DETECTION OF TEMPORAL BONE CHOLESTEATOMA BY MULTIDETECTOR COMPUTED TOMOGRAPHY

Seema Gul[1], Ummara Siddique Umer[2], Shahjehan Alam[3], Syed Ghuas[4], Muhammad Saleem Khan[5], Sarah Javed[6]

[1-4] Department of Radiology, Rehman Medical Institute, Peshawar - Pakistan.
[5] Deputy Director, Public Health Services Academy, Peshawar - Pakistan.
[6] Department of Radiology, Hayatabad Medical Complex, Peshawar - Pakistan.
Address for correspondence:
Dr. Seema Gul
Associate Professor, Department of Radiology, Rehman Medical Institute, Peshawar - Pakistan.
E-mail: dr.seemagul@live.com
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ABSTRACT

Objective: To determine the CT patterns of temporal bone cholesteatoma in patients presenting with chronic discharge from ear.

Methodology: This was a cross-sectional study conducted at Department of Radiology, Rehman Medical Institute Peshawar from January 2013 to June 2014. 78 patients with chronic discharging ear, who were referred from E.N.T outpatient department, were included in the study. All scans were performed on 128 slice Multidetector Computed tomography (MDCT) scanner.0.5mm reconstructed images in bone window and 3mm images in soft tissue window were viewed on 5.1 vitrea workstation in axial, coronal and sagittal planes. The CT studies were correlated with clinical examination findings, surgical and histopathology. Basic radiologic patterns of cholesteatoma described on CT scan were assessed. The data was processed using Microsoft excel 2007.

Results: Cholesteatoma was present in 48 (61%) cases. The disease was bilateral in 7 cases (14 %), 39 (81 %) were unilateral. 25(52%) were left sided and 14 (29%) right-sided. 24 (30 %) patients were characterized as having otomastoiditis whereas 7(8%) patients were radiologically difficult to characterize if they were cholesteatoma or not.

Conclusion: Cholesteatomas can cause bone erosions and should be detected early. The important role of MDCT lies in the early detection of cholesteatoma, and more conservative surgical procedures can be used to eradicate the disease.

Key Words: Cholesteatoma, Temporal Bone, High resolution computed tomography, Multidetector computed tomography

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INTRODUCTION

Cholesteatoma has been recognized clinically and radiologically for many years[1]. There is a typical history of recurrent middle ear infections which cause persistent foul-smelling ear discharge, hearing loss and tympanic membrane perforation. The diagnosis of cholesteatoma is usually made on otologic examination[2]. Cholesteatoma may be either congenital or acquired[3]. The term "cholesteatoma" is controversial. According to its literal transcription, the word derives from "cholesterol" and "tumor", but in truth it is an epidermoid cyst. Cholesterol crystals are not observed in the structure of the lesion which also does not present a tumor-like nature[4,5]. Chronic suppurative otitis media (CSOM) is purulent inflammation of the middle ear cleft[1]. CSOM can be without cholesteatoma that is recognized clinically as safe type, or with cholesteatoma i.e. the unsafe type[6]. The differential diagnoses of a middle ear mass include cholesteatoma, rhabdomyosarcoma, Langerhans cell histiocytoma, squamous cell carcinoma, metastasis, giant cell tumor and xanthoma[4]. Current-generation CT has allowed increased resolution of the structures within the temporal bones and is now considered the investigation of choice[7].

Congenital cholesteatoma originate from embryonic epithelial remains, tend to occur in the anterior tympanic cavity, proximal to the epitympanum or stapes[8]. Acquired cholesteatoma is the main complication of chronic otitis media[1,4]. It is more common than the congenital type. The cardinal feature of this disease on CT is temporal bone erosion. It has an osteolytic potential, which may be explained by the presence of collagenase in the lesion periphery, since collagen is the main protein of the bone tissue[4,5,8]. They may occur in the pars flaccida (82%) and pars tensa (18%), extending towards the Prussak's space[9]. Because of its location in the Prussak's space, acquired cholesteatomas of the pars flaccida generally displace the malle-

