EAS Journal of Radiology and Imaging Technology
Abbreviated Key Title: EAS J Radiol Imaging Technol
ISSN: 2663-1008 (Print) & ISSN: 2663-7340 (Online)
Published By East African Scholars Publisher, Kenya

Volume-8 | Issue-6 | Nov-Dec-2026 | DOI: https://doi.org/10.36349/easjrit.2026.v08i06.011

OPEN ACCESS

Original Research Article

Role of High-Resolution Computed Tomography of Temporal Bone in Chronic Suppurative Otitis Media

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Article History
Received: 13.09.2026
Accepted: 06.11.2026
Published: 09.11.2026

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: ***Background*:** Chronic suppurative otitis media (CSOM) may cause persistent middle-ear disease, ossicular damage and complications involving the temporal bone. High-resolution computed tomography (HRCT) provides detailed anatomical assessment and helps define disease extent before surgery. This study evaluated HRCT findings in patients with CSOM and compared imaging features between atticoantral and tubotympanic disease. ***Methods*:** This descriptive observational cross-sectional study included 70 patients with clinical features suggestive of CSOM. Participants underwent clinical and audiological assessment, including pure-tone audiometry, followed by HRCT of the temporal bone. Imaging findings related to middle-ear and mastoid opacification, ossicular involvement and bony changes were recorded. Associations between clinical type, HRCT findings and hearing loss were analysed using appropriate statistical tests. ***Results*:** In this cohort, mean age was 24.5 ± 9.4 years, and 60.0% of participants were male. Ear discharge (94.3%) and hearing loss (90.0%) were the commonest symptoms. HRCT showed soft-tissue opacification in 88.6% of patients, most frequently involving the mesotympanum (67.1%) and epitympanum (57.1%). Ossicular erosion was present in 47.1%, with the incus most commonly affected (44.3%). Scutum erosion was the most frequent bony abnormality (45.7%). Atticoantral disease showed significantly higher frequencies of soft-tissue opacification, epitympanic, antral and aditus involvement, ossicular erosion and scutum erosion than tubotympanic disease. The number of eroded ossicles was significantly associated with the degree of hearing loss ($p<0.001$). ***Conclusion*:** HRCT demonstrated the anatomical extent of CSOM and identified ossicular and adjacent bony abnormalities. Destructive imaging findings were more frequent in atticoantral disease, and greater ossicular involvement was associated with more severe hearing loss. HRCT is a useful adjunct for preoperative assessment and surgical planning when interpreted with clinical and audiological findings.

Keywords: Chronic Suppurative Otitis Media.

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INTRODUCTION

Chronic suppurative otitis media (CSOM) is a chronic inflammatory condition of the middle-ear cleft, commonly involving the tympanic cavity and mastoid air-cell system. It is characterised clinically by persistent or recurrent ear discharge through a perforated tympanic membrane and may result in conductive, sensorineural, or mixed hearing impairment. The disease remains an important cause of preventable hearing loss, particularly in low- and middle-income countries. The global burden of otitis media is substantial, with considerable variation in prevalence across geographical regions and populations [1].

CSOM is commonly classified into tubotympanic and atticoantral types. The tubotympanic type is generally associated with a central tympanic membrane perforation and predominantly mucosal disease, whereas the atticoantral type is associated with attic or marginal disease and may be accompanied by cholesteatoma and progressive bony destruction [2, 3]. Cholesteatoma is characterised by the accumulation of

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keratinising squamous epithelium within the middle-ear cleft. Its expansile and erosive behaviour may lead to destruction of the ossicular chain and adjacent temporal bone structures, resulting in hearing impairment and potentially serious complications [2-4].

The temporal bone contains several closely related anatomical structures, including the ossicles, facial nerve canal, tegmen tympani, sigmoid sinus plate and bony labyrinth. Disease extension into the epitympanum, aditus ad antrum, mastoid antrum, mastoid air cells, sinus tympani and facial recess may be difficult to assess clinically, particularly when the tympanic membrane is obscured by discharge or granulation tissue. In addition, erosion of the scutum, ossicles, tegmen tympani, facial nerve canal or lateral semicircular canal may influence disease severity and surgical planning [4, 5].

