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OTOLOGY

Endoscopic open technique in patients with middle ear cholesteatoma

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Abstract The objective of this study was to describe an endoscopic open "centrifugal" technique used to treat middle ear cholesteatoma with antral and periantral extension, using a retrospective chart and video review of a case series performed in a university tertiary referral center. Charts and videos of patients who underwent middle ear endoscopic surgery from January 2007 to September 2009 were reviewed. Patients who were treated with endoscopic "centrifuge" open techniques were included in the study. Surgical indications were collected and the surgical technique described. The final study group consisted of 12/150 subjects (9 males and 3 females with a mean age of 40 years). All 12 patients who underwent endoscopic open tympanoplasty had antral, periantral or mastoid involvement of cholesteatoma with or without posterior canal wall erosion. They had sclerotic mastoids with the presence of the antrum and, in some cases, small periantral mastoid cells. In 9/12 patients, external auditory canal reconstruction was performed with a cartilage graft. In 3/12 patients, canal reconstruction was not performed. No subjects required a meatoplasty of the external auditory canal. Endoscopic "centrifugal" open techniques can be an option in the surgical management of middle ear cholesteatoma involving antral and periantral mastoid cells, in the case of sclerotic mastoids. Further study will be necessary to examine the long-term consequences of the endoscopic "centrifugal" open technique. Level of evidence: 2C.

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Introduction

Surgical management of cholesteatomas is still a controversial issue. Classic concepts are of course based on microscopic surgical management, as is the traditional classification of open tympanoplasties (canal wall down (CWD)) and closed tympanoplasties (canal wall up), depending on the preservation of the posterior ear canal wall. The choice between these two techniques is based on a number of factors, although in most cases, the main factors influencing the definitive attitude toward surgical management of cholesteatoma are the experience, personal beliefs and confidence of each surgeon with each technique.

As is well known, traditional CWD tympanoplasty requires a retroauricular excision and a radical mastoidectomy and allows posterior-superior canal wall removal. A number of surgeons choose CWD tympanoplasties in the case of mastoid involvement by cholesteatoma. This procedure certainly needs a meatoplasty to maintain a wide external auditory canal, allowing aeration of the mastoid cavity as well as easy access for examination and office-based cleaning of the epithelized mastoid cavity.

From our 6-year experience in endoscopic ear surgery, we have come to believe that new anatomical [1] and physiological [2, 3] concepts should be introduced in middle ear surgery. Endoscopic approaches to middle ear are generally very preservative techniques, as thoroughly described in our earlier articles, and in most cases they avoid mastoidectomy[4] due to the possibility of an around-the-corner view of most of the inaccessible spaces

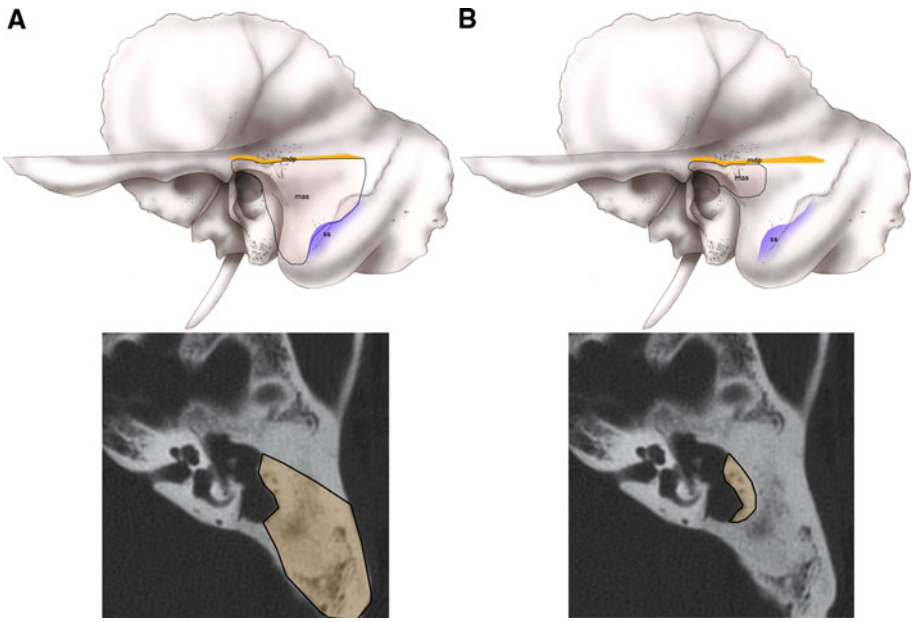

Fig. 1 Schematic drawing and CT scan axial view representing the bony structures during a traditional open technique **(a),** and during a transcanal endoscopic centrifuge open technique **(b)**

