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Comparative Study between CT Findings and Intra-Operative Findings in Patients with CSOM (Attico-Antral Disease)

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Abstract

The goal of th study is to evaluate the role of high‐resolution computed tomography (HRCT) temporal bone in patients with active squamosal chronic otitis media (COM). 30 patients with active squamosal COM underwent preoperative HRCT temporal bone followed by surgery. Their intra‐operative findings were compared and correlated with the radiological findings, to calculate the predictive value of HRCT temporal bone. According to the present study, HRCT was highly sensitive for detecting mastoid pneumatization, soft tissue extension, ossicular erosion, tegmen and sigmoid sinus erosion, and less sensitive for fallopian canal erosion and lateral sinus fistula. It was specific for all these parameters.The present study concludes that HRCT can be recommended not only in cases suspected with potential complications but also in all cases of COM to know the extent of disease, varied pneumatization, and the presence of anatomical variations, which should alert the clinician and guide in surgical approach and treatment plan.

Keywords: Cholesteatoma; mastoidectomy; attico-antral.

1. Introduction:

Middle ear infection are the commonnest causes of tympanic membrane perforations. Other causes are traumatic as foreign bodies through the external auditory canal and iatrogenic post-tympanostomy tube insertion [1]. CSOM has been documented to be the most common cause of preventable hearing loss [2]. The diagnosis of CSOM is made clinically by otoscopic examination, in addition to microscopic and endoscopic evaluation. Special imaging as computed tomography (CT) and magnetic resonance imaging (MRI), may suggest the presence of cholesteatoma within the temporal bone, and may be used to complement the clinical diagnosis [3]. Cholesteatoma is a keratin-

producing squamous epithelial cyst of the middle ear cleft [4]. The most common locations of cholesteatoma are the attic, posterior mesotympanum; although they may develop anywhere within the pneumatized portions of the temporal bone. Cholesteatoma may be acquired or congenital, with a similar morphologic appearance [4]. Erosion of the ossicular chain is a common finding in cholesteatoma, resulting in a poor hearing conduction mechanism [5]. CT of the temporal bone usually cannot distinguish soft tissue from effusion or granulation tissue in the patients [6]. In attic cholesteatoma, erosion of the scutum (the first sign of aural cholesteatoma) in the coronal view can be assessed clearly. Bony erosion occurs more commonly in the long process of the incus, the body of the incus, and the head of the malleus. Cholesteatoma of the pars tensa extends to the long process of the incus and the superstructure of the stapes. Expansion of aditus ad antrum increases the probability of attic cholesteatoma [7]. The most common site of labyrinthine fistula is the lateral canal dome; and the most involved segment of the facial nerve is the tympanic segment [7]. CT is the imaging modality of choice for evaluation of middle ear structures and their pathologies such as cholesteatoma [8]. CT scan is useful for planning the surgical approach, determining the extension and site of cholesteatoma and its sac, assessing the ossicles, evaluating the facial nerve, tegmen and sinus plate, and determining dural, sigmoid sinus, and jugular bulb positions [9]. CT scan findings of cholesteatoma consist of a soft tissue mass with local bone erosion and also middle ear opacification due to granulation tissue, pus and effusion. Findings suggesting cholesteatoma include scutum erosion , aditus ad antrum widening, erosion of ossicles, labyrinthine fistula, facial nerve canal erosion, tegmen plate dehiscence, mastoid destruction (automastoidectomy), sigmoid plate dehiscence, and external auditory canal roof erosion [10].

2. Patients and Methods:

This study was performed on 30 patients of either sex, suffering from attico-antral type of CSOM undergoing mastoidectomy and collected randomly according the inclusion & exclusion criteria in the department of Otorhinolaryngology of Beni-Suef University hospital from July 2019 to January 2020.

2.1 Inclusion criteria:

All patients clinically diagnosed with attico-antral type of CSOM (as patients with offensive aural discharge, aural polyp, marginal perforation, …….) were included in the study.

