tomography on patients with chronic otitis media. Indian J Otolaryngol Head Neck Surg. 2012; 64(1):67-70.
10. Watts S, Flood LM, Clifford K. A systemic approach to interpretation of computed tomography scans prior to surgery of middle ear cholesteatoma. J Laryngol Otology. 2000;114:454-458.
11. Santhoshikumari M, Madhavi J, Bala Krishna N, Meghanadh KR, Jyothy A. Prevalence and associated risk factors of Otitis Media and its subtypes in South Indian population. Egyptian Journal of Ear, Nose, Throat and Allied Sciences 2016 July; 17(2) : 57-62.
12. Keskin S, Cetin H, Gurkan Tore H. The Correlation of Temporal Bone CT with Surgery Findings in Evaluation of Chronic Inflammatory Diseases of The Middle Ear. Eur J Gen Med 2011;8(1): 24-30
13. Aljehani M, Alhussini R. The Correaltion between Pre-operative findings of high resolution findings of computed tomography (HRCT) and Intra-operative findings of chronic otitis media (COM).Clin Med Insights Ear Nose Throat. 2019 Aug 19; 12: 117955069870471.
14. Rogha M, Hashemi S M, Mokhtarinejad F, Eshaghian A and Dadgostar A. Comparison of preoperative Temporal Bone CT with intraoperative Findings in Patients with Cholesteatoma. Iran J Otorhinolaryngol. 2014 Jan; 26(74): 7-12
15. Sreedhar S, Pujary K, Agarwal A C, R. Balakrishnan. Role of High-resolution computed tomography scan in the evaluation of cholesteatoma: A correlation of high resolution computed tomography with intra-operative findings. Indian Journal of Otology April 2015, Vol 21, Issue 2

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16. Nanjaraj CP, Nagarajegowda PH, Kannan VP, et al. Chronic otitis media: High resolution computed tomographic evaluation of the temporal bone with surgical correlation. J. Evid. Based Med. Healthc. 2016; 3(40), 1955-1962. DOI: 10.18410/jebmh/2016/436.
17. Sarin V, Kaur T, Sood AS. Role of Pre-operative High Resolution Computed tomography of temporal bone in Squamous Chronic Otitis Media. Pakistan Journal of Otolaryngology 2015; 31: 51-55.
18. Poswal P, Padiyar BV, Kumar A, Taneja A. Preoperative High resolution Computed Tomography of the Temporal Bone and its correlation to intraoperative findings in Squamous Chronic Otitis Media – A Prospective Observational Study. Int J Adv Integ Med Sci 2018;3(1):18-21.
19. Prem Kumar Chidambaram, Vivil Vidya Rajkumar R, Vinayagam S, Senthil Kumar Aiyappan, Bulabai karpagam. High resolution CT imaging in pathologies of temporal bone. International Journal of Contemporary Medicine Surgery and Radiology. 2019;4(3):C11-C17.
20. V. Tamilarasan, G. Yuvabalakumaran, Md. Ameen, Vinay Jadhav. Role of CT in documenting the extent of temporal bone and middle ear involvement among patients with Chronic otitis media. International Journal of Contemporary Medicine Surgery and Radiology. 2019; 4(4): D1-D5.
21. Pramod V, Raghuraj U, Shrikrishna U. Correlation of intraoperative and HRCT of temporal bone findings in CSOM. IP Journal of Otorhinolaryngology and Allied Science, January-March 2020:3(1):10-17.
22. Dorjee L. Comparison of Preoperative Temporal bone HRCT findings with Intraoperative findings in patients with Cholesteatoma. http://repository-tnmgrmu.ac.in/id/eprint/11330
23. Sirigiri RR and Dwaraknath K. Correlative Study of HRCT in Attico-Antral Disease. Indian J Otolaryngol Head Neck Surg (April–June 2011);63(2):155–158.
24. Payal G, Pranjal K, Gul M, Mittal M K and Rai A K. Computed tomography in chronic suppurative otitis media: Value in Surgical planning. Indian J Otolaryngol Head Neck Surg. 2012 Sep; 64(3): 225-229.
25. R.G. Aiyer Abhishek. To evaluate the role of HRCT temporal bone in cholesteatoma cases. International Journal of Surgery October 2013; Volume 11, Issue 8, Page 638.
26. Shah CP, Shah PC, Shah SD. Role of HRCT temporal bone in Pre-operative evaluation of Cholesteatoma. International Journal Of Medical Science and Public Heath 2014, Vol 3, Issue 1.
27. Kanotra S, Gupta R, Gupta N, Sharma R, Gupta R, Kotwal S. Correlation of high-resolution of computed tomography temporal bone findings with intra-operative findings in patients with Cholesteatoma. Indian J Otol 2015; 21:280-5.
28. Hiral Happani, Jagruti Kalola, Hiren Rathod, Anjana Trivedi. Role of HRCT temporal bone in patients with Chronic suppurative otitis media. International Jorunal of Contemporary Medicine surgery and Radiology. 2018;3 (3): C70-C72.
29. Khavasi P, Malashetti S, Chandrashekarayya S.H. An evaluation of preoperative high resolution computed tomography of temporal bone in cholesteatoma. International Journal of Otorhinolaryngology and Head Neck Surgery 2018 Mar; 4(2): 413-417.
30. Madan G, Turamanlar O, Gönül Y, Gülsari Y. Comparison of Preoperative Temporal Bone HRCT and Intraoperative findings in patients with Chronic otitis media. Erciyes Med J 2015; 37(4): 138-42.
31. Sharma VK, Prajapati N, Sharma R, Iqbal Z, Dadoo S. Radiological Changes in Anatomy of Temporal bone in cases of unsafe chronic suppurative otitis media. A retrospective study. Indian J Otol 2017; 23: 176-9.