in the tympanic cavity [5, 6]. Nonetheless, in the case of mastoid involvement of the inflammatory pathology, these authors would still recommend aborting endoscopic procedures in favor of microscopic techniques, to obtain adequate control of the mastoid extension of the pathology. In a number of selected cases, a type of open endoscopic technique has been performed in our department during recent years. In particular, in the case of sclerotic mastoids, and antral or periantral involvement of cholesteatoma, classic microscopic techniques would provide the removal of all of the bone between the middle cranial fossa plane superiorly and the sigmoid sinus inferiorly and posteriorly, spending a lot of time drilling to create a radical mastoidectomy with a wide mastoid cavity (Fig. 1a; Fig. 2). Moreover, in the case of a low middle cranial fossa dura, access to the antrum would be increasingly difficult in some cases, so as to even make necessary a higher displacement of the dura to obtain adequate visualization of the antral, periantral and epitympanic region to remove the pathology (Fig. 2d–f). In the above-mentioned cases, an endoscopic transcanal technique was performed, removing only the bony tissues necessary to visualize the pathology, i.e. the most superior and posterior portions of the medial external canal wall creating a small open cavity, so as to obtain direct exposure of the cholesteatoma in the mastoid (Fig. 1b). This procedure allowed us to bypass the mastoid bone, required minimal bone drilling and avoided the canal meatoplasty. As mentioned above, the presence of a sclerotic mastoid bone, as often found in chronic inflammatory pathology of the middle ear, represented a fundamental prerequisite due to the obvious ventilatory exclusion of the mastoid that such operation would provoke.

The aim of this paper was to describe our experiences with this type of endoscopic open technique, with particular attention being paid to the surgical technique. The term "centrifugal" used in this study, underlines the fact that the cholesteatoma in this technique was followed from the middle ear cleft toward a more external site such as the mastoid, as described later.

Materials and methods

From January 2007 to September 2009, 150 endoscopic tympanoplasties were performed for middle ear cholesteatoma at the ENT Department of the Policlinico di Modena in the University Hospital of Modena tertiary referral center. All of the operations were video recorded and stored on a computer. In February 2010, a retrospective chart and video review of patients who underwent to endoscopic tympanoplasty was performed and all patients who underwent the open centrifuge endoscopic technique were included in the study. Surgical interventions were all performed by two experienced surgeons with a similar attitude to endoscopic middle ear surgery (D.M. and L.P.).

Surgical equipment

Surgical equipment consisted of the standard aural microsurgical instrument set plus a special dedicated set for endoscopic middle ear surgery; 3 mm diameter, 0 and 45° angled, 20- and 15-cm length rigid endoscopes were used (Explorent). Video equipment consisted of a three-chip video camera and 20″ high-definition monitor (Karl Storz, Tuttlingen, Germany).

