JMSCR Vol||05||Issue||10||Page 28625-28629||October 2017

www.jmscr.igmpublication.org
Impact Factor 5.84
Index Copernicus Value: 71.58
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossref DOI: https://dx.doi.org/10.18535/jmscr/v5i10.24

IGM Publication
Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Analyzing the Role of High Resolution Computed Tomography of Temporal Bone in Acquired Middle Ear Cholesteatoma

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Abstract
Background: *Acquired middle ear cholesteatoma is the anomalous proliferation of keratinized, stratified squamous epithelium with properties of growth, migration and osseous erosion. High resolution computed tomographic scanning aid in the assessment of the temporal bone anatomy, soft tissue lesions, extent of involvement, bony erosions and other complications. This study was performed to understand the characteristic findings in temporal bone in acquired middle ear cholesteatoma, and to assess the prevalence of the abnormal findings, based on high resolution computed tomography (HRCT).*
Materials and Methods: *Cross-sectional study was conducted in 32 clinically diagnosed cases of acquired middle ear cholesteatoma, who underwent HRCT in the Department of Radiodiagnosis, Government Medical College, Thrissur, from January 2015- June 2016 whose data were collected and statistically analysed.*
Results: *The main finding on HRCT was nondependent soft tissue density in middle ear cavity with associated bone erosions and expansions. Soft tissue density mainly invoved the epitympannum, mastoid antrum and aditus ad antrum. It was noted in the posterior tympanic recesses also. Scutum was the commonest site of bone erosion, followed by the ossicles. Erosions were noted in critical sites like the lateral semicircular canal, tegmen, sinus plate and facial nerve canal. Mastoids were sclerotic in most cases. Features of cholesteatoma were noted in the opposite ear in few cases.*
Conclusion: *Acquired middle ear cholesteatoma appears in HRCT as soft tissue mass which usually erodes and expands bone, thus leading to intratemporal and extratemporal complications. Studying the HRCT images in axial, coronal and sagittal planes help in better visualisation of the abnormalities.*
Keywords: *Cholesteatoma; Middle Ear; Computed Tomography; Temporal Bone.*

Introduction

Cholesteatoma is a non-neoplastic lesion of the temporal bone, with proliferation of keratinized, stratified squamous epithelium, generally affecting the middle ear. They have osteolytic potential, can be locally destructive and have properties of growth, migration and osseous erosion[1]. Cholesteatoma affecting the ear can be

of two forms- congenital and acquired. Congenital cholesteatoma originate from embryonic epithelial remains[2]. Acquired cholesteatoma is the most common type, accounting for 98% of cases. It is further divided into primary and secondary. Cholesteatoma occurring as a result of chronic otitis media and perforation of tympanic membrane is called as secondary acquired cholesteatoma. Those arising from retraction pockets in the absence of infection are known as primary acquired cholesteatoma. They may be developing due to the extension of squamous epithelium from the pars flaccida into the unresolved mesenchyme of the epitympanum in early life[3]. Acquired cholesteatoma often involves the middle ear. Chronic suppurative otitis media associated with cholesteatoma is considered to be the unsafe type.

Without management it can cause diverse complications such as tinnitus, vertigo, hearing loss, labyrinthitis, facial nerve paralysis, and intracranial complications. Exploratory surgery is the treatment of choice[4]. The type of surgery performed depends on the extent of disease, 3 which is directly related to the extent of the underlying erosions. Therefore, detailed radiologic assessment of the temporal bone in cholesteatoma is important[5].

Evaluation of temporal bone is difficult because of its complex anatomy containing multiple small structures within a moderately compact area. With technological advancements, computed tomo-graphy (CT) temporal bone scans have become more valuable for evaluation of patients with cholesteatoma. High resolution computed tomographic scanning and three dimensional reconstructions aid in better assessment of the temporal bone anatomy, soft tissue lesions, and extent of involvement, bony erosions and other complications[6]. High resolution computed tomography (HRCT) can predict accurately the status of the structures of the temporal bone. It can serve as a road map to assist the surgeon during cholesteatoma surgery[7], and more limited, directed procedures can be done to eradicate the disease while preserving function, thereby avoiding considerable morbidity[8].