us head and the body of the incus medially. From the Prussak's space, the mass can easily extend itself posteriorly in the superior incudal space towards the posterolateral portion of the attic, and then, through the aditus ad antrum, towards the antrum and the mastoid air cells[10]. The diagnosis of cholesteatoma is based on clinical evaluation (otoscopy), where retraction of the tympanic membrane with pars flaccida perforation and a whitish mass in the middle ear are observed[11]. The ability of Multidetector Computed Tomography (MDCT) to predict accurately the status of the structures of the temporal bone represents a major advance in delineating pathology prior to surgical exploration of ears with cholesteatoma[12]. MDCT is considered the imaging method of choice in the evaluation of middle ear cholesteatoma. Magnetic resonance imaging (MRI) has gained importance in the evaluation of complicated cholesteatoma and in the postoperative follow-up of patients to evaluate residual or recurrent cholesteatoma[4,5]. Role played by preoperative CT imaging is evaluation of lesion extent (attic, antrum and mastoid); detection of complications, such as bone lysis and cerebromeningeal complications; and detection of anatomical variations (jugular dehiscence and lateralized sinus). Special attention should be given to the tympanic sinus and to the facial recess, since they are locations whose visualization is difficult during the surgery, and are frequent sites of residual disease.

METHODOLOGY

This was a cross-sectional study conducted at Department of Radiology, Rehman Medical Institute Peshawar from January 2013 to June2014. We retrospectively collected 78 patients with chronic discharging ear, who were referred from E.N.T outpatient department. Clinically patients were with either a marginal tympanic membrane perforation or a tympanic membrane inadequately visualized owing to the presence of granulations or squamous debris in the external auditory meatus. All scans were performed on 128 slice Multidetector Computed tomography (MDCT) scanner in the Department of Radiology, Rehman Medical Institute Peshawar.0.5mm reconstructed images in bone window and 3mm images in soft tissue window were viewed on 5.1 vitrea workstation in axial, coronal and sagittal planes. Non-contrast CT was adequate. Intravenous contrast medium was only given in those patients with suspicion of intracranial extension. The data was processed using Microsoft excel 2007. The CT findings were compared with clinical examination findings, surgical and histopathological results. The pre-operative CT scans were reported to assess characteristic cholesteatoma findings, location and extension of soft tissues in middle ear, integrity of scutum, erosion of the ossicular chain, integrity of the thin bony septum of facial nerve canal, the semicircular canals and the tegmen, extension of cholesteatoma outside the middle ear, integrity of mastoid air cells, trabeculae, as well as relationship and proximity of soft tissues with the tympanic membrane were assessed.

Radiological signs indicating cholesteatoma in the attic included erosion or destruction of scutum or spur (the lateral wall of the attic), widening of the aditus ad antrum (loss of figure of "8" appearance) , antral wall erosions and widening , ossicular erosions and destruction , medial attic wall erosion which may lead to facial nerve canal involvement, which may cause paresis or paralysis , erosion of the lateral semicircular canal which may result into fistula formation (Figure 1), dehiscence of tegmen tympani , dehiscence of sigmoid sinus plate, erosion of the external auditory canal (EAC), and automastoidectomy.

RESULTS

Cholesteatoma was present in 47 (60%) cases. The disease was bilateral in 19 % and 81 % were unilateral (Table1 & 2). 25 (52%) cholesteatomas were left sided and 14 (29%) right-sided (Figure.2). Middle ear cholesteatoma was seen more in males (Males=24, females=23). 24 (30 %) patients were reported as CSOM (Figure.4) whereas 7(8%) patients were radiologically difficult to characterize if they were cholesteatoma or not. 14 cases were proven on post-operative histopathology. Geographic origin and age distribution of patients with cholesteatoma is shown in table 1. Location and extent of cholesteatoma is shown in table 2. Middle ear bony wall erosion is shown in table 3. Incidental non-related findings are shown in table 4.