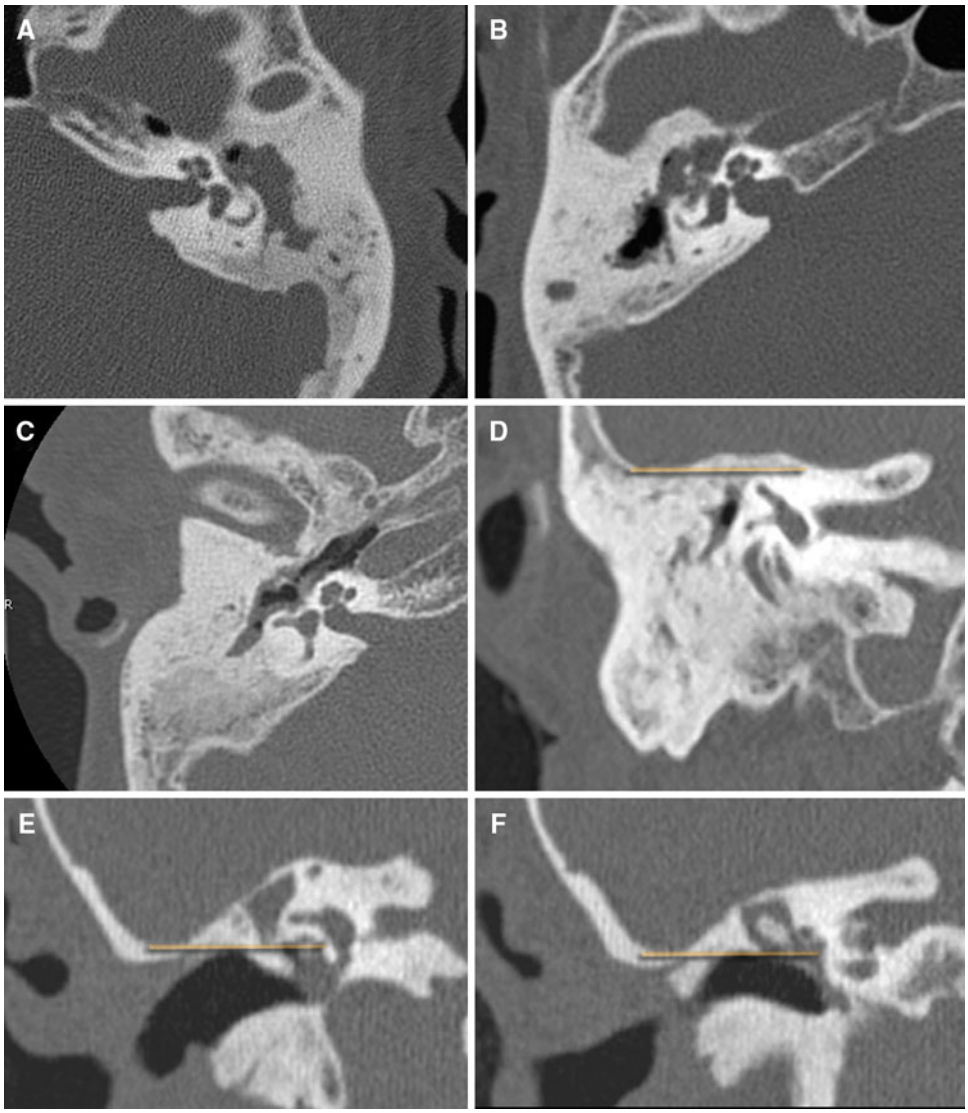

Fig. 2 CT scans in axial view in subjects with sclerotic mastoid (**a–c**); CT scan in coronal view in subjects with sclerotic mastoid associated with low middle canal fossa (**e–f**) or without low middle cranial fossa (**g**)

Surgical technique

All of the surgical procedures were performed by an exclusive endoscopic transcanal approach. During the procedures, the surgeon held the endoscope in the left hand, using surgical instruments with the right hand. Using the 0° endoscope, a wide posterior tympanomeatal flap (from 1 to 6 o'clock) was opened. This flap was elevated and then transposed inferiorly to uncover the superior and posterior portions of the medial external canal wall; the tympanic membrane was carefully dissected from the long process of the malleus transposing the flap inferiorly, thus maintaining the tympanic membrane adherent to the inferior portion of the handle of the malleus; at this point, a clear view of the protympanum and eustachian tube region was possible.

Then, drilling with a diamond bur, the scutum was totally removed until the anterior bony wall of the epitympanic space was explorable, representing the anterior limit of the dissection. Then, dissection of the cholesteatoma was performed from the anterior bony wall of the anterior epitympanic space to the posterior epitympanic space toward the antrum and the periantral mastoid cells maintaining the integrity of the sac whenever possible (Fig. 3).

The attitude toward the ossicular chain was preserved as much as possible, but when an epidermization of the medial surface of the ossicular chain was present, the incudomalleolar joint was removed exposing the medial attic (Fig. 3c–e).

The bony dissection of the cholesteatoma from the lateral aspect of the attic was complete when the tegmen could be visualized completely with the endoscope. When preserved, the body and the short process of the incus were used as a landmark for the antrum: these anatomical structures indicated the location of the antrum, so by

