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Research Article

CORRELATION OF PREOPERATIVE HRCT TEMPORAL BONE WITH INTRAOPERATIVE FINDINGS IN UNSAFE CSOM:- STATISTICAL ANALYSIS

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A B S T R A C T

Background: HRCT is often used to evaluate diseases of middle ear and mastoid such as cholesteatoma and gives useful information to the surgeon about the possible anatomical variations and extent of underlying disease process and thus complements the clinical examination. This study was undertaken to compare the Preoperative HRCT and intra-operative findings in unsafe CSOM. **Material and Methods:** This prospective study was conducted in the Department of ENT HNS in a tertiary care hospital on a sample size of 55 patients with clinical diagnosis of unsafe CSOM. HRCT temporal bone was done in all enrolled patients who were subsequently operated. The intra-operative findings were compared with preoperative HRCT and results were analysed using standard statistical methods. **Results:** Majority of patients were in the age group of 21-30 years with a total of 31 (56.36%) male and 24(43.64%) female patients. The study showed bony erosion in 48(87.27%) patients on HRCT that included erosion of scutum, tegmen, sigmoid Sinus plate, external auditory canal, Facial nerve canal, lateral semicircular canal and erosion of Malleus, Incus and stapes in 37(67.27%) patients,7(12.72%) patients, 3(5.45%) patients, 7(12.72%) patients, 5(9.09%) patients,3(5.45%) patients,20(36.36%) patients, 31(56.36%) patients and 24(43.63%) patients and the results for the same findings intra-operatively were 36 (65.45%) patients, 8(14.54%) patients,5(9.09%) patients, 8(14.45%) patients 7(12.72%) patients,2(3.63%) patients, 24(43.63%) patients, 34(61.81%) patients and 26(47.27%) patients respectively. In the detection of bony erosion HRCT showed an average sensitivity of 85.96%, specificity of 99.91%,PPV of 94.43%,NPV of 93.36% and an average accuracy of 96.52% and results for the detection of soft tissue lesions depicting cholesteatoma showed an average sensitivity of 98.20%,specificity of 96.88%,PPV of 89.42%,NPV of 96.75% and an average accuracy of 97.75%.**Conclusion:**HRCT serves as a road map to assist the surgeon in planning the management and predict the functional outcome of surgery undertaken.

INTRODUCTION

The Otitis media remains a significant international problem in terms of prevalence, economics, and sequelae. Cholesteatomas are cyst like expansile lesions of the temporal bone lined by stratified squamous epithelium that contains desquamated keratin. They most frequently involve the middle ear and mastoid but they may develop anywhere within the pneumatized portions of the temporal bone[1].

The sac slowly enlarges by accumulation of keratin and other debris until the walls of the attic are reached.

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The accumulation of keratin may cause infection, otorrhea, bone destruction, hearing loss, facial nerve paralysis, labrynthine fistulae, and intracranial complications such as epidural and subdural abscesses, parenchymal brain abscesses, meningitis and thrombophelebites of the dural venous sinuses[1].

The diagnosis of cholesteatoma is made on symptoms, otoscopy, otoendoscopy and examination under microscope.

Special imaging procedures such as high-resolution computed tomography (HRCT) may suggest the presence of cholesteatoma within the temporal bone and may be used to complement the clinical examination. In high resolution CT thin sections and high resolution algorithms are used. Multi-slice CT uses very thin slices of temporal bone, so it provides

significant advantages in terms of delivering a lower radiation dose and differentiation between bone and soft tissue[2,3].

It must be emphasized that CT scanning is not routinely advocated for cholesteatoma diagnosis. An HRCT 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[4,5].

CT scan findings of an acquired cholesteatoma of temporal bone consist of homogenous mass with local bone erosion, scutum erosion, erosion of ossicles, middle ear opacification, labyrinthine fistula and widening of aditus and antrum[6].Hidden areas of middle ear such as sinus tympani and facial recess are well appreciated on HRCT, allowing better understanding of aetiology, pathology, diseases course with early detection of complications which alters treatment modality and has considerably reduced the morbidity and mortality pertaining to the lesions of temporal bone[7,8]. Additionally, imaging results may be used by surgeons to enhance the informed consent process prior to surgery, whilst discussing the risks of potential complication[9]. A variety of standard surgical approaches are currently used to remove cholesteatomas. All of these procedures can be broadly categorized as either intact canal wall or canal wall down approaches.

