

Application of high resolution computer tomography in external ear canal cholesteatoma diagnosis

Yubin Chen, Peng Li*

Department of Otolaryngology Head and Neck Surgery, The Third Affiliated Hospital of Sun Yat-Sen University, Guangzhou, 510630, PR China

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Abstract

Objective: To evaluate High Resolution Computer Tomography (HRCT) in the diagnosis of external ear canal cholesteatoma.

Methods: In this retrospective study, HRCTs of 27 patients with external ear canal cholesteatoma were reviewed. The changes in the external ear canal, tympanic membrane (TM), scutum, tympanum and mastoid were measured and categorized.

Results: Fourteen patients showed no or mild destruction in the external ear canal (stage I group). Eight patients had obvious enlargement in the external ear canal (stage II group) but showed limited destructions of the mastoid bone and no damage of the tympanums. Five patients had serious destruction of the mastoid bone and damage of the tympanum (stage III group). All patients in the stage III group showed a compression of manubriums and TMs, with 3 having damages on ossicular chain. Bone destruction of the vertical section of facial nerve canal was discovered in one case in the stage III group.

Conclusion: HRCT can provide detail information about the extent of external ear canal cholesteatoma. Such information can be used to identify special situations with serious complications and to differentiate external ear canal cholesteatoma from middle ear cholesteatoma.

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Keywords: External ear canal; Cholesteatoma; Computer tomography

External ear canal cholesteatoma (EECC), also known as obstructive keratosis, has an incident rate of 0.1% worldwide (Anthony and Anthony, 1982). In China, the incident rate of EECC is much higher because Chinese has relatively longer and narrower external ear canal than European or American. EECC usually occurs in adults with equal incident rates for both men and women. Single-ear involvement is more common (Xie et al., 2010; Xue, 2009). Since this disease is destructive and can invade the middle ear causing hearing damages, external ear canal cholesteatoma is easily confused with middle ear cholesteatoma during clinical diagnosis. High-Resolution Computer Tomography (HRCT) offers structure

images with high resolution and accurate anatomical positioning. It can provide important image information of external ear canal cholesteatoma for accurate diagnosis, better choice of surgical approach, and better prognostic assessment. In this study, we reviewed the HRCT image features of external ear canal cholesteatoma for patients treated at our hospital over the past a few years.

1. Materials and methods

1.1. Clinical data

Twenty-seven patients with external ear canal cholesteatoma who were treated at the 3rd affiliated hospital of Sun Yat-Sen University during the period between March 2008 and March 2011 were retrospectively evaluated in this report. The diagnosis of all cases was confirmed by pathology after

* Corresponding author.

E-mail address: lp76@163.net (P. Li).

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surgery. Among those 27 cases, 10 were males and 17 were females, with the age ranging from 21 to 45 years and the median age of 36.4 years. The duration of disease was 1–5 years.

1.2. CT examination

CT 320 from Toshiba in Japan was used. Tube voltage was set at 135 kv, tube current was set at 350 mA and the slice thickness was 0.5 mm. The scanned images were sent directly to the workstation for multi-planar reconstruction and three-dimensional reconstruction.

1.3. Clinical classification

According to Holt staging (Holt, 1992), there are three stages for external ear canal cholesteatoma progression. Stage I is characterized by local pit in the external ear canal bone, but stage I has no or mild expansion and no destruction in tympanic membrane. Stage II is characterized by local pouch formation in external ear canal, with significant expansion and severe destruction in bone quality. Stage III is characterized by cholesteatoma in the mastoid and epitympanic cavity.

2. Results

Soft tissue density lesions in external ear canal presented in all cases. Clinical diagnosis showed that the canal was filled with keratin debris and surrounded by granulation tissue. CT value of the lesions was 68.9 ± 13.4 HU. Among the 27 cases, 14 were at stage I with normal or mild destruction in external ear canal bone (as shown in Fig. 1). Patients at this early stage mainly experienced ear fullness, occlusion or slight hearing loss. Eight patients were at stage II with the external ear canal expanding significantly and showing flask-like shape. No destruction in epitympanic cavity presented in patients at stage

II (as shown in Fig. 2). Patients at this stage complained a mild to severe pain and otorrhea, as well as occlusion and hearing loss. Five patients were at Stage III with the development of epitympanic cavity. Manubrium mallei and tympanic membrane of all 5 patients were pressed and moved inward. Ossicular chains in 3 of them were damaged. Patients at this stage encountered more obvious otorrhea and hearing loss. Bone destruction of facial nerve vertical section was discovered in 1 case (as shown in Figs. 3 and 4) who fortunately survived a facial paralysis.