2.2 Exclusion criteria:

1. Patients with previous ear surgery.
2. Suspicious pathology e.g malignancy
3. Associated trauma to the ear
4. Patients unfit for surgery.
5. Patients with anomalies dated since birth.

2.3 Pre-operative assessment:

Pre-operatively all patients were subjected to all of the following:

1. Routine Full history taking.
2. Routine Complete Oto-rhino-laryngological examination.
3. Routine Audiological assessment including pure tone audiometry and tympanometry.
4. Routine laboratory investigations including complete blood picture, coagulation profile, blood sugar, liver and renal function tests.
5. Routine written informed consent all patients or their relatives.
6. HRCT scan of the temporal bone (corner stone)

2.4 Surgery:

- The procedure was performed under general anesthesia.
- All patients were prepared and draped in a sterile fashion.
- Variable techniques of mastoidectomy were performed according to the pathology seen during ear exploration

The following parameters were compared between CT & intra-operative findings:

- Soft tissue lesions including (middle ear, attic & mastoid)
- Mastoid involvement (well pneumatized (cellular), partially pneumatized (diploic), not pneumatized (sclerotic))
- Scutum (eroded or not)
- Tegmen plate (eroded or not)
- Sinus plate (eroded or not, position (normal position or anteriorly displaced))
- Ossicular chain (eroded or not)
- The facial canal (eroded or not, position (normal position or displaced))
- LSCC (eroded or not)
- Involvement of the facial recess and sinus tympani (ST)
- Eustachian tube (ET) involvement

High resolution computed tomography (HRCT) scan of the temporal bone was performed with 1 mm sections in both axial and coronal planes and findings were recorded and tabulated. All patients had done surgical exploration and intrasurgical signs were recorded. Finally a comparison was done between CT and intraoperative findings.

2.5 Statistical methodology:

• Data analysis was done using SPSS intercooled version 16.0. Data was analyzed using paired sample T test to compare data between CT and intraoperative finding. Graphs were produced by using Excel or SPSS program.

The results significance was evaluated in the sort of P-value * that was classified into:

- Non-significant if P-value > 0.05
- Significant if P-value ≤ 0.05

- Highly significant if P-value ≤ 0.001

*P value considered significant if it is less than 0.05

3. Results:

In our study, there were a total of 30 patients, 18 females and 12 males. On examination, 16 patients had a postero‑superior quadrant retraction pocket with cholesteatoma flakes, 10 patients had attic cholesteatoma with pars flaccida perforation and 4 patients has extensive cholesteatoma involving all the middle ear cleft with aural poly.

(A) Soft tissue involvement in the middle ear cleft:

HRCT cannot distinguish cholesteatoma sac from granulations or pus in the middle ear cleft but associated bony ersions may raise the possibility of chlesteatoma.The preoperative CT findings regarding soft tissue involvement in middle ear cleft (mastoid, attic, tympanic cavity, ET, facial recess and sinus tympani) were compared with those recorded intraoperatively. Table (1)

Table (1): Comparison between CT and Intra-Operative Findings regarding soft tissue involvement in the middle ear cleft

	Finding	CT (30 cases)	Intraoperative (30 cases)	P value*
Soft tissue in mastoid	Absent (No. of cases)	10	10	1.00
	Present (No. of cases)	20	20	
	Undefined (No. of cases)	0	0	
soft tissue in attic	Absent (No. of cases)	2	2	1.00
	Present (No. of cases)	28	28	
	Undefined (No. of cases)	0	0	
Soft tissue in ME	Absent (No. of cases)	12	12	1.00
	Present (No. of cases)	18	18	
	Undefined (No. of cases)	0	0	
Soft tissue in ET	Absent (No. of cases)	24	24	1.00
	Present (No. of cases)	6	6	
	Undefined (No. of cases)	0	0	
Sinus tympani and facial recess involvement	Absent (No. of cases)	12	12	1.00
	Present (No. of cases)	18	18	
	Undefined (No. of cases)	0	0	