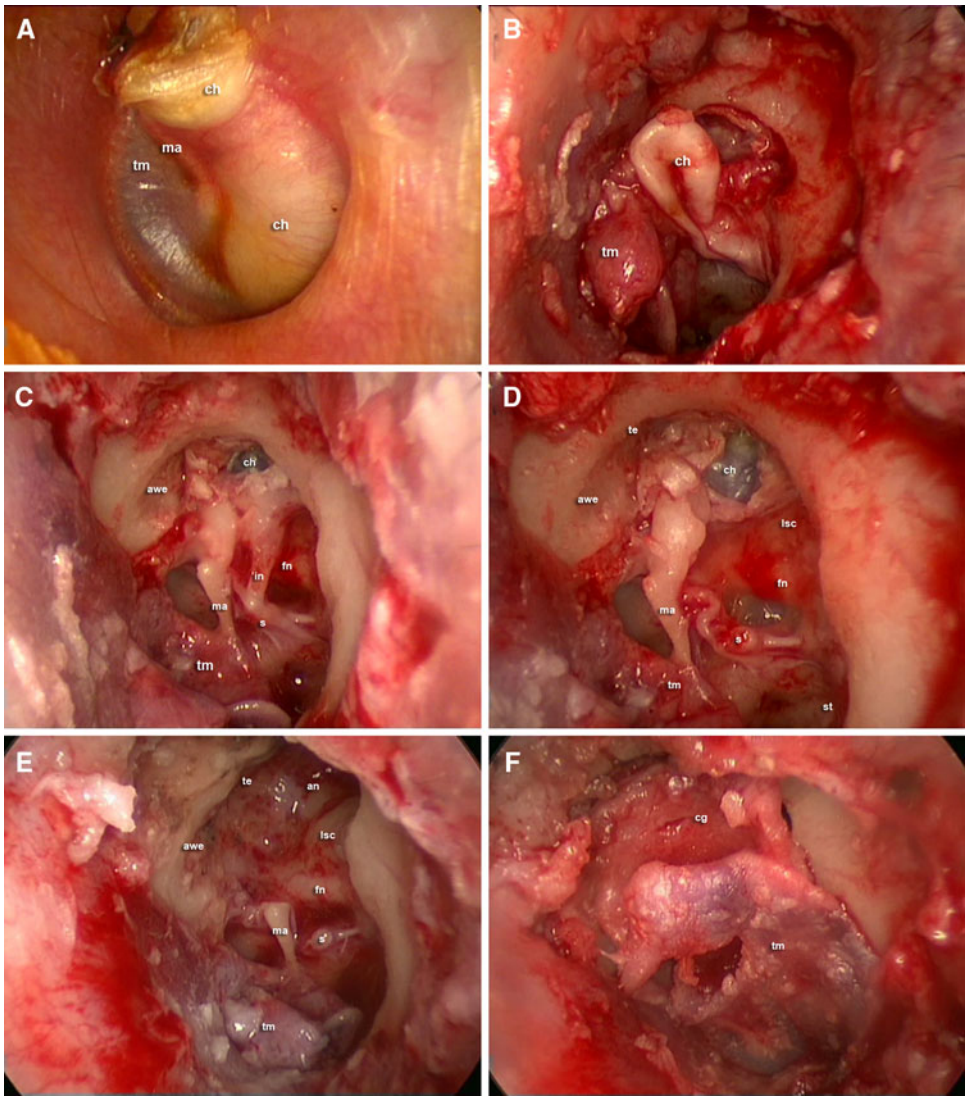

Fig. 3 Patient with middle ear cholesteatoma (**a**); the tympanomeatal flap was transposed inferiorly and the sac of the cholesteatoma was gently dissected from the mesotympanum and retrotympanum spaces maintaining the integrity of the sac (**b**); a n epidermization of the epitympanic space was visible involving the medial aspect of the ossicular chain and with posterior extension to the antrum (**c**); epitympanic compartments after incus removal allowed us to see the sac extension (**d**); tympanic open cavity after drilling of the posterior bony wall of the external meatal canal and cholesteatoma removal (**e**); reconstruction of the posterior bony wall of the external meatal canal and of the lateral attic by tragal graft; tympanic membrane was repositioned over the graft (**f**)

drilling the bone over the short process of the incus, it was possible to reach the antrum. A 45° endoscope was then used to remove the most superior and posterior bony wall of the medial portion of the external auditory canal reaching the antrum and the periantral mastoid cells: this procedure was performed having direct control over the important anatomical structures lying in the posterior and medial wall of the tympanic cavity, the facial nerve and the lateral semicircular canal, which could be visualized directly (Fig. 4). The bony wall of the posterior auditory canal was removed following the course of the second and third portions of the facial nerve until the antrum and periantral mastoid cells were merged to the tympanic cavity (Fig. 4b–d); at the end of this procedure, a sort of small open cavity was created. This procedure allowed us to isolate the most posterior extension of the cholesteatoma sac removing en bloc the disease and maintaining the integrity of the sac whenever possible. After these surgical steps, a 45° endoscope was used to check the retrotympanic spaces removing the cholesteatoma sac in these spaces. When located, mesotympanic and hypotympanic cholesteatoma fragments were removed aided by the view from a 0° endoscope.