All patients were treated with debris aspirations under otoendoscopy. Topical antibiotic/steroid was applied to treat the granulation tissues and infections of the canal wall. All

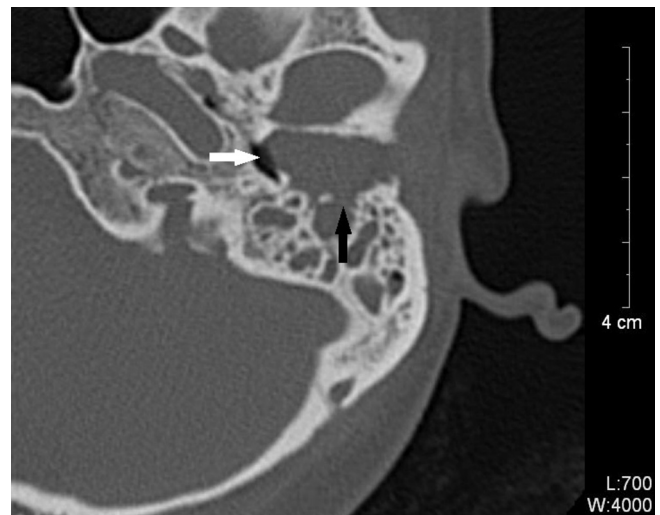


Fig. 2. (Axial scanning) Anterior wall of left mastoid was destroyed (black arrow), while tympanic cavity was still normal (white arrow).

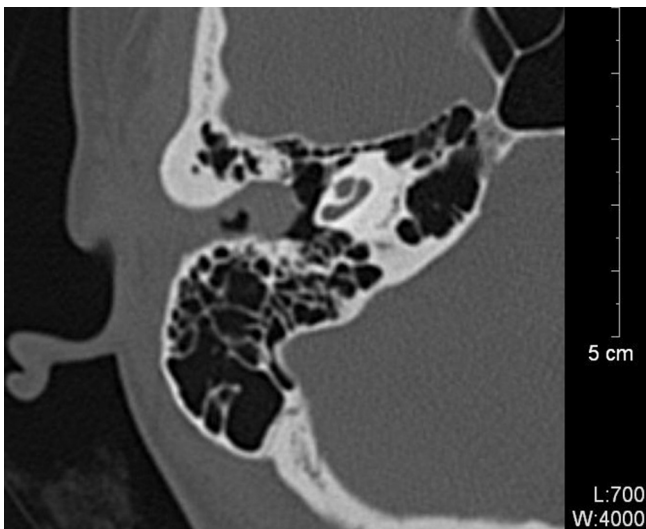


Fig. 1. (Axial scanning) The right external acoustic meatus showed mild enlargement. The edge was smooth.



Fig. 3. (Coronal view) Inward movement of tympanic membrane and ossicular chain in the left ear. A narrow gas chamber was still visible between the tympanic membrane and the intratympanic wall (white arrow). The external wall of epitympanic cavity and the inner wall of the ear canal were destroyed (black arrow).



Fig. 4. (Axial scanning) Left facial nerve canal in its mastoid portion was destroyed (white arrow).

three stage-III cases with eardrum and ossicular chain damages received myringoplasty under microscopy. Bone destruction of the vertical section of facial nerve was merely covered with fascia after the debris was cleansed. No patient experienced facial paralysis.

3. Discussion

3.1. Causes for external ear canal cholesteatoma

External ear canal cholesteatoma is formed because of the accumulation of squamous keratinized material in the external ear canal. The expansion of external ear canal cholesteatoma leads to the formation of periostitis and sequestrum with inflammatory stimuli of lysosomal enzymes, collagenase, prostaglandins and other factors, as well as the swelling pressure (Heilbrun et al., 2003). There are several mechanisms for the cholesteatoma formation, as described below. 1) Trauma or iatrogenic trauma in the external ear canal causes flap introversion or epithelial implantation. 2) Congenital stenosis of external ear canal, cartilage tumors or chronic inflammation makes it difficult to discharge squamous epithelium and cerumen. 3) External ear canal cholesteatoma can also be formed spontaneously, more commonly in the elderly. It often involves single-ear. The occurrence is related to muscle relaxation in the elderly, weak mandibular movement and epithelium in the external ear canal with the loss of migration function due to degradation (Liu, 2006; Jiang et al., 2002).