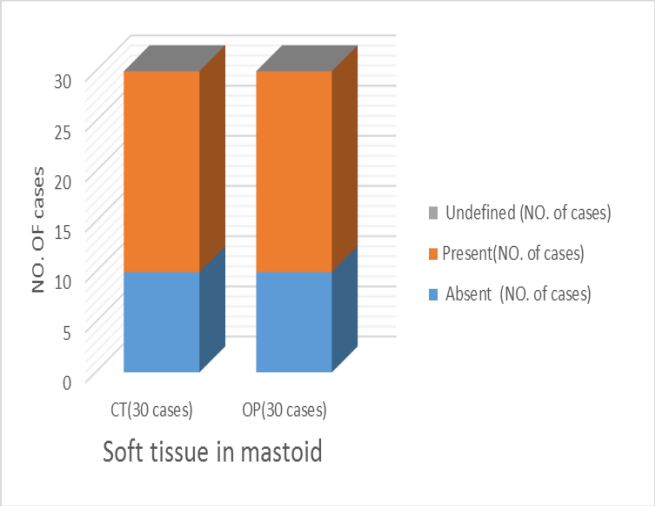

Figure (1):soft tissue in mastoid in CT and intraoperative

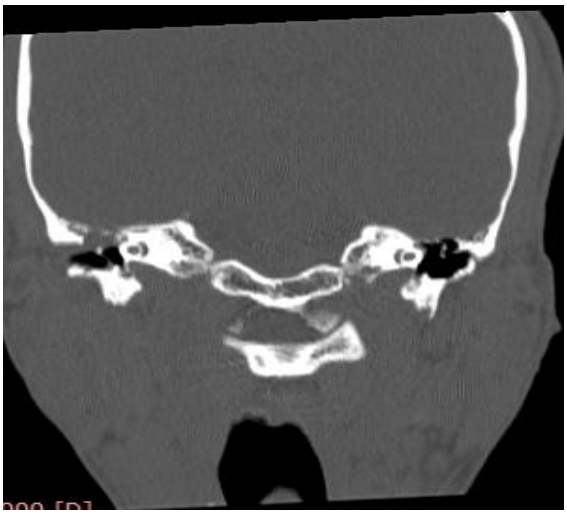

Figure (2); Attic cholesteatoma

(B) Pneumatization Of Mastoid:

Mastoids were observed in all cases. In 20 cases they were sclerotic (not pneumatized); while 8 cases are partially pneumatized when 2 cases appear to be well pneumatized by the Preoperative HRCT. Theses findings were in a great agreement with the intraoperative findings where we found 20 cases had sclerotic mastoid, 7 cases had well pneumatized mastoid and the remaining 3 cases has a partially pneuamatized mastoid. (Table 2)

Table (2): Comparison between CT and Intra-Operative Findings regarding Mastoid pneumatization

	Finding	**CT (30 cases)**	**Intraoperative (30 cases)**	**P value***
Mastoid pneumatization	Well pneumatized (NO. of cases)	2	3	.843
	Partially pneumatized (NO. of cases)	8	7	
	Not pneumatized (NO. of cases)	20	20	

(C) Scutum erosion:

In our study, we were searching for any bony erosions in the HRCT that may raise the possibility of cholesteatoma to have a general idea about the case and possible intraoperative complications. Scutum was found to be eroded in 14 cases and intact in 16 cases but intraoperatively it was found to be eroded in 18 cases and intact in 12 cases only. (Table 3)

Table (3): Comparison between CT and Intra-Operative Findings regarding scutum erosion

	Finding	**CT (30 cases)**	**Intraoperative (30 cases)**	**P value***
Scutum	Not eroded (No. of cases)	16	12	.309
	Eroded (No. of cases)	14	18	
	Undefined (No. of cases)	0	0	