Aims and Objectives

- To evaluate the efficacy of HRCT temporal bone in diagnosis of unsafe CSOM and to know the extent of involvement of disease.
- To compare the HRCT findings with the surgical findings.
- To assess the diagnostic accuracy of HRCT temporal bone.

MATERIAL AND METHODS

This study was conducted in Department of ENT HNS in a tertiary care hospital on 55 patients with a clinical diagnosis of unsafe CSOM. After the proper informal consent all the patients underwent multi-slice HRCT temporal bone. All patients were operated by consultant level surgeons. Intra-operative surgical findings were recorded and were correlated with pre-operative HRCT for statistical significance.

RESULTS

55 patients comprising of 31(56.36%) males and 24(43.63%) females were taken up for study, with majority of patients [21 (38.18%)] falling in age group of 21-30 years. (Table 1). The presenting symptoms included otorrohea in 51(92.72) patients, hearing impairment in 47(85.54) patients, otalgia in 18(32.72%) patients, tinnitus in 12(21.18%) patients and vertigo and facial weakness in 02(03.63%) patients each. (Table 2).

The study showed bony erosion in 48(82%) patients on HRCT that included erosion of scutum, tegmen, sigmoid sinus plate, external auditory canal, facial nerve canal, lateral semicircular canal and erosion of malleus, incus and stapes in 37(67.72%) patients, 7(12.72%) patients, 3(5.45%) patients, 7(12.72%) patients, 5(9.09%) patients,3(5,45%) patients,20(36.36%) patients. 31(56.36%) patients and 24(43.63%) patients respectively and the results for the corresponding bony erosion intra-operatively were 36 (64.45%) patients, 8(14.54%) patients,5(9.09%) patients, 8(14.45%) patients,7(12.72%) patients,2(3.63%) patients, 24(43.63%) patients 34(61.81%) patients and 26(47.27%) patients respectively (Tabl 3).In the detection of bony erosions HRCT showed sensitivity, specificity, positive predictive value, negative predictive value and accuracy of(100%,94.75%,92.27%,100% and 98.18%) for erosion of scutum, (87.50%,100%,100%,97.91%,98.18%) for erosion of tegmen, (60%,100%,100%,96.15%,96.36%) for erosion of sigmoid sinus plate,(87.50%,100%,100%, 97.91%,98.18%) for erosion of external auditory canal, (71.42%,100%, 100%,96.74%,96.36%) for erosion/ dehiscence of facial nerve canal, (100%,100%,67.66%, 100%,98.10%) for erosion of lateral semicircular canal, (83.33%,100%,100%, 88.57%,92.72%) for erosion of malleus,(91.17%,100%, 100%,87.50%94.54%) for erosion of incus and (92.30%,100%,100%,93.54%,96.36%) for erosion of stapes respectively. For the detection of soft tissue lesion depicting cholesteatoma the HRCT showed sensitivity, specificity, PPV, NPV and accuracy of (92.80%,100%,100%, 93.10%,96.36%) in the attic region, (100%,96%,96.79%, 100%,98.10%) in attico-antral region, (100%,97.77%,90.90%, 100%,98.18%) in the antrumand air cell system and (100%,93.75%,70%,100%,94.54%) in the mesotympanum region respectively.(Table 4).

Table 1 Age and sex wise distribution

Age group(Years)	Sex			Laterality		
	Male	Female	Total	Right	Left	Total
1-10	02	01	03	02	01	03
11-20	06	05	11	07	04	11
21-30	14	07	21	07	14	21
31-40	06	06	12	08	04	12
41-50	02	03	05	04	01	05
51-60	01	01	02	01	01	02
61-70	0	01	01	0	01	01
Total	31	24	55	29	26	55

Table 2 Clinical presentation

Clinical features.	No of patients.	Percentage.
Otorrohea	51	92.72
Hearing impairement	47	85.54
Otalgia	18	32.72
Tinitus	12	21.18
Vertigo	02	03.63
Facial weakness	02	03.63