DISCUSSION

Chronic otitis media still prevails as one of the most common otological problems encountered worldwide especially in the developing countries. Due to the penury in these parts of the world, neglect of the disease causes progression to cholesteatoma formation and complications. Modern high-resolution multidetector computed tomographic scans (MDCT) have allowed for earlier diagnosis when signs and symptoms are present[13,14]. CT produces excellent images of middle ear soft-tissue masses and appears to be the diagnostic method of choice for cholesteatomas[15]. CT images provide a more precise definition of the anatomic extent of the disease of the middle ear and the relationship of cholesteatoma masses to the contiguous structures. There is typically a history of recurrent middle ear infections, some with tympanic membrane perforation[16]. Acquired cholesteatoma may occur at any age but are more commonly seen in patients less than 30 years of age[16]. Our CT findings have shown that cholesteatoma (n=47) had highest incidence in the age group 10-20 years. These composed of 24 males and 23 females. A

Table 1: Age distribution of patients with cholesteatoma

Age group	Number of patients
10 to 20	19
21 to 30	12
31 to 40	7
41 to 50	7
51 to 60	1
61 to 70	0
71 to 80	1
Total	47

Table 2: Location and extent of cholesteatoma

Location and extension	No. of patients
Attic	45
Attico-antral	45
Middle ear cavity	47
Isolated prussac space involvement	2

Table 3: Middle ear bony wall erosion

Bony wall erosion	No. of patients
Blunted scutum	47
Eroded scutum and lateral attic wall	47
Eroded tegmen	2
Thinning of the tegmen	25
Eroded sigmoid sinus plate	1
Eroded superior and posterior meatal wall With External auditory canal involvement	9
Fistula formation	7

Table 4: Incidental non-related findings

Incidental non-related findings	Number of Patients
Sinusitis	12
Polyp	4
Brain infarct	1

study done by Kemppainen et al also showed that the incidence of cholesteatoma was higher among males under the age of 50 years[8] . One of the important advantages of the CT scan is the detection of early cholesteatoma with subtle bony erosion or ossicular displacement. This early detection by CT scan with the use of a simple noninvasive surgical technique (atticotomy) can preserve hearing. In our study, early Prussak's space cholesteatoma was detected in 2 patients as a localized small soft tissue density mass slightly eroding the scutum and displacing the ossicles medially.

In cases in which the diagnosis is not obvious on otological examination, CT is helpful in demonstrating a soft tissue mass with characteristic ossicular displacement and erosion of bone. Cholesteatoma in hidden areas, such as the posterior tympanic recess, may be revealed by CT even if it is not detected by otologic

Figure 1: 50 years old female with left chronic otomastoiditis. 0.5mm MDCT coronal reformatted image of the petrous bone. There is evidence of abnormal soft tissue density involving the left middle ear cavity and extending into left external auditory canal. Scutum tip is preserved.

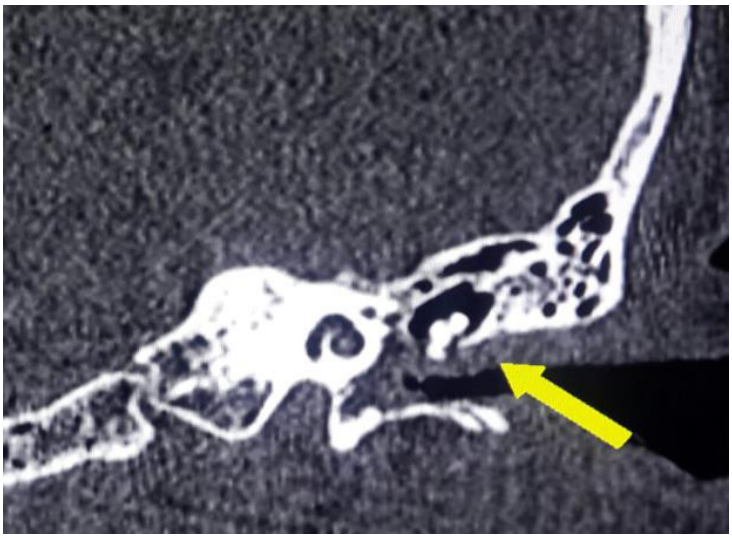

Figure 2: Coronal reformat of an adult patient with chronic right ear discharge. CT image reveals atico-antral opacification of right temporal bone with involvement of middle ear cavity. The scutum tip is relatively blunt and raised strong suspicion of cholesteatoma.