High-resolution computed tomography (HRCT) has an important role in the radiological assessment of CSOM because of its high spatial resolution and ability to demonstrate fine bony anatomy. Thin-section imaging with multiplanar reconstruction helps evaluate the middle-ear spaces, mastoid pneumatization, distribution of soft-tissue opacification and integrity of the ossicular chain. It also provides information regarding bony erosions and anatomical variations that may be relevant before surgery [4-6]. Earlier studies by O'Donoghue *et al*., and Jackler *et al*., demonstrated the usefulness of CT in evaluating the extent of middle-ear disease and identifying associated bone destruction [7, 8]. Subsequent studies have further assessed its contribution to preoperative evaluation and the identification of complications in CSOM [9. 10].

However, HRCT has certain limitations. Soft-tissue opacification on CT may represent cholesteatoma, granulation tissue, mucosal thickening or retained secretions; these entities cannot always be reliably differentiated on the basis of CT attenuation alone [2-4]. Therefore, imaging findings need to be interpreted alongside clinical and otoscopic findings. MRI, particularly diffusion-weighted imaging, may provide additional information when differentiation of cholesteatoma from other soft-tissue lesions is required [2].

The present study evaluated the spectrum of HRCT findings in patients with CSOM, with particular emphasis on the anatomical extent of disease, mastoid pneumatization, ossicular chain involvement and associated bony erosions. It also compared selected radiological findings between atticoantral and tubotympanic disease and assessed the relationship between ossicular erosion and hearing loss. This assessment was intended to provide a structured description of temporal bone involvement and the radiological features associated with the two clinical types of CSOM.

The study was designed as a descriptive observational study with a cross-sectional design and was conducted in the Department of Radiodiagnosis, B.J. Government Medical College and Sassoon General Hospital, Pune, Maharashtra, over a period of 18 months. A total of 70 patients with a clinical diagnosis of chronic suppurative otitis media were included. The sample size was estimated using Cochran's formula, and participants were recruited by convenience sampling. Patients of either sex and all age groups who fulfilled the eligibility criteria and provided informed consent were enrolled. Patients with cochlear implants or other electrical devices at the skull base, previous ear surgery, history of head trauma, unwillingness to participate, or known allergy to iodinated contrast media were excluded. A detailed clinical history, otoscopic examination and pure-tone audiometry were performed, and the disease was classified as atticoantral or tubotympanic CSOM. HRCT of the temporal bone was performed using a Siemens SOMATOM Definition Edge 128-slice multidetector CT scanner. Thin-section images of 0.6 mm were acquired and reconstructed using a high-spatial-frequency bone algorithm, with axial, coronal and sagittal reformations. Contrast-enhanced imaging with 50 mL intravenous Iohexol was performed when complications were suspected. The images were evaluated for soft-tissue opacification, disease extension, mastoid pneumatization, ossicular erosion and associated bony defects. Data were analysed using IBM SPSS Statistics version 26.0. Descriptive statistics, chi-square test and Fisher's exact test were applied as appropriate. A p-value of less than 0.05 was considered statistically significant [1].

RESULT

Table 1: Demographic, Clinical and Audiological Profile of the Study Population (N = 70)

Variable	Category	Number (n)	Percentage (%)
Age (years)			
	≤10	4	5.7
	11–20	24	34.3
	21–30	21	30.0
	31–40	16	22.9
	41–50	5	7.1
	Mean ± SD	24.5 ± 9.4 years	—
	Median (range)	22 (5–44) years	—

Variable	Category	Number (n)	Percentage (%)
Sex			
	Male	42	60.0
	Female	28	40.0
Laterality			
	Right	31	44.3
	Left	22	31.4
	Bilateral	17	24.3
Type of CSOM			
	Atticoantral (unsafe)	37	52.9
	Tubotympanic (safe)	33	47.1
Duration of symptoms (months)			
	<6	23	32.9
	6–12	17	24.3
	13–24	13	18.6
	25–60	15	21.4
	>60	2	2.9
	Median (IQR)	11 (6–22) months	—
Presenting symptoms*			
	Ear discharge	66	94.3
	Hearing loss	63	90.0
	Ear pain	35	50.0
	Headache	15	21.4
	Vertigo	9	12.9
	Tinnitus	4	5.7
	Facial weakness	0	0.0
Type of hearing loss			
	Conductive	38	54.3
	Mixed	17	24.3
	Sensorineural	8	11.4
	Normal	7	10.0
Degree of hearing loss			
	Mild	21	30.0
	Moderate	22	31.4
	Moderately severe	9	12.9
	Severe	9	12.9
	Profound	2	2.9
	Normal	7	10.0