3.2. CT features of the external ear canal cholesteatoma development

Cholesteatoma is localized in external ear canal with visible soft tissue shadow. The inner side of soft tissue is smooth, while the external ear canal bone enlarges and gradually shows flask-like expansion. The ear canal bone gets thinner. The bone defect

edge is smooth, the middle ear gas chamber remains, and the ossicular chain is unchanged. With the progression of cholesteatoma, swelling of the external ear canal may extend inward, backward, or forward to oppress and invade structures such as the end of external auditory canal, middle ear cavity, mastoid cavity and temporomandibular joint, leading to soft tissue density shadow and bone destruction in CT imaging. 1) **Inward.** At the early stage, cholesteatoma expands inward. Tympanic membrane keeps its structure integrity, but retracts due to pressure. As the tumor grows, the tympanic membrane shifts inward, gets thinner, and gradually damages the external canal of epitympanic cavity. The destruction of suprameatal wall and scutum shield structure in the external auditory canal usually makes it hard to differentiate cholesteatoma from the epitympanic cavity. Most external auditory canal cholesteatoma is blocked by the tympanic membrane from invading middle ear, although the tympanic membrane and ossicular chain move inward. A narrow gas chamber is still visible between the tympanic membrane and the intratympanic wall in CT image. This feature is an important evidence that the external ear cholesteatoma begins to expand into the middle ear (Figs. 2 and 3). With the further development of external ear canal cholesteatoma into the middle ear, this disease will cause tympanic membrane absorption, ossicle loss or other worse damages such as the destruction or loss of facial nerve bone tube that usually causes facial nerve exposure or even facial paralysis for some patients. 2) **Anteriorly.** The external ear canal cholesteatoma can move anteriorly and invade anterior bones in the ear canal including the temporomandibular joint. The destruction of anterior bone in the ear canal is visible in CT image. Inflammatory soft tissue at temporomandibular joint capsule also can be monitored by CT image. 3) **Posteriorly.** The external ear canal cholesteatoma can cause invasion into mastoid posteriorly. The gasification of mastoid demonstrates that the external ear canal cholesteatoma can damage the bone and invade into mastoid, since such patients mostly have pneumatic mastoid and thin external auditory canal wall as well as thin posterior bone. CT images showed serious damages in canal wall and mastoid bone, as well as soft tissue shadow or effusion caused by obstructive inflammation in sinus mastoid and sinuses tympani (Figs. 2 and 4). In some patients, even anterior sigmoid sinus bone was damaged, exposing the sigmoid sinus.

3.3. Complications from external ear canal cholesteatoma

Although external ear canal cholesteatoma occurs in the external ear, its further development can damage the anterior wall and inferior wall. For patients with high jugular bulb, the development of external ear canal cholesteatoma can easily lead to jugular bulb exposure, or even rupture, resulting in complications such as severe bleeding. If the external ear canal cholesteatoma invades the middle ear, it will cause the same damages as middle ear cholesteatoma does, such as the destruction of facial nerve canal, labyrinth bone, sigmoid sinus and skull base.

3.4. Differences between external ear canal cholesteatoma and middle ear cholesteatoma

The diagnosis of external ear canal cholesteatoma at early stage is relatively easy using CT image. However, after cholesteatoma invades the middle ear, the destruction in the middle ear shows similar CT imaging characteristics as those caused by middle ear cholesteatoma. Therefore, we should pay attention to the following different characteristics between these two diseases. 1) Most external ear canal cholesteatoma is pneumatic or diploic mastoid. Cholesteatoma initially occurs in the external ear canal, so bone destruction in the external ear canal is severe. Therefore, cholesteatoma has some discriminable imaging features, such as stenosis of external auditory canal and a flask-like shape for the inner section. The external canal of epitympanic cavity and scutum shield structure show destructive bone defect from outside towards inside. The anterior mastoid bone and temporomandibular joint might also be damaged. The overall trend is that the damage expands from the external ear canal to the surroundings. 2) While the middle ear cholesteatoma is usually more sclerotic mastoid or mixed type, the disease is centered in the middle ear and no abnormal expansion happens on the external ear canal. For middle ear cholesteatoma that involves epitympanic cavity, the external canal of epitympanic cavity and scutum shield structure show destructive bone defects from inside towards outside. Aditus and antrum tympanicum may expand. All these features are unique for middle ear cholesteatoma.

In summary, HRCT can provide detail information about the extent of external ear canal cholesteatoma, which can be used to identify special situations that involve complications, and to differentiate external ear canal cholesteatoma from middle ear cholesteatoma. Although high-resolution CT can indeed bring clearer anatomic image and specific characteristics, it is worthwhile to emphasize that an accurate diagnosis must be based on comprehensive analysis of detailed

medical history, course characteristics, and intraoperative exploration.

Financial disclosures and conflict of interest

There is not any conflict of financial interest in this research.

The content of this paper has not been published or submitted for publication elsewhere.

Ethical approval

All procedures performed in this study were in compliance with the ethical standards of the Health Ethics Committee of Sun Yat-Sen University and were approved by the ethic committee at Sun Yat-Sen University.

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