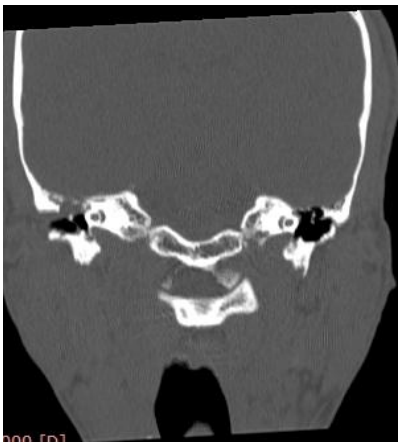

Figure (3): Erosion of the scutum in attic cholesteatoma

(D) Tegmen And Sinus Plates (Erosion & Position):

Detection of tegmen and sinus plates conditions preoperatively is very important to avoid injury of vital structures as dura & sigmoid sinus respectively. Tegmen plate erosion was seen in 4 cases on CT, but intraoperatively erosion was found in only 2 cases. Intact dural plate was seen in 26 cases on CT but intact dural plate was present in 28 cases intraoperatively. Assessment of tegmen plate position is of great importance to avoid injury to the dura intraoperatively, we found low set dura in only one case and confirmed intraoperatively. Sinus plate erosion was seen in 3 cases and intact sinus plate was seen in 27 cases, the same findings were confirmed intraoperatively. Assessment of sinus plate position is very importance to avoid injury to the sigmoid sinus intraoperatively. We found anteriorly displaced sigmoid sinus in only 2 cases that are confirmed intraoperatively.

Table (4): Comparison between CT and Intra-Operative Findings regarding tegmen and sinus plates (erosion and position)

	Finding	CT (30 cases)	Intraoperative (30 cases)	P value*
Tegmen plate erosion	Eroded (No. of cases)	4	2	.398
	Not eroded (No. of cases)	26	28	
	Undefined (No. of cases)	0	0	
Tegmen plate position	Normal position (No. of cases)	29	29	1.00
	Low set dura (No. of cases)	1	1	
	Undefined (No. of cases)	0	0	
Sinus plate erosion	Eroded (No. of cases)	3	3	1.00
	Not eroded (No. of cases)	27	27	
	Undefined (No. of cases)	0	0	
Sinus plate position	Normal position (No. of cases)	28	28	1.00
	Anteriorly displaced (No. of cases)	2	2	
	Undefined (No. of cases)	0	0	

[E] Ossicular Status:

Assessment of the ear ossicles is very important as ossicular erosion is a good indicator of cholesteatoma. Regarding ear ossicles malleus appeared to be intact in 6 cases on CT, intraoperatively it was found to be intact in 4 cases in the remaining 2 cases it was partially eroded. On CT malleus appeared eroded in 24 cases and all these cases were confirmed intraoperatively. On CT incus appeared to be intact in 4 cases, intraoperatively it was found to be intact in 2 cases, in the remaining 2 cases it was partially necrosed. On CT incus appeared to be eroded in 26 cases and all these cases were confirmed intraoperatively. On CT Stapes appeared to be eroded in 4 cases that are confirmed intraoperatively. While it was found to be intact in 14 cases by CT, but intraoperatively it was intact in only 10 cases. It is important to mention that the stapes was not visualized in 12 cases, intraoperatively it was eroded in 5 cases and intact in 7 cases.

Table (5): OSSICULAR STATUS

	Finding	CT (30 cases)	Intraoperative (30 cases)	P value*
Malleus	Eroded (No. of cases)	24	26	.498
	Not eroded (No. of cases)	6	4	

	Undefined (No. of cases)	0	0	
Incus	Eroded (No. of cases)	26	28	.398
	Not eroded (No. of cases)	4	2	
	Undefined (No. of cases)	0	0	
Stapes	Eroded (No. of cases)	4	13	0.013
	Not eroded (No. of cases)	14	17	
	Undefined (No. of cases)	12	0	