Table 2: Overall HRCT Findings and Anatomical Distribution of Disease (N = 70)

HRCT finding	Present n (%)	Absent n (%)
Mastoid pneumatization		
Sclerotic	47 (67.1)	23 (32.9)
Diploic	15 (21.4)	55 (78.6)
Well-pneumatized	8 (11.4)	62 (88.6)
Soft-tissue opacification	62 (88.6)	8 (11.4)
Sites of disease extension*		
Epitympanum	40 (57.1)	30 (42.9)
Mesotympanum	47 (67.1)	23 (32.9)
Hypotympanum	9 (12.9)	61 (87.1)
Protympanum	6 (8.6)	64 (91.4)
Antrum	37 (52.9)	33 (47.1)
Aditus	35 (50.0)	35 (50.0)
Mastoid air cells	39 (55.7)	31 (44.3)
Sinus tympani	12 (17.1)	58 (82.9)
Facial recess	8 (11.4)	62 (88.6)

Table 3: Comparison of HRCT Findings between Atticoantral and Tubotympanic CSOM

HRCT parameter	Atticoantral (n=37), n (%)	Tubotympanic (n=33), n (%)	p-value
Mastoid pneumatization			**0.492**
Sclerotic	27 (73.0)	20 (60.6)	
Diploic	6 (16.2)	9 (27.3)	
Well-pneumatized	4 (10.8)	4 (12.1)	
Soft-tissue opacification			**0.022**
Present	36 (97.3)	26 (78.8)	
Absent	1 (2.7)	7 (21.2)	
Disease extension			
Epitympanum	34 (91.9)	6 (18.2)	<0.001
Mesotympanum	21 (56.8)	26 (78.8)	0.088
Hypotympanum	3 (8.1)	6 (18.2)	0.290
Protympanum	3 (8.1)	3 (9.1)	1.000
Antrum	30 (81.1)	7 (21.2)	<0.001
Aditus	29 (78.4)	6 (18.2)	<0.001
Mastoid air cells	26 (70.3)	13 (39.4)	0.019
Sinus tympani	10 (27.0)	2 (6.1)	0.027
Facial recess	7 (18.9)	1 (3.0)	0.058

Table 4: Ossicular Chain Erosion, Pattern of Involvement and Association with Hearing Loss

Parameter	Category / comparison	Number (n)	Percentage (%) / p-value
Ossicular erosion in total cohort (N=70)			
Any ossicular erosion	Present	33	47.1
Individual ossicle*	Incus	31	44.3
	Malleus	24	34.3
	Stapes	12	17.1
Number eroded	None	37	52.9
	One	9	12.9
	Two	14	20.0
	Three	10	14.3
Ossicular erosion by CSOM type			
Malleus	Atticoantral / tubotympanic	21 / 3	56.8 / 9.1; p<0.001
Incus	Atticoantral / tubotympanic	25 / 6	67.6 / 18.2; p<0.001
Stapes	Atticoantral / tubotympanic	10 / 2	27.0 / 6.1; p=0.027
Any ossicular erosion	Atticoantral / tubotympanic	27 / 6	73.0 / 18.2; p<0.001
Pattern among patients with erosion (n=33)			
Incus + malleus	12	12	36.4
Malleus + incus + stapes	10	10	30.3
Isolated incus	7	7	21.2
Isolated malleus	2	2	6.1
Incus + stapes	2	2	6.1
Number of eroded ossicles and hearing-loss degree (n=63)			
0 ossicles	Mild / Moderate / Mod. severe / Severe / Profound	17 / 13 / 0 / 0 / 0	Total 30
1 ossicle	Mild / Moderate / Mod. severe / Severe / Profound	4 / 4 / 1 / 0 / 0	Total 9
2 ossicles	Mild / Moderate / Mod. severe / Severe / Profound	0 / 3 / 4 / 5 / 2	Total 14
3 ossicles	Mild / Moderate / Mod. severe / Severe / Profound	0 / 2 / 4 / 4 / 0	Total 10
Association			p<0.001