Materials and methods

A cross sectional study was conducted in 32 patients with clinical diagnosis of acquired middle ear cholesteatoma, who came for HRCT temporal bone in the Department of Radiodiagnosis, Medical college, Thrissur, during the period of January 2015 to June 2016. Patients with history of trauma or surgery of temporal bone and patients not giving consent were excluded from the study.

Study Instrument: HRCT imaging of temporal bone was conducted on Somatom Emo 16, Siemens, with a slice thickness of 0.6mm.images were studied in axial, sagittal and coronal planes.

Study procedure: After obtaining clearance from Ethical committee and Institutional Research Board, study was commenced. The imaging findings of temporal bone in acquired middle ear choleseatoma were assessed with specific attention to the location and extent, involvement of aditus and mastoid antrum, abnormal soft tissue densities in ear, osseous erosions, ossicular integrity, condition of external and inner ear, status of facial canal and walls of middle ear, involvement of opposite ear and anatomical variations.

Data collection and analysis: The clinical and HRCT findings of each case were collected in a detailed proforma. The data collected was entered into Microsoft Excel 2010 worksheet and statistical analysis was done using Epi Info™ 7 software for obtaining the frequency tables.

Results

In this cross sectional study of 32 cases, mean age was found to be 27 years. 20 were males and 12 were females with male to female ratio of 1.6:1. Out of 32 patients, 25 (78%) had hearing loss. In HRCT, all the patients had soft tissue density in the middle ear. 31 cases had bony erosions associated with the soft tissue.

The soft tissue density in the middle ear cavity was nondependant in location in 25 cases ad it was filling the whole middle ear cavity in 7 cases.

Table 1 showing percentage of soft tissue involvement depending on location

SITES	No of cases
Epitympanum	32(100%)
Mesotympanum	12(37.5%)
Hypotympanum	7(21.9%)
Mastoid antrum	32(100%)
Aditus ad antrum	29(90%)
Posterior tympanic recess	13(40.6%)

Ossicular erosions were present in 25 (78%) cases. Ossicular chains were intact in 7 cases. Complete ossicular erosion in 10 (31.2%) and partial erosion in 15 (46.8%) cases. Incus was most commonly involved (78.1%) followed by Stapes (68.7%) and Malleus (65.6%).

Table 2 showing sites of bony involvement

Site of bone erosion	No of cases
Scutum	27(84.4%)
Ossicles	25(78%)
korners septum	23(71.8%)
Facial canal	6(18.8%)
LSCC	2(6.2%)
Tegmen	13(40.6%)
Sinus plate	4(12.5%)
EAC	3(9.4%)
Mastoid tubercle	24(75%)
Carotid canal	0

Facial nerve canal erosion was seen in 6 cases. Tympanic segment is involved in 5 cases and mastoid segment in one case. Intracranial complication is seen in only one case in the form of temporal lobe abscess. 6 cases show features of cholesteatoma in opposite ear.

Discussion

In our study of 32 cases, all the patients had soft tissue density in middle ear. Bone erosions were found in 31cases. 25 cases (78%) had the soft tissue in nondependent location. In 7 cases (22%), the soft tissue was totally filling the middle ear cavity. Soft tissue mass in middle ear cavity was seen in all the patients in a similar study by Digge et al[9] and it was most commonly found in nondependent location. Gyanu J et al[10]. found that the hallmark of cholesteatoma was soft tissue density alone and/or bony erosion or smooth bony expansion, as it was present in all their study subjects.