Table 3 HRCT and Intra-operative findings

Findings	On Hrct		Intra-Operatively	
	No. of patients	Percentage of patients	No. of patients	Percentage Of patients
Erosion of Scutum	37	67.27	36	69.45
Erosion of tegmen	07	12.72	08	14.54
Erosion of sigmoid sinus plate	03	05.45	05	09.09
Erosion of EAC	07	12.72	08	14,54
Dehiscent/Erosion of Facial canal	05	09.09	O7	12.72
Erosion of LSSC	03	05.45	02	03.63
Incus erosion	31	56.36	34	61.81
Mallus erosion	20	36.36	24	43.63
Stapes erosion	24	43.63	26	47.27
Attic	26	47.27	28	50.90
Attico-antral	31	56.36	30	54.54
Antrum and air cell system	11	20	10	18.18
Mesotympanum	10	18.18	07	12.72

Table 4 Statistical Analysis

	True positive	True negative	False positive	False negative	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy%
Erosion of Scutum	36	18	01	0	100	94.75	92.27	100	98.18
Erosion of tegmen	07	47	0	01	87.50	100	100	97.91	98.18
Erosion of sigmoid sinus plate	03	50	0	02	60	100	100	96.15	96.36
Erosion of EAC	07	47	0	01	87.50	100	100	97.91	98.18
Dehiscent/Erosion of Facial canal	05	48	0	02	71.42	100	100	96.74	96.36
Erosion of LSSC	02	52	01	0	100	100	67.66	100	98.10
Incus erosion	31	21	0	03	91.17	100	100	87.50	94.54
Mallus erosion	20	31	0	04	83.33	100	100	88.57	92.72
Stapes erosion	24	29	0	02	92.30	100	100	93.54	96.36
Attic	26	27	0	02	92.80	100	100	93.10	96.36
Attico-antral	30	24	01	0	100	96	96.79	100	98.10
Antrum and air cell system	10	44	01	0	100	97.77	90.90	100	98.18
Mesotympanum	07	45	03	0	100	93.75	70	100	94.54

PPV = Positive predictive value. NPV= Negative predictive value.

DISCUSSION

Cholesteatoma is a non-neoplastic temporal bone lesion, which in an expansile collection of exfoliative keratin produced by keratinizing stratified squamous epithelium[10]. Middle ear cholesteatoma may be congenital or acquired, with the acquired variety forming the bulk of cases of middle ear[11].

It is estimated that over 20 million people worldwide are affected with otitis media, of these one fourth (about five million) have a cholesteatoma[12]. The incidence of cholesteatoma is reported as 3 per 1000,000 in children and 9.2 per 1000000 adults. Males slightly outnumber females in a ratio of 1.4:1 and are more frequently found in persons younger than 50 years of age[13]. In the present study male, female ratio of 1.3:1 was observed and highest incidence was seen in the age group of 21-30 years. RaghavM *et al*[14], Niveditha J[15] and MdIzhar K[16] reported similar age and sex patterns.

The first and most frequent symptom of acquired cholesteatoma is otorrhea that can be unrelenting or periodically recurrent in nature[12]. Pain (which may be an indicator of advanced disease) and earache are common symptoms prior to episode of purulent discharge[17]. Hearing loss can be progressive conductive or sensorineural, with conductive hearing loss resulting from impaired movement of ossicles[18]. Tinnitus is a common clinical complaint that may be the result of sigmoid sinus compression by cholesteatoma or can be result of damage to the cochlea leading to irreparable sensorineural hearing loss[18,19]. In the current study patients presented with the clinical symptoms of otorrhea, hearing impairment, otalgia, tinnitus, vertigo and facial weakness. Otorrhea was the commonest symptom. The similar clinical presentations were reported by Niveditha J[15], Lyngwa G[20], Priya Y[21] in their respective studies.

High-resolution computed tomography (HRCT) is the imaging technique of choice in case of clinically suspected cholesteatoma. HRCT due to its excellent spatial resolution has a high sensitivity with a high negative predictive value for a middle ear and mastoid, which is free of any pathology. However in case of a middle ear soft tissue mass, its specificity is low because soft tissue may depict granulation tissue, effusion, cholesterol granuloma or neoplasma[22]. The hall mark of cholesteatoma is bony destruction.