Table 5: HRCT-Detected Bony Erosions and Selected Clinical-Radiological Associations

Finding / association	Atticoantral / exposed group n (%)	Tubotympanic / comparison group n (%)	p-value / effect estimate
Bony erosions by CSOM type			
Scutum erosion	29/37 (78.4)	3/33 (9.1)	<0.001
Tegmen tympani erosion	4/37 (10.8)	1/33 (3.0)	0.361
Sigmoid sinus plate erosion	7/37 (18.9)	0/33 (0.0)	0.012

Finding / association	Atticoantral / exposed group n (%)	Tubotympanic / comparison group n (%)	p-value / effect estimate
Facial nerve canal dehiscence	6/37 (16.2)	2/33 (6.1)	0.266
Lateral semicircular canal fistula	4/37 (10.8)	0/33 (0.0)	0.117
Mastoid cortex erosion	9/37 (24.3)	1/33 (3.0)	0.015
External auditory canal erosion	5/37 (13.5)	0/33 (0.0)	0.056
Scutum erosion and ossicular erosion (N=70)			
Scutum erosion present	21 with ossicular erosion; 11 without	32 total	OR 4.14; p=0.009
Scutum erosion absent	12 with ossicular erosion; 26 without	38 total	
Lateral semicircular canal fistula and vertigo (N=70)			
Fistula present	3 with vertigo; 1 without	4 total	OR 30.00; p=0.006
Fistula absent	6 with vertigo; 60 without	66 total	
Facial nerve canal dehiscence and facial weakness (N=70)			
Dehiscence present	0 with weakness; 8 without	8 total	p=1.000
Dehiscence absent	0 with weakness; 62 without	62 total	

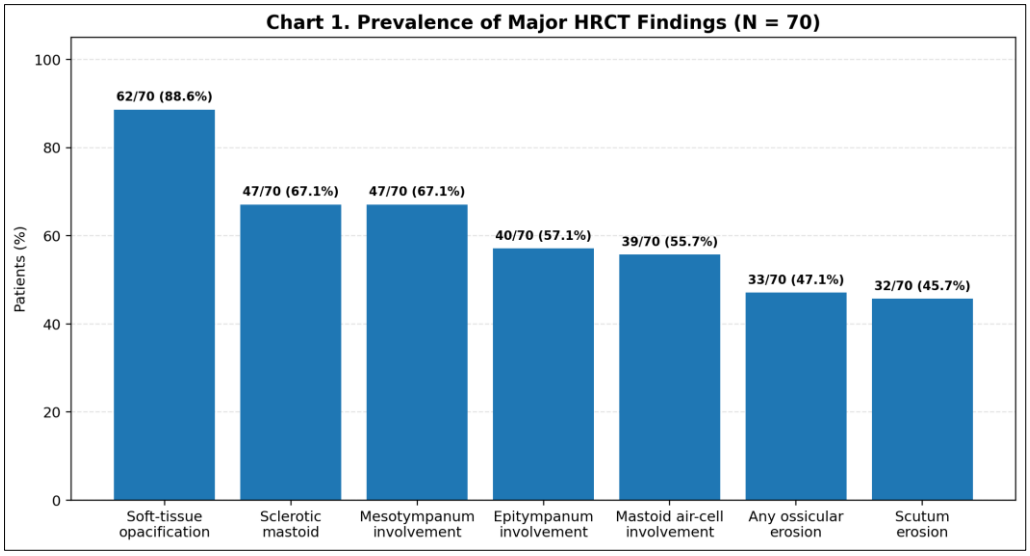


Chart 1: Prevalence of Major HRCT Findings in the Study Population (N = 70)

