Limits of conventional temporal bone computed tomography in the management of cholesteatoma otitis media: Report of 96 cases

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Introduction
Cholesteatoma is a dangerous chronic otitis media, with keratine accumulation causing bone erosion and invasive damages. Computed tomography (CT) is commonly indicated to evaluate the extension and the complications of cholesteatoma.

Materials and methods
In 96 patients with cholesteatoma otitis, preoperative CT data were compared with surgical findings using the sensitivity, specificity, and the predictive value of a CT-scan for anatomical structures.

Results
A CT scan offers an adequate anatomical conformation of the tympanomastoid cavities. The lysis of the tegmen (Se = 61%, Sp = 79%) and the erosion of the scutum (Se = 100%, Sp = 51%) are well visualized on coronal sections. CT is very sensitive to objective ossicular chain lysis (Se = 90%) but with a low specificity (Sp = 71%). The performance of CT in the facial canal erosion (Se = 45%, Sp = 78%) and in the labyrinthine fistulae (Se = 46%, Sp = 98%) was insufficient with the conventional scanning machine used.

Conclusion
A CT-scan should be a routine exam before cholesteatoma surgery, but with improved resolution, and therefore sensitivity, to characterize all middle ear structures and complications of the disease.

Keywords:
cholesteatoma, computed tomography, predictive value, sensitivity, specificity

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Introduction

Cholesteatoma of the temporal bone usually occurs in the middle ear and can cause serious intrapetrous complications [1,2]. This dangerous disease results from ingrowth of keratinizing squamous epithelium from the external to the middle ear [3]. Bone resorption is still the most characteristic feature of this chronic otitis media [4]. To date, temporal bone CT-scan is the preferred radiological exam to precisely determine, preoperatively, the extension of the disease and petrous bone complications [4–6].

Materials and methods

We present a retrospective study, carried out over a period of 12 years (2001–2012), of 96 patients followed and treated for cholesteatomatous otitis media at the ENT Department of the Military Hospital of Tunis, Tunisia. All the patients benefited from a temporal bone CT-scan in the coronal and axial planes before surgery. In order to precisely determine the real performance and limits of CT-scan in the preoperative workup, we performed a correlation between the radiological data and the surgical findings using the sensitivity (Se), specificity (Sp), positive predictive value (PPV), and negative predictive value (NPV) for many factors.

Scans were performed using the Siemens Somatom Plus 4 (Technical Prospects, Siemens Medical Parts Provider, Appleton, WI, USA). Parameters applied included 512 matrix, 200 field of view, 1 mm section thickness (contiguous slices), fast scan mode, beam hardening correction, 140 kV, and 94 mA exposure.

Results

Our study included 35 men and 25 women. Their mean age was 35 years (12–64). Cholesteatoma was diagnosed through an otoscopic examination and all the patients benefited from a temporal bone CT-scan before surgery to evaluate the extension of the disease and to look for intrapetrous or extrapetrous complications. The main abnormalities found were ossicular lysis (81%), tegmen tympani erosion (28%), scutum lysis (61%), labyrinthine fistula (8%), and Fallopian canal erosion (27%).

Scutum erosion is valuable in the diagnosis of attic cholesteatoma. It was used by the radiologist in 59 cases

and verified peroperatively in 24 cases (Fig. 1). CT-scan has an excellent sensitivity to determine this complication (100%), but with a low specificity (51%) as scutum lysis can occur in simple chronic otitis media (Table 1).

Preoperative CT-scan also provides information about temporal bone anatomic conditions and variants that may incur additional surgical risks. Superficial or prolapsed sigmoid sinus and/or meningeal dehiscence are considered anatomic difficulties (AD) for the surgical approach. The sensitivity of CT-scan in the detection of these abnormalities is 83% (Table 2). This sensitivity is lower for tegmen tympani lysis (Fig. 2 and Table 3).

CT-scan objected an ossicular chain lysis (OCL) in 81% of the cases (Fig. 3). The incus, the stapes, and the malleus were involved, respectively, in 91, 82, and 75% of the cases. The sensitivity of CT-scans were sensitive for visualization of OCL (Se = 90%). However, as ossicular lysis is frequent even in simple chronic otitis media, the specificity of CT-scan is relatively low (71%) (Table 4).