Presence of soft tissue density in middle ear cavity co-existent with ossicular and mastoid bony erosion is highly specific for cholesteatoma. In attic cholesteatoma, the ingrowth of epithelium from the pars flacida into the epitympanum is evident by the erosion of scutum. Ossicular erosion is more frequently encountered in pars tensa cholesteatom.[23]

In the present study, soft tissue mass lesion suggestive of cholesteatoma was recorded in 26 (47.27%) patients in attic, 31 (56.36%) patients in attico-antrum, 11 (20%) patients in antrum and air cell system and in 10 (18.18%) patients in mesotympanum on HRCT and intra-operatively in 28 (50.90%) patients, 30 (54.54%) patients, 10 (18.18%) patients and in 7 (12.72%) patients respectively.

Thus, HRCT in detection of cholesteatoma showed an average sensitivity of 98.20%, specificity of 96.88%, PPV of 89.42%, NPV of 96.75% and accuracy of 97.79% with highest sensitivity (100%) seen in attico-antral, attic and air cell system and mesotympanum, highest specificity (100%) in attic region, highest PPV (100%) in attic, highest NPV (100%) in attico-antral, antrum and air cells and mesotympanum, and highest accuracy (98.18%) in the attico-antral region. Similar to current study the correlation of HRCT with intra-operative findings was labelled as good to excellent by Sneha M.[24]

The results are also in accordance with the studies undertaken by Lyngwa G *et al*[20], Sabieh B *et al*[24], RaghavM *et al*[13] and Kumar P *et al*[25]. In the current study, bone erosioin in one or other form was seen in 48 (82%) patients and this finding is consistent with the studies by Lyngwa G *et al*[20,] Alzoubi FQ *et al*[26] and O'Reilly BJ *et al*[27]. In the current study HRCT findings suggestive of scutum erosion were seen in 37 (67.27%) patients and the same finding was observed in 36 (65.45%) patients intra-operatively. Thus detection of scutum erosion on HRCT showed sensitivity, specificity, PPV, NPV and accuracy of 100%, 94.75%, 92.27%, 100% and 98.18%, respectively. Kumar P[7] Sreedhar, S *et al*[8] and Pramod V*et al*[28] observed sensitivity and specificity of (100%, 92%), (100%, 94.70%) and (95%, 100%) respectively in their studies. Lyngwa G *et al*[20] reported 100% values of sensitivity, specificity, PPV and NPV in series of 50 patients. In the current study accuracy rate of 98.10% for correctly identifying scutum erosion on HRCT is well in accordance with above mentioned studies. Rocher P[29] described correlation of

radiological and surgical findings as excellent in case of scutum.

In the current study Tegmen was recorded as eroded on HRCT in 7 (12.72%) patients, whereas intra-operatively the finding was observed in 8 (14.54%) patients. Thus detection of HRCT in this case showed a sensitivity, specificity, PPV, NPV and accuracy of 87.50%, 100%, 100%, 97.91% and 98.18%, respectively. There is variation in literature in statistical significance of HRCT in detecting erosion of tegmen. Lyngwa G *et al*[20], Pramod V *et al*[28], SunitaM *et al*[30] and Baviskar S *et al*[31] reported 100% sensitivity and specificity whereas MdIzhar K *et al*[16] and Sabeeh B *et al*[25] reported sensitivity and specificity of (80%, 93%) and (62.5%, 83.33%) respectively. In the same way PPV and NPV has also been reported differently.Sunita D *et al*[22] reported PPV and NPV of 60% and 100% and Sabeeh B *et al*[25] reported PPV and NPV of 41.07% and 92.11% and Baviskar S *et al*[31] reported PPV and NPV of 100%.

In the current study sigmoid sinus plate erosion was recorded in 3 (5.45%) patients on HRCT and in 5 (9.09%) patients intra-operatively. The detection of sigmoid sinus plate erosion on HRCT showed sensitivity, specificity, PPV, NPV and accuracy of 60%, 100%, 100%, 96.15% and 96.36% respectively and is in accordance with the other studies in literature by Lyngwa G etal[20], Prakash MD *et al*[32]and Chatterjee P *et al*[33].