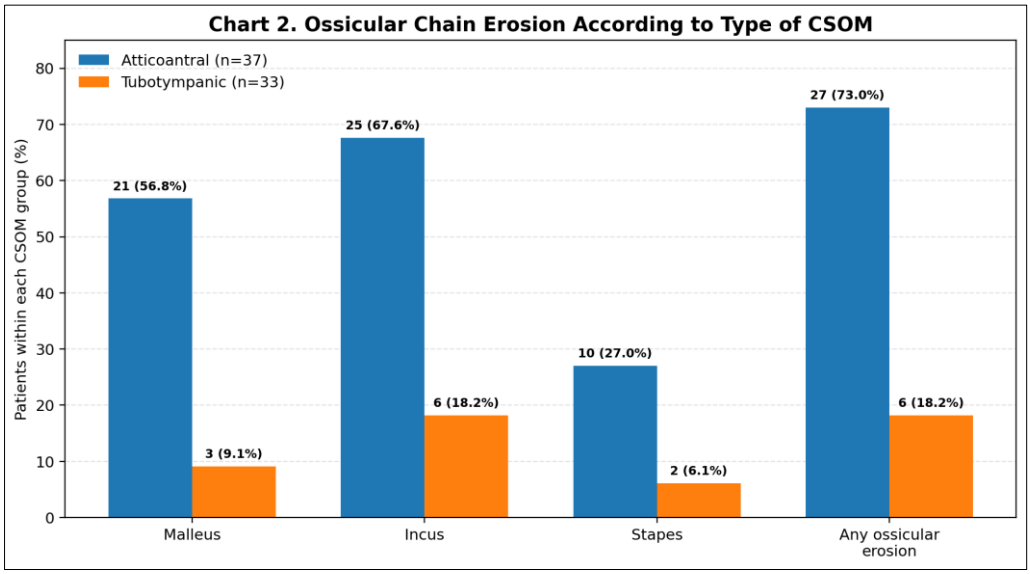


Chart 2: Ossicular Chain Erosion According to Type of CSOM

The present study included 70 patients with chronic suppurative otitis media (CSOM). The mean age was 24.5 ± 9.4 years, with a median of 22 years and a range of 5–44 years. The largest proportion belonged to the 11–20-year age group (34.3%), followed by 21–30 years (30.0%) and 31–40 years (22.9%). Males constituted 60.0% and females 40.0%. Disease was right-sided in 44.3%, left-sided in 31.4% and bilateral in 24.3%. Atticoantral disease was observed in 52.9%, while 47.1% had the tubotympanic type. The median symptom duration was 11 months (IQR 6–22). Ear discharge (94.3%) and hearing loss (90.0%) were the most frequent symptoms, followed by ear pain (50.0%).

Pure-tone audiometry showed conductive hearing loss in 54.3%, mixed hearing loss in 24.3% and sensorineural hearing loss in 11.4%; hearing was within normal limits in 10.0%. Moderate hearing loss was most frequent (31.4%), followed by mild hearing loss (30.0%). Moderately severe and severe hearing loss were each observed in 12.9%, while profound hearing loss was noted in 2.9%.

On HRCT, sclerotic mastoid pneumatization was the predominant pattern (67.1%), followed by diploic (21.4%) and well-pneumatized mastoids (11.4%). Middle-ear or mastoid soft-tissue opacification was present in 88.6%. The mesotympanum was most frequently involved (67.1%), followed by the epitympanum (57.1%), mastoid air cells (55.7%), antrum (52.9%) and aditus (50.0%). Sinus tympani and facial recess involvement was seen in 17.1% and 11.4%, respectively.

Ossicular chain erosion was identified in 47.1%. The incus was most frequently affected (44.3%), followed by the malleus (34.3%) and stapes (17.1%). One ossicle was eroded in 12.9%, two in 20.0% and all three in 14.3%. Among patients with ossicular erosion, combined incus and malleus involvement was the most frequent pattern (36.4%), followed by erosion of all three ossicles (30.3%) and isolated incus erosion (21.2%).

Scutum erosion was the most frequent bony abnormality (45.7%). Mastoid cortex erosion was present in 14.3%, facial nerve canal dehiscence in 11.4%, sigmoid sinus plate erosion in 10.0%, and tegmen tympani and external auditory canal erosion in 7.1% each. A lateral semicircular canal fistula was identified in 5.7%.

Soft-tissue opacification was more frequent in atticoantral than tubotympanic disease (97.3% versus 78.8%; p=0.022). Epitympanic, antral and aditus involvement, as well as mastoid air-cell opacification, was significantly more frequent in atticoantral disease. Sinus tympani involvement was also more frequent (27.0% versus 6.1%; p=0.027). Mesotympanic, hypotympanic and protympanic involvement did not differ significantly. Ossicular erosion was substantially more frequent in atticoantral than tubotympanic disease (73.0% versus 18.2%; p<0.001), with significantly greater involvement of the malleus, incus and stapes.