The fallopian canal was eroded in 23% of our patients (Fig. 4). It seems that CT-scan is not very sensitive in showing this complication (Se = 45%). Yet, when used by the radiologist preoperatively, Fallopian canal

Table 1 Scutum lysis

	Scutum lysis (CT-scan)	Absence of scutum lysis (CT-scan)	Total	
Scutum lysis (peroperative)	24	0	24	Se=100%Sp=51%PPV=41%NPV=100%
Absence of scutum lysis (peroperative)	35	37	72	
	59	37	96	

CT, computed tomography; NPV, negative predictive value; PPV, positive predictive value; Se, sensitivity; Sp, specificity.

Table 2 Anatomic difficulties

	AD (CT-scan)	Absence of AD (CT-scan)	Total	
AD (peroperative)	24	4	28	Se=85%Sp=65%PPV=50%NPV=92%
Absence of AD (peroperative)	24	44	68	
	48	48	96	

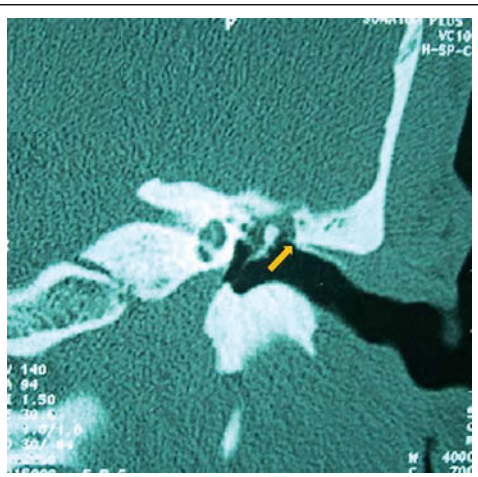
AD, Anatomic difficulties; CT, computed tomography; NPV, negative predictive value; PPV, positive predictive value; Se, sensitivity; Sp, specificity.

Table 3 Lysis of tegmen tympani

	Lysis of TT (CT-scan)	Absence of lysis of TT (CT-scan)	Total	
Lysis of TT (peroperative)	11	7	18	Se=61%Sp=79%PPV=41%NPV=90%
Absence of lysis of TT (peroperative)	16	62	78	
	27	69	96	

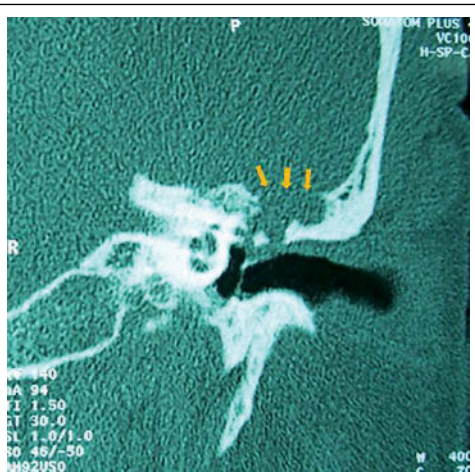
CT, computed tomography; NPV, negative predictive value; PPV, positive predictive value; TT, tegmen tympani; Se, sensitivity; Sp, specificity.

Figure 1



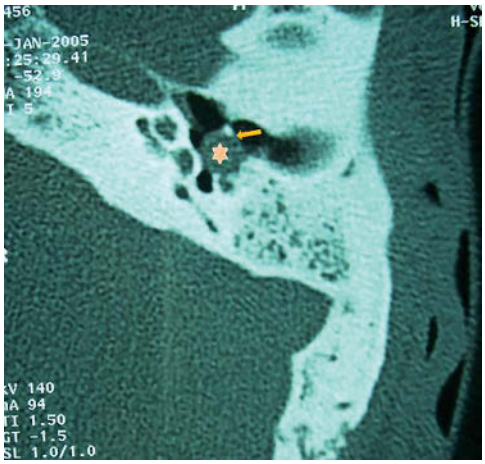
Lysis of the scutum (arrow).

Figure 2



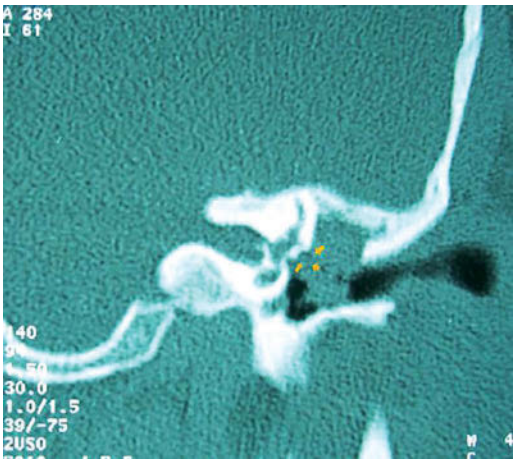
Lysis of the tegmen (arrows).