In the current study external auditory canal erosion was recorded in 7 (12.72%) patients on HRCT and in 8 (14.45%) patients intra-operatively. The detection of external auditory canal erosion on HRCT showed sensitivity, specificity, PPV, NPV and accuracy of 87.50%, 100%, 100%, 97.91% and 98.10% respectively. Raghav M *et al*[14] in a study of 48 patients observed posterior canal wall erosion in 9 (18.75%) patients equally on HRCT and intra-operatively. Sunita D *et al*[22] and Bahadur *et al*[34] reported an incidence of 8% and 16.7% respectively in case of external auditory canal erosion.

In the present study facial nerve canal was noticed dehiscent / eroded in 5 (9.09%) patients on HRCT and in 7 (12.72%) patients intra-operatively. Lyngwa G etal[20] reported 10% erosion in their study whereas Maglialo G *et al*[35] reported a higher incidence of 27%. In the current study detection of facial canal dehiscence / erosion on HRCT showed a sensitivity, specificity, PPV, NPV and accuracy of 71.42%, 100%, 100%, 96.74% and 96.36% respectively. The low sensitivity in the present study is comparable to studies undertaken by SunitaM *et al*[30] and Datta G *et al*[36] . There are studies in literature which show a lesser value of sensitivity than the current one. Kanotra S *et al*[37] and Rai T *et al*[38] recorded sensitivity of 33.3% each but specificity was comparable to current study. The current study observed an accuracy rate of 96.36% against 84% reported by Buch A etal[22]. Gaurano JL *et al*[39] observed that preoperative demonstration of facial nerve canal was often difficult, not only because of small size of facial nerve but also due to its oblique orientation and the presence of developmental dehiscence, particularly when abutted by soft tissue. In the current study lateral semicircular canal was recorded as eroded on HRCT in 03 (5.45%) patients and intra-operatively in 02(3.635) patients. These findings are consistent with Silver *et al*[40] according to whom patients with vertigo and chronic middle ear disease may have a cholesteatoma with a fistula between the middle and inner ear and the fistula usually involves lateral semicircular canal.

The detection of erosion of lateral semicircular canal on HRCT showed a sensitivity and specificity of 100%, PPV of 67.66%, NPV of 100% and accuracy of 98.18%. 0n HRCT sensitivity and specificity of 100% was also observed in their studies by Sumita M *et al*[30] and Datta G *et al*[36]. A sensitivity of 100% and specificity of 98% was noticed by Kumar P *et al*[7]. A PPV of 66% and NPV of 100% in the current study is comparable to study of Sabeeh B *et al*[25].

In the present study detection of ossicular erosion on HRCT showed sensitivity, specificity, PPV, NPV and accuracy of (83.33%, 100%, 100%, 88.57% and 92.72%) for malleus, (91.17%, 100%, 100%, 87.5% and 94.54%) for incus and (92.30%, 100%, 100%, 93.54% and 96.36%) for stapes respectively. The results in our study are well in accordance with the study by Datta G *et al*[36] who recorded sensitivity and specificity of 94% and 100% respectively in case of malleus. Similarly, Lyngwa G *et al*[20] Sunita M *et al*[28], Dutta G *et al*[36] and Kanotra S *et al*[37] recorded a sensitivity and specificity of (91%, 100%), (86%, 100%), (87%, 100%) and (95.70%, 100%) respectively in case of stapes, which are similar to the current study. Sunita M *et al*[22] and Kanotra S[37]recorded sensitivity and specificity of (82%, 100%) and (91%, 100%) respectively for stapes and are similar to the current study. Gareth YL etal[20] reported PPV and NPV of (92.30%, 89.6%) for malleus, (100%, 84.2%) for incus and (100%, 86.8%) for stapes which are in ressemblance to the current study.

CONCLUSION

HRCT scans of the temporal bone have significantly enhanced the preoperative evaluation of unsafe CSOM(Cholesteatoma). This study has shown that HRCT imaging effectively depicts the integrity or erosion of dural plate, sinus plate, lateral semicircular canal and lateral cortical wall. On HRCT the ear ossicles malleus and incus are very well depicted. Stapes integrity is better seen peroperatively.

It is concluded that computed tomography despite of its pitfalls such as more radiation exposure and higher cost delineates the location and extent of the disease, and provides information on anatomical variations and complications. It serves as a road map to assist the surgeon during surgery and predict the functional outcome of surgery undertaken.

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