Scutum erosion was significantly more common in atticoantral disease (78.4% versus 9.1%; p<0.001). Sigmoid sinus plate erosion and mastoid cortex erosion were also significantly more frequent in this group. Differences in tegmen tympani erosion, facial nerve canal dehiscence, lateral semicircular canal fistula and external auditory canal erosion were not statistically significant. The number of eroded ossicles was significantly associated with degree of hearing loss (p<0.001). Patients without ossicular erosion predominantly had mild or moderate hearing loss, whereas involvement of two or three ossicles was more often associated with moderately severe or severe hearing loss.

DISCUSSION

The present study evaluated the role of HRCT of the temporal bone in demonstrating the extent of disease and associated structural changes in patients with CSOM. The study population was predominantly young, with most patients in the second and third decades of life. Ear discharge and hearing loss were the leading presenting complaints. These findings reflect the clinical and functional burden associated with chronic middle-ear disease, including its contribution to preventable hearing impairment [1].

Soft-tissue opacification was frequent, involving the middle ear and/or mastoid in nearly nine out of ten patients. The mesotympanum and epitympanum were commonly involved, with frequent extension into the antrum, aditus and mastoid air cells. HRCT provides detailed assessment of temporal-bone anatomy and disease distribution, making it useful for preoperative mapping in patients with chronically discharging ears [2-9]. However, soft-tissue attenuation on CT is not specific for cholesteatoma and may also represent granulation tissue, mucosal thickening or fluid. Imaging findings should therefore be interpreted alongside clinical and otoscopic findings.

Ossicular erosion was present in 47.1%, with the incus being the most frequently affected ossicle. This pattern is consistent with the recognised vulnerability of the long process of the incus in chronic middle-ear disease. HRCT can demonstrate ossicular-chain abnormalities and provide useful anatomical information before surgery. Earlier studies have also examined the predictive value of CT in chronic suppurative ear disease [5, 6]. Nevertheless, CT findings should not be treated as a substitute for direct operative assessment when establishing the definitive extent of disease.

Atticoantral disease demonstrated a greater burden of several HRCT abnormalities than tubotympanic disease. Epitympanic, antral and aditus

involvement, ossicular erosion and scutum erosion were significantly more frequent in the atticoantral group. These findings demonstrate the greater frequency of destructive temporal-bone changes in the atticoantral pattern within this cohort. The higher frequency of mastoid and selected adjacent bony involvement further supports systematic review of the middle ear, aditus, antrum and mastoid on preoperative imaging [2-9].

A significant association was observed between the number of eroded ossicles and degree of hearing loss. More extensive ossicular involvement was generally associated with greater hearing impairment. This is anatomically plausible because disruption of the ossicular chain can impair sound conduction. However, hearing loss in CSOM may also be influenced by tympanic membrane changes, middle-ear mucosal disease and inner-ear involvement; the association should not be interpreted as evidence that ossicular erosion is the sole determinant of hearing impairment.

The study also identified less frequent but clinically important findings, including facial nerve canal dehiscence, lateral semicircular canal fistula, tegmen tympani erosion and sigmoid sinus plate erosion. Recognition of these findings may influence surgical planning and assessment of potential complications. Results should be interpreted in light of the descriptive observational design, modest sample size and convenience sampling. The study did not establish diagnostic sensitivity or specificity against operative findings; diagnostic-accuracy estimates therefore cannot be inferred from the present data.

CONCLUSION

HRCT of the temporal bone demonstrated the extent and anatomical distribution of CSOM, including soft-tissue involvement, ossicular erosion and associated bony changes. Atticoantral disease showed significantly more frequent epitympanic and mastoid involvement, ossicular erosion and scutum erosion than tubotympanic disease. The extent of ossicular erosion was significantly associated with degree of hearing loss. HRCT is a valuable tool for preoperative assessment and surgical planning when interpreted alongside clinical and audiological findings.

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Cite This Article: Wade, S. S., Bagale, S., & Pawar, S. S. (2026). Role of High-Resolution Computed Tomography of Temporal Bone in Chronic Suppurative Otitis Media. *EAS J Radiol Imaging Technol, 8*(6), 220-226. https://doi.org/10.36349/easjrit.2026.v08i06.011

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