Figure 3



Spherical mass of the antrum highly suggestive of cholesteatoma (star) with contiguous lysis of the uncus (arrow).

Figure 4



Erosion of the second portion of the facial nerve canal (arrows).

Table 4 Ossicular chain lysis

	OCL (CT-scan)	Absence of OCL (CT-scan)	Total	
OCL (peroperative)	74	8	82	Se=90%Sp=71%PPV=95%NPV=56%
Absence of OCL (peroperative)	4	10	14	
	78	18	96	

CT, computed tomography; NPV, negative predictive value; OCL, ossicular chain lysis; PPV, positive predictive value; Se, sensitivity; Sp, specificity.

Table 5 Fallopian canal erosion

	FCE (CT-scan)	Absence of FCE (CT-scan)	Total	
FCE (peroperative)	10	12	22	Se=45%Sp=78%PPV=38%NPV=83%
Absence of FCE (peroperative)	16	58	74	
	26	70	96	

CT, computed tomography; FCE, fallopian canal erosion; NPV, negative predictive value; PPV, positive predictive value; Se, sensitivity; Sp, specificity.

erosion is often confirmed during surgery (Sp = 78%) (Table 5).

Finally, we found, during surgery, a lysis of the lateral semicircular canal (LSCC) in 13% of our patients (Fig. 5). CT-scan showed this complication in only eight patients (Se = 46%), but with an excellent specificity (98%) (Table 6).

Discussion

Abnormal extension of the keratinizing epithelium of the external acoustic meatus into the middle ear cavity through the tympanic membrane is considered to be the main cause of middle ear cholesteatoma [1,5]. This dangerous disease can also be because of a squamous epithelium trapped within the middle ear during embryogenesis. Resulting in congenital cholesteatoma [7]. Ingrowths of cholesteatoma result in erosion of the surrounding bony structures. Bony erosion is related to the combined effects of the cholesteatoma mass and collagenase activity [3]. The possible consequences of such an osteolysis are complications including ossicular destruction, automastoidectomy, meningitis, dural sinus thrombosis, facial nerve palsy, labyrinthine fistula, and extension to the petrous bone [5,6]. For several years, imaging of the ear has been a routine test in the preoperative workup of the disease and most recent reports recommend a CT-scan as part of the preoperative workup in middle ear cholesteatoma [3,8,9]. CT-scan imaging allows a comprehensive preoperative evaluation of the anatomic variations and bone details of the middle ear as well as the ossicular chain and soft tissue [10–12].

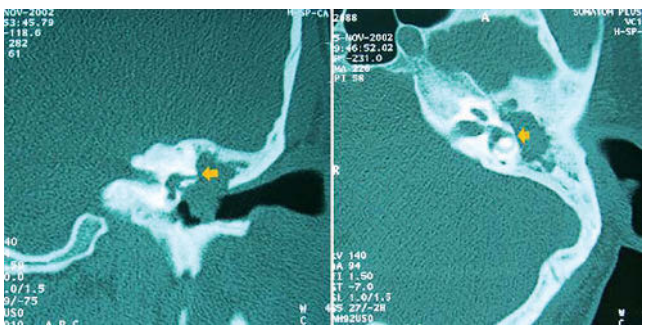
In our study, we attempted to precisely determine

Table 6 LSCC lysis

	LSCC lysis (CT-scan)	Absence of LSCC lysis (CT-scan)	Total	
LSCC lysis (peroperative)	6	7	13	Se=46%Sp=98%PPV=75%NPV=92%
Absence of LSCC lysis (peroperative)	2	81	83	
	8	88	96	

CT, computed tomography; NPV, negative predictive value; PPV, positive predictive value; Se, sensitivity; Sp, specificity.

Figure 5



Lysis of the lateral semicircular canal with labyrinthine fistula (arrows) in coronal (a) and axial (b) view.

the performance of CT-scan in different temporal bone variations and complications in the presence of cholesteatoma. Thus, a correlation was performed between preoperative radiological data and surgical findings using four statistical tests: sensitivity (Se), specificity (Sp), PPV, and NPV.

The most frequent radiological signs of cholesteatoma are middle ear mass and bony lysis [1].

Our comparison of radiological and surgical findings, it was found that CT-scan yields, overall, an adequate anatomical confirmation of the tympanomastoid cavities.