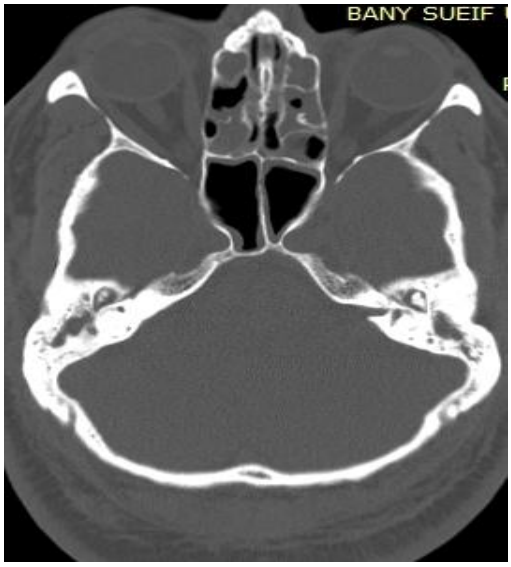

Figure (4): Intact malleus and incus (but were dislocated)

[F] Facial canal erosion and position:

Facial nerve canal appeared to be eroded in 2 cases in tympanic segment on CT but was confirmed in only 1 case intraoperatively (this case has clinically facial nerve palsy prior to surgery by 2 days). Erosion of the vertical segment of the facial nerve was also documented in this cases intraoperatively, but it was not reported preoperatively on CT. Regarding facial nerve canal position wasnot displaced as reported by HRCT to be confirmed intraoperatively. (Table 6)

Table (6): Comparison between CT and Intra-Operative Findings regarding facial nerve canal (erosion and position)

	Finding	**CT (30 cases)**	**Intraoperative (30 cases)**	**P value***
Facial canal erosion	Eroded (No. of cases)	2	1	.561
	Not eroded (No. of cases)	28	29	

	Undefined (No. of cases)	0	0	
Facial canal position	Normal position (No. of cases)	30	30	1.00
	Displaced (No. of cases)	0	0	
	Undefined (No. of cases)	0	0	

[G] LSCC erosion:

Lateral semicircular canal was documented to be eroded in 3 cases on CT but intraoperatively it was found to be eroded in 5 cases. (Table 7)

Table (7): Comparison between CT and Intra-Operative Findings regarding LSCC erosion

	Finding	**CT (30 cases)**	**Intraoperative (30 cases)**	**P value***
LSCC erosion	Eroded (No. of cases)	3	5	.456
	Not eroded (No. of cases)	27	25	
	Undefined (No. of cases)	0	0	

4. Discussion:

Preoperative imaging of the temporal bone plays an important role in assessment of patients with suppurative COM and cholesteatoma by giving preoperative information of the closed spaces of the middle ear. However, radiological evaluation of the temporal bone is difficult owing to complicated anatomical structure of the middle ear and inner ear. A major advance in imaging of the ear structures has occurred with the development of HRCT [11]. CT has the ability to detect early bone erosions as well as air replacement with tiny soft tissue densities ,which are the key finding of CSOM and cholesteatoma.

Soft tissue involvement:

HRCT had sensitivity = 100 %, specificity = 100 %, P value = 1.00 in predicting the extension of soft tissue mass in the middle ear cleft. This finding is in agreement with that of [12] and [13] who reported a sensitivity of 90 % and 87.5 %, respectively. Commenting on certain findings as ET, sinus tymapni or facial recess involvement is very important, because these areas may be site of residual cholesteatoma sac, resulting in recurrence, whenever knowing such findings preoperatively make the surgeon search for choleateatoma in theses areas to ensure complete eradication of the pathological disease. And in our study we found great correlation between the preoperative and intraoperative findings regarding these items of sensitivity and specificity of 100 %. But, HRCT is less sensitive in differentiating cholesteatoma sac from granulations or pus in

the middle ear cleft , in the absence of bone erosions, as all will show opacification of the middle ear cleft . Sure diagnosis was made intraoperatively , but -at CT- the association of bony erosions may raise the possibility of cholesteatoma. The previous findings were in agreement with [14], [15] and [16] while [17] believed that it was possible to identify cholesteatoma by the low attenuation value. [18] stduy found that the presence of a well differentiated edge in the mass was a sure indication of cholesteatoma. Bony erosion, an additional sign for the presence of cholesteatoma, was identified in the studies by [15] and [19] who found cholesteatoma to be present in 80% of the cases with bony erosion that were explored.