The soft tissue was found in the epitympannum and mastoid antrum in all the cases (100%). Mafee et al. mentioned that HRCT could demonstrate cholesteatoma in hidden areas such as posterior tympanic recesses, which could not be detected by the otologic examination[11]. In the study by Gyanu et al. on HRCT, epitympanum and antrum were the commonest sites of cholesteatoma (90% each). Involvment of mesotympanum was there in 45% of the cases and hypotympanum was involved in 40% of the cases studied by them[10]. Aditus and antrum was involved in 78% of the cases in a similar study by Digge et al[9].

In this study, 31 cases (96.8%) showed bone erosions in HRCT. Scutum erosion was the commonest (27 cases-84.4%), followed by the ossicular chain in 25 cases(78%). Abele et al. mentioned that osseous erosion involving the scutum or ossicles is key to distinguishing a cholesteatoma from benign debris or otitis media on CT[12]. Mafee et al[11] and David et al[13] described the criteria indicating cholesteatoma as "blunting of the scutum's normally sharp tip is often the earliest sign of attic cholesteatoma."

Ossicular erosion was found in 25 cases (78%) in this study. Erosion was total in 10 and partial in 15 cases. Incus was the most common ossicle showing erosion (78%), followed by stapes (68.7%) and malleus (65.6%). Long process of incus, by virtue of its limited ligamentous support and poor blood supply was the most common part showing erosion (71.8%). The findings were similar to the study by Gomaa et al[8].,in which the ossicular chain was completely eroded in 57.14% cases. Incus was the most commonly eroded, found in 88.2% of patients, followed by malleus, found in 67.9% cases. Gaurano et al., reported stapes erosion in 65.62% cases on HRCT in a similar study[14].

Facial nerve canal erosion was found in 6 cases (18.7%) in this study. The tympanic segment was eroded in 5 cases. One case showed erosion in the mastoid segment. According to a study by Ávila AFA et al. the most common site of facial canal to erode is its tympanic segment[15]. Though facial canal erosion was seen in 6 cases, only one of them presented with facial palsy in this study. Avila AFA at el. stated in a similar study that the facial nerve canal may be eroded, but the function of the nerve can be spared. Facial palsy occurs only in approximately 1% to 4% of patients with cholesteatoma.

Aditus ad antrum is the superoposterior communication between the attic and the mastoid antrum. When cholesteatoma is present, it may erode its wall and widen the "waistline" (aditus) resulting in the loss of the "figure of 8"[11]. In this study, 29 cases(90.6%) had soft tissue density in the aditus ad antrum. 25 cases(78%) in the study population showed widening of the aditus. Gomaa et al stated that signs indicating cholesteatoma in the attic include erosion or destruction of scutum and widening of the aditus ad antrum with loss of the "figure of 8" appearance[8]. 67% cases in the study by Gaurano et al showed involvement of the aditus and 39.06% had widening of aditus with loss of "figure of 8"[14].

In this study, all the mastoids were sclerotic, possibly due to chronic infection. Mastoid antrum showed soft tissue density in all the cases in this study. Erosion of mastoid trabeculae were noted in 24 cases (75%). Mastoid cortex dehiscence was noted in 4 cases (13%). Sclerotic mastoid was the most common finding encountered in 60.7% cases in a similar study by Gomaa et al[8]. The mastoid antra were replaced by soft tissue densities in 85.9% cases in that study. Mastoid cortex dehiscence was seen in 5% patients in the study by Gyanu J et al[10].

In present study, 6 cases (19%) showed features of cholesteatoma in the opposite ear. The other ear was involved in 10% of the cases in the study by Digge P et al[9]. But Gomaa et al. found opposite ear involvement only in 3.57% cases[8].

Conclusion

Acquired middle ear cholesteatoma is certainly one of the main areas of interest in modern clinical otology. Despite voluminous research on acquired cholesteatoma, knowledge gaps in the understanding of this disease remain. HRCT enables better understanding of the changes occurring in the complex anatomy of temporal bone in patients with acquired middle ear cholesteatoma . It can serve as a road map to assist the surgeon during cholesteatoma surgery and more limited, directed procedures can be done to eradicate the disease while preserving function, thereby avoiding considerable morbidity.

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