For the lysis of the tegmen tympani, which is a thin bony roof, radiological data seem imprecise, requiring thinner CT-scan slices on coronal sections [1,4,13].

In contrast, the lysis of the scutum, which represents a thick bony relief, is well visualized in frontal CT-scan images [4,14].

For middle ear content, CT seems to be the examination of choice for identifying areas of osteolysis and screening for the main complications associated with cholesteatoma [8]. The predictive value of CT-scan depends on the anatomic structure studied.

Even if OCL is frequent in cholesteatoma otitis, it remains nonspecific and can be found in other forms of chronic otitis media [1,4]. Fine structures of the auditory ossicles could be delineated clearly in the images reconstructed using the multislice scan CT, which allows a slice thickness of 0.5 mm [15]. High-resolution computed tomography (HRCT) is most valuable for the detection of early erosive changes in the ossicles, particularly in the smaller parts such as the incudostapedial junction [13].

The erosion of the Fallopian canal along its pathway through the temporal bone, especially of the tympanic segment of the canal, may be difficult to interpret [8]. In our study, the sensitivity of CT-scan to objective a Fallopian canal erosion was 42%. High-resolution inframillimetric CT slices and complete immobilization of the head of the patient during radiological exploration are necessary for an accurate and complete study of the facial nerve canal [11,12,14]. To clearly visualize this part of the canal, coronal images must be analyzed meticulously [12].

Labyrinthine fistulae because of LSCC erosion complicate cholesteatoma in 5–20% of the cases [2,16–18]. This canal is the most frequently eroded because of its close proximity to the medial wall of the attic anatomically.

The bony lysis of the LSCC can be either cortical or total and necessitates the combination of coronal and axial inframillimetric slices to appreciate it to avoid a false impression of a labyrinthine fistula [8,13,19,20]. A comparative study with the controlateral temporal bone may be helpful to avoid false-positive results [11,12,21]. For our patients, the sensitivity of CT-scan was 50% but with a good PPV (80%).

For the assessment of all these variations and abnormalities, an adequate technique and a good radiologic interpretation of temporal bone CT-scan are needed.

In our study, we used a conventional CT-scan with 1 mm section thickness. However, the middle ear structures are very small and fine; thus, a HRCT with inframillimetric slices may offer a best topographic study [22]. HRCT has clearly shown its superiority in the evaluation of the temporal bone, particularly utilizing thin-section, high-resolution techniques. HRCT provides a more precise definition of the anatomic extent of the disease of the middle ear and

the relationship of these cholesteatoma masses with the contiguous structures [13].

Conventional CT-scans also have other limitations and usually cannot differentiate a cholesteatoma from granulation tissue, pus, and fluid, which are present in chronic otitis media without the presence of a cholesteatoma [23].

In some cases, CT assessment should be supplemented by MRI when meningocephalic infection, intracranial extension, or sigmoid sinus thrombosis is suspected. Depending on the clinical presentation, venous angio-MRI or venous angio-CT may be used to detect sigmoid sinus thrombosis [24]. In addition, a number of articles in the literature suggest that diffusion-weighted MRI may be able to distinguish between recurrent or persistent middle ear cholesteatoma and to differentiate scar tissue from granulation tissue [25,26].

Conclusion

CT scanning must be systematic in the preoperative workup of cholesteatomatous otitis media. By improving its resolution, CT may offer an excellent topographic study of the tympanomastoid cavities and the middle ear structures.

Acknowledgements

Conflicts of interest

None declared.

References

1 Ayache D, Schmerber S, Lavieille JP, Roger G, Gratacap B. Middle ear cholesteatoma. Ann Otolaryngol Chir Cervicofac 2006; 123:120-37.

2 Robert Y, Dubrulle F, Carcasset S, Hennequin C, Gaillandre L, Vanecloo FM, Lemaitre L. Petrous bone extension of middle-ear acquired cholesteatoma. Acta Radiol 1996; 37:166–170.

3 Tran Ba Huy P. Chronic otitis media. Natural history and clinical features. EMC Otorhinolaryngol 2005;2:26-61.

4 Zylberberg F, Williams MT, Ayache D, Piekarski JD. CT-scan of middle ear cholesteatoma. Feuillets Radiol 2000; 40:48-57.