Pneumatization of mastoid:

As regarding mastoid pneumatization, they were sclerotic (not pneumatized) in 20 cases; while 8 cases are partially pneumatized when 2 cases appear to be well pneumatized by the Preoperative HRCT. Theses findings were in a great agreement with the intraoperative findings where we found 20 cases had sclerotic mastoid, 7 cases had well pneumatized mastoid and the remaining 3 cases had a partially pneuamatized mastoid. In our study, HRCT has sensitivity = 100% , specificity = 66.66 % and P value .843 in predicting the pneumatization of mastoid when compared with the intra‑operative results. Similar results were reported by [15], [20], [21] and [22] who also found a strong agreement between HRCT and intra‑operative findings in case of mastoid air cell complex.

Scutum erosion

In our study, scutum was found to be eroded in 14 cases and intact in 16 cases but intraoperatively it was found to be eroded in 18 cases and intact in 12 cases only. Erosion of the scutum was found -intraoperatively- to be the early bony erosion taking place in cases with attic cholesteatoma. Being one of the earliest signs may explain why CT may miss very early erosions, which may exceed the capability (and sensitivity) of CT

Tegmen and sinus plates (Erosion and position)

Tegmen plate was found to be intact in 26 cases and erosion was present in 4 cases on CT. While intraoperatively tegmen plate was found to be intact in 28 cases and eroded in 2 cases only. [15] detected all their cases but also had eight false positive cases. [17] missed 3 out of 8 cases. [14] commented that it is not possible to demonstrate a dehiscence in the tegmen on axial scan alone but even using coronal cuts they found the effect of partial averaging could give the false impression of a defect. Regarding the tegmen plate position, it was reported a low set dura in only one case and confirmed intraoperatively, Assessment of tegmen plate position is of great importance to avoid injury to the dura intraoperatively. Sinus plate erosion was seen in 3 cases and intact sinus plate was seen in 27 cases, the same findings were confirmed intraoperatively.

Assessment of sinus plate position is very importance to avoid injury to the sigmoid sinus intraoperatively. We found anteriorly displaced sigmoid sinus in only 2 cases that are confirmed intraoperatively. On comparing the HRCT findings with Intra‑operative findings regarding tegmen plate erosion in the present study, the sensitivity = 100 % , specificity = 92.85 % and P value = 0.398 , thereby implying that there was no statistically significant difference between the HRCT report when it was compared to the gold standard (intra‑operative findings). A similar specificity rate of 95% was reported by [23] and a specificity rate of 91.93% were also reported by [24] and [22]. A similar value of 100% sensitivity, of HRCT, was also reported by [25], [26], [27] and [22]. A poor sensitivity rate of HRCT to detect tegmen tympani erosion was reported by [15] and [14] while a moderate association was seen by [20]**,** and [28]. Regarding sinus plate erosions, the present study reported the sensitivity = 100 , specificity = 100 and p value 1. [22] reported results similar to that documented by the present study while [21] intra‑operatively found sigmoid sinus plate erosion in eight patients whereas it was reported by HRCT in only six patients.

Ossicular status:

Assessment of the ear ossicles is very important as ossicular erosion is a good indicator of cholesteatoma. Malleus appeared to be intact in 6 cases on CT, intraoperatively it was found to be intact in 4 cases, in the remaining 2 cases it was partially eroded. On CT malleus appeared eroded in 24 cases and all these cases were confirmed intraoperatively, making the HRCT, sensitivity= 92.3 % , specificity = 100 %, P value = 0.498 in the present study. A specificity rate of 100% was also reported by [21], [25] and [26] however, they all reported HRCT to be 100% sensitive, which was higher as compared to the present study. The sensitivity, specificity, and P value of the present study were comparable to the study conducted by [22]. According to a study conducted by [29] there is a good radiosurgical correlation for malleus while [28] reported an excellent correlation. On CT incus appeared to be intact in 4 cases, intraoperatively it was found to be intact in 2 cases, in the remaining 2 cases it was partially necrosed. On CT incus appeared to be eroded in 26 cases and all these cases were confirmed intraoperatively. Therefore, HRCT was found to be 92.85 % sensitive , 100 % specific with P value = 0.0.398 implying an insignificant difference between HRCT and intra‑operative findings. [22] and [21] observed low sensitivity of 87% as compared to the present study. Results comparable to the present study were also reported by [26] whereas [30] reported a sensitivity rate of 84.6%. A good radio‑surgical correlation was reported by [29] and [28] for incus. On CT Stapes appeared to be eroded in 4 cases that are