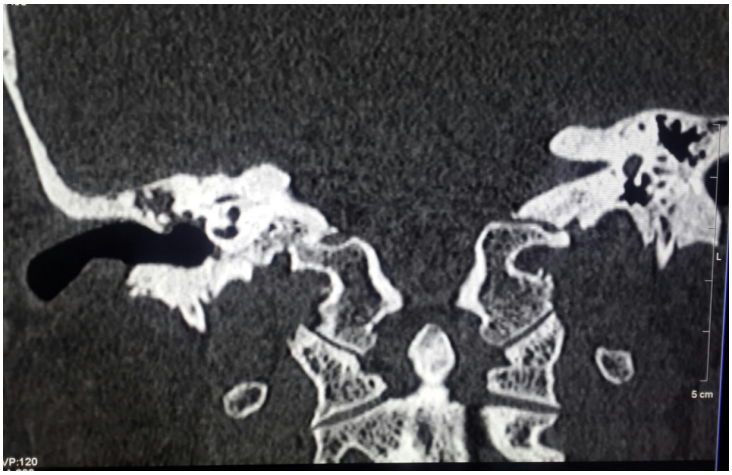

Figure 3: Right attico antral cholesteatoma. MDCT examination of the petrous bone. Axial section revealed evidence of abnormal soft tissue density involve the right middle ear cavity.The lesion extended through the attic with widening of its opening and thinning of the roof of the left middle ear cavity. The bony ossicles are not visualized in this image.

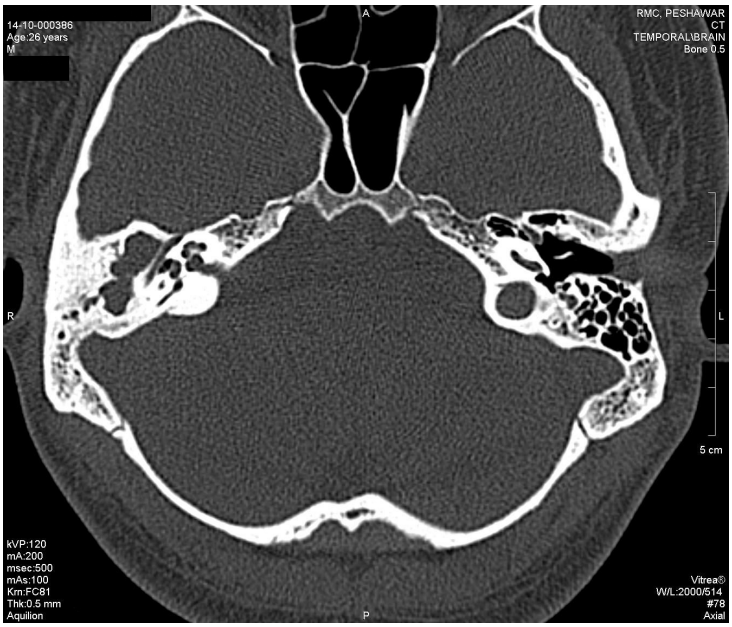

Figure 4: High resolution CT examination of petrous bone. Coronal reformat reveals completely opacified right epitympanum with bony erosion of antero-lateral wall of antrum with extension of soft tissues via widened aditus into the middle ear cavity and prusac's space. Ossicles are partly eroded and being displaced medially.

Figure 5: Right focal cholesteatoma. MDCT Coronal reformat showing a well-defined radical cavity involving the right mastoid, connected with the middle ear cavity with marked expansion of the aditus ad antrum, mastoid antrum and epitympanic cavity. There is blunted scutum tip (arrow). Left sided normal sharp scutum tip seen.