5 M François. Complications of acute and chronic otitis media. EMC Otorhinolaryngol 2005; 2:92–106.

6 MT Williams, D Ayache. Imaging in adult chronic otitis. J Radiol 2006; 87:1743–1755.

7 Chung J, Cushing SL, James AL, Gordon KA, Papsin BC. Congenital cholesteatoma and cochlear implantation: implications for management. Cochlear Implants Int 2013; 14:32–35.

8 Ayache D, Darrouzet V, Dubrulle F, Vincent C, Bobin S, Williams M, Martin C, French Society of Otolaryngology Head and Neck Surgery (SFORL). Imaging of non-operated cholesteatoma: clinical practice guidelines. Eur Ann Otorhinolaryngol Head Neck Dis 2012; 129:148–152.

9 Yates PD, Flood LM, Banerjee A, Clifford K. CT scanning of middle ear cholesteatoma: what does the surgeon want to know? Br J Radiol 2002; 75:847–852.

10 Park MH, Rah YC, Kim YH, Kim JH. Usefulness of computed tomography Hounsfield unit density in preoperative detection of cholesteatoma in mastoid ad antrum. Am J Otolaryngol 2011; 32:194–197.

11 Silver AJ, Janecka I, Wazen J, Hilal SK, Rutledge JN. Complicated cholesteatomas: CT findings in inner ear complications of middle ear cholesteatomas. Radiology 1987; 164:47–51.

12 Vasdev A, Boubagra K, Lavieille JP, Bessou P, Lefournier V. Computerized tomographic images of secondary cholesteatomas of the middle ear and the petrous bone. J Neuroradiol 1994; 21:181–193.

13 Gaurano JL, Joharjy IA. Middle ear cholesteatoma: characteristic CT findings in 64 patients. Ann Saudi Med 2004; 24:442–447.

14 Fraysse B, Furia F, Manelfe C, Prère J, Azan L, Fayad J. CT-scan and cholesteatoma. Rev Laryngol Otol Rhinol 1987;108:467-71.

15 Urano K, Nakayama K, Miyashita H, Isono M, Hijii Y, Murata K. Evaluation of reconstructed 3-D images of the middle ear using multi-slice scan CT. Int Congress Series 2003; 1240:1487–1490.

16 Fuse T, Tada Y, Aoyagi M, Sugai Y. CT detection of facial canal dehiscence and semicircular canal fistula: comparison with surgical findings. J Comput Assist Tomogr 1996; 20:221–224.

17 Gersdorff MC, Nouwen J, Decat M, Degols JC, Bosch P. Labyrinthine fistula after cholesteatomatous chronic otitis media. Am J Otol 2000; 21:32–35.

18 Parisier SC, Edelstein DR, Han JC, Weiss MH. Management of labyrinthine fistulas caused by cholesteatoma. Otolaryngol Head Neck Surg 1991; 104:110–115.

19 Romanet P, Duvillard C, Delouane M, Vigne P, De Raigniac E, Darantiere S *et al.* Labyrinthine fistulae and cholesteatoma. Ann Otolaryngol Chir Cervicofac 2001;118:181-6.

20 Soda-Merhy A, Betancourt-Suárez MA. Surgical treatment of labyrinthine fistula caused by cholesteatoma. Otolaryngol Head Neck Surg 2000; 122:739–742.

21 Gordon AG. Cholesteatoma, cerebrospinal fluid leakage, and chronic otitis media. Otol Neurotol 2006; 27:1205, author reply 1205

22 Vignaud J, Marsot-Dupuch K, Derosier C, Cordoliani YS, Pharaboz C. Imaging of the inner ear.Fr J Otorhinolaryngol 1994; 43:31-9.

23 Manolis EN, Filippou DK, Tsoumakas C, Diomidous M, Cunningham MJ, Katostaras T, *et al.* Radiologic evaluation of the ear anatomy in pediatric cholesteatoma. J Craniofac Surg 2009; 20:807–810.

24 DM Fahmy, SM Ragab. Detection of post operative residual cholesteatoma using PROPELLER DWI combined with conventional MRI. Egypt J Radiol Nucl Med 2012; 43:543–548.

25 Vercruysse JP, De Foer B, Pouillon M, Somers T, Casselman J, Offeciers E. The value of diffusion-weighted MR imaging in the diagnosis of primary acquired and residual cholesteatoma: a surgical verified study of 100 patients. Eur Radiol 2006; 16:1461–1467.

26 Szymański M, Trojanowska A, Szymańska A, Morshed K. The use of MRI DWI-imaging in assessment of cholesteatoma recurrences after canal wall up technique [in Polish]. Otolaryngol Pol 2012; 66:45–48.