confirmed intraoperatively. While it was found to be intact in 14 cases by CT, but intraoperatively it was intact in only 10 cases. It is important to mention that the stapes was not visualized in 12 cases and cannot be assessed preoperatively, intraoperatively it was eroded in 5 cases and intact in 7 cases. In our study, HRCT had a sensitivity of 30.76 % and specificity of 82.35 % and P value 0.013. [21] reported HRCT to be specific but less sensitive as compared to the present study, and a similar observation was made by [17]. [30] and [28] have reported a good radiosurgical correlation for stapes while [26] and [22] have reported HRCT to be poor in detecting stapes. We believe that the stapes is a very tiny bone, with thin components that may be even thinner than the collimated CT x-ray beam, and this may render it vulnerable to averaging (partial volume) artifacts, hence the remarkable low sensitivity as compared to the rest of the ossicles.

Facial canal erosion and position:

Facial nerve canal appeared to be eroded in 2 cases in tympanic segment on CT but was confirmed in only 1 case intraoperatively (this case has clinically facial nerve palsy prior to surgery by 2 days). Erosion of the vertical segment of the facial nerve was also documented in this cases intraoperatively, but it was not reported preoperatively on CT. Regarding facial nerve canal position was not displaced as reported by HRCT to be confirmed intraoperatively. The present study reported sensitivity 100 % specificity 96.55 % and P value 0.561of in detecting the facial canal erosion. Similar results were also observed by [27] and [21] but poor and insignificant correlation between the two was reported by [15]**,** [17], [25], [28], [26], [23] and [29]. [17] however, reported HRCT to be 100% accurate. [22] reported sensitivity and specificity to be comparable to the present study, while [31] in their study, observed a sensitivity and specificity of 69% and 87%, respectively.

Lateral semicircular canal erosion:

Lateral semicircular canal was documented to be eroded in 3 cases on CT but intraoperatively it was found to be eroded in 5 cases. Sensitivity = 60 % , specificity = 100 %, P value = 0.456 were reported in the present study in detecting lateral semicircular canal erosion, thereby pointing out an insignificant statistical difference between the HRCT temporal bone and intra‑operative findings (gold standard). [22] reported 100% sensitivity, specificity, P value much higher than the present study. [27]**,** [28], [17] and [25] also reported HRCT to be 100% sensitive in predicting lateral semi‑circular canal erosion while [21] reported it to be only 25% sensitive. [23] reported a weak correlation between HRCT temporal bone and intra‑operative findings.

5. Conclusion and Recommendations

HRCT has high reliability for the parameters such as mastoid pneumatization, cholesteatoma extension in the middle ear and mastoid, and the presence of complications such as sigmoid sinus plate erosion and tegmen mastoideum erosion. HRCT is recommended in cases with suspected potential complications as well as all cases of COM to know the extent of disease, varied pneumatization, and the presence of anatomical variations, which should alert the clinician and guide in surgical approach and treatment plan.

HRCT of the temporal bone is therefore a useful guide to the surgeon in managing patients with CSOM with attico-antral disease. We believe that HRCT is a guide as to the nature of the disease (destructive/non-destructive), potential dangers (such as SCC fistula) and possible complications and this information can assist the surgeon in the choice of surgery to be performed (cortical mastoidectomy with tympanoplasty or modified or radical mastoidectomy).

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