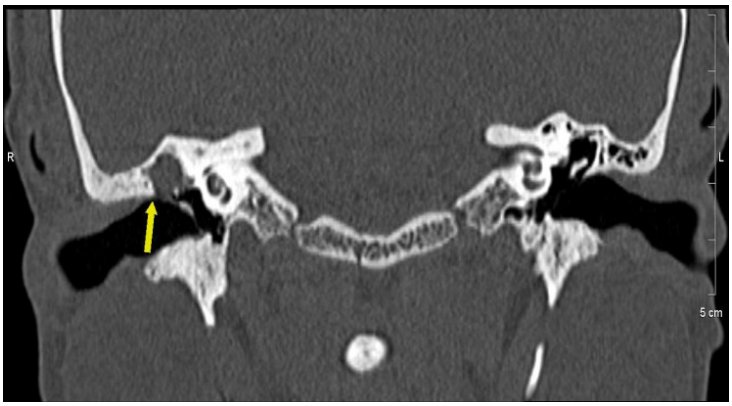

Figure 5a

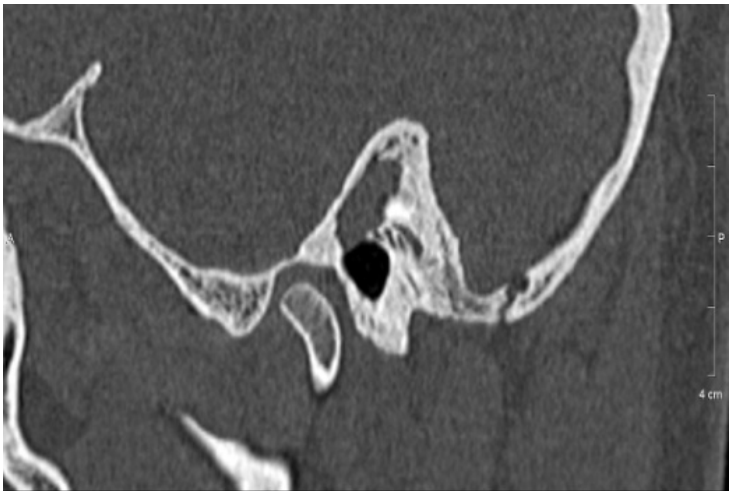

Figure 5b

examination. CT scan also provide information about congenital anatomic variations that may be encountered during surgery, as well as the complications of cholesteatoma[17]. The hallmarks of cholesteatoma are the presence of soft tissue density in the middle ear cavity, ossicular erosions, smooth erosions of the middle ear borders and adjacent structures. These changes, when associated with bony expansion of the middle ear cavity, are highly suggestive of cholesteatoma[9]. MDCT is most valuable for detection of early erosive changes in the ossicles, particularly in the smaller parts, as well as in the detection of non-dependent soft tissue opacification suggestive of cholesteatoma[15]. Our study demonstrates that CT findings (Figures 2, 3, 4& 5) that suggest a diagnosis of middle ear cholesteatoma consist of i) non-dependent or completely opacifying polypoidal soft tissue densities in the middle ear cavity and antrum (focal, partial or total), ii) with associated expansion and smooth erosion of the walls, iii) blunted or eroded scutum tip iv) ossicular displacement or erosions. These features are almost similar to those described in the literature[13,17,18]. The only difference is that in our study we considered involvement of scutum as a separate entity for a very high suspicion for cholesteatoma. Mafee et al[17] and David et al[19] described the criteria indicating cholesteatoma as blunting of the scutum's normally sharp tip as often the earliest sign of attic cholesteatoma[17,19]. Joselitol et al also stated that signs indicating cholesteatoma in the attic include erosion or destruction of scutum and widening of the aditus andantrum with loss of the Figure 8 appearance[9].

Because cholesteatoma is commonly a complication of CSOM, there is almost always co-existing inflammatory disease in adjacent mastoid air cells[13]. Our study