On the basis of the dimensions of the final open cavity, the surgical reconstruction was planned as follows:

– When the confluence of the periantral and antral region to the tympanic cleft formed a wide cavity, a temporalis fascia graft was placed excluding the mastoid and the epitympanum from the tympanic cavity (Fig. 4e, f).
– When the confluence of the periantral and antral region to the tympanic cleft formed a small cavity, we performed a reconstruction of the external canal with an auricular cartilage graft stabilized with fibrin glue, thus closing the bony defect (Fig. 3f).

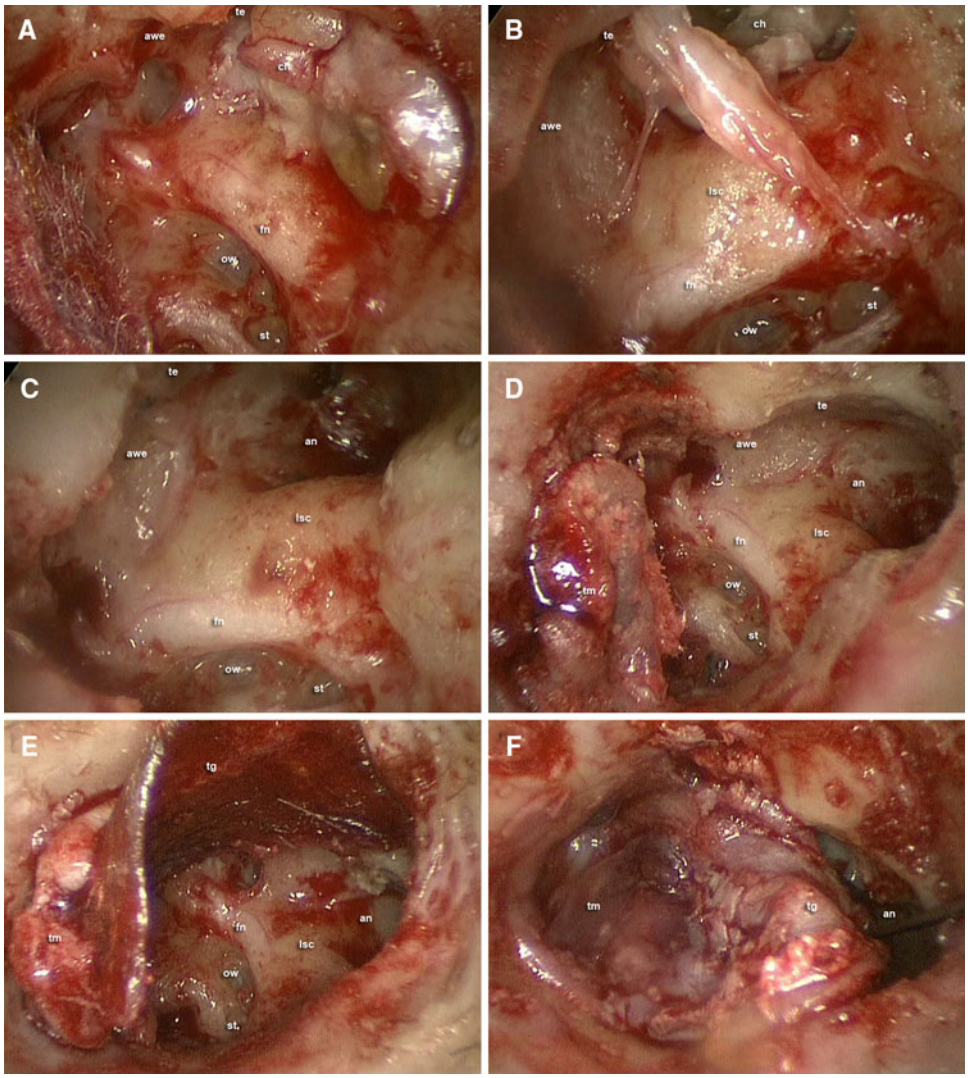

Fig. 4 Patient with attic cholesteatoma involving posteriorly the attic (**a