demonstrates this in all patients. CSOM without cholesteatoma is indicated on CT when air cells appear opaque by soft tissue or fluid densities but maintain their normal trabecular pattern or whenever there is obliteration of mastoid antrum and periantral cells by increased reactive bone formation/sclerosis[17]. In our series, 24 patients had these CT features. These were confidently labeled as CSOM. Complete opacification of the middle ear with no bony destruction makes radiologic differentiation of cholesteatoma from middle ear effusions and granulation tissue difficult, if not impossible[13,18]. The presence of an air-fluid level or a soft tissue (fluid) mass in the dependent portion of the middle ear would render support to a diagnosis of effusion. When CT features of cholesteatoma present with an air fluid level, possibility of infected cholesteatoma should be considered[13]. One of our patients had these features. In our series, non-dependent, homogeneous and polypoidal soft tissue densities were present in the mastoid antrum and middle ear cavity. In some of our cases (n=7), soft tissues occupied all spaces at the time of CT study with antral expansion, abutting the ossicular chain and bulging into the external auditory meatus. These patients were considered as having equivocal features with possibility of CSOM and ± possibility of associated cholesteatoma. Many of the patients have both granulation tissue and cholesteatoma, which cannot be radiographically distinguished[17]. Our study showed that all patients with cholesteatoma had at least one of the CT criteria indicating cholesteatoma, and 47 patients showed all features of radiological findings of cholesteatoma. Chee et al concluded in their series of 36 patients that 34 patients (94.4%) had been correctly diagnosed by CT[12]. Joselito et al reported in their series of 64 patients that the analysis of the preoperative CT scan correlated with the surgical findings and histopathologic reports with a high degree of accuracy (96.8%)[9]. In our study, 14 cases were later on proven on biopsy. Rest of the CT diagnosed cholesteatoma cases were either operated in another center or didn't come for follow up visit. Ossicular chain erosion occurred in 8 patients. The literature presents higher frequency, with sensitivity ranging from 80% to 100%[21]. El-Essawy et al[22] in a series of 32 cases concluded that temporal bone complications including bone erosion and cavity formation were seen in all patients with cholesteatoma (100%) which is similar to our study; sclerosis of the mastoid and ossicular destruction were seen in 93.81% of patients whereas in our study ossicular chain destruction was seen in 17% of cases. Palva and fellows concluded in their study that the labyrinthine fistula may occur in 10% of patients with chronic ear infection due to cholesteatoma[23]. Our study did not detect any labyrinthine fistula on CT images. Joselito et al stated that preoperative demonstration of facial nerve canal involvement was often difficult not only because of the small size of the facial nerve canal but also due to its oblique orientation and the presence of developmental dehiscence, particularly when abutted by the soft tissue[9]. CT analysis shows anatomic structure implicated in cholesteatoma damages[20]. Preoperative computed tomography is necessary for the diagnosis and the evaluation of chronic middle ear cholesteatoma in order to show extending lesion and to detect complications[20]. Cholesteatoma can be accurately diagnosed by CT scan. Mafee et al reported in his series of 48 patients with cholesteatoma that 46 of them (96%) were diagnosed correctly using preoperative CT scans[17]. MDCT is highly accurate to demonstrate the presence of abnormal tissue in the middle ear and mastoid, with sensitivity ranging between 70% to 96% [8,9]. But one of its limitations is that it cannot define if the tissue is inflammatory, fibrotic or cholesteatoma. However, the presence of bone erosion of structures such as scutum, ossicular chain, tympanic tegmen, bone labyrinth and lateral wall of the attic, is strongly indicative of cholesteatoma. At times, the differential diagnosis between CSOM and cholesteatoma cannot be accurately done with MDCT, since the radiological findings are very similar and many times overlap each other. In such cases, histopathological workup is necessary[4].

CONCLUSION

Patients with chronic discharging ear cholesteatoma should be scanned using MDCT scanner as many relevant structures are best seen in multiplanar images and it is helpful in diagnosing characteristic findings of cholesteatomas. MDCT is a unique method of detection of early cholesteatoma as well as detection of cholesteatoma in hidden areas. CT scanning serves as a road map to assist the surgeon during cholesteatoma surgery. With the more prevalent use of CT, considerable morbidity may be avoided.

RECOMMENDATION

We recommend that the study should be done on large number of patients with a proper follow up as well as at multiple centers.

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CONTRIBUTORS

SG conceived the idea, planned the study, and drafted the manuscript. USU, SA, SG and SJ helped acquisition of data and did statistical analysis. MSK drafted and critically revised the manuscript. All authors contributed significantly to the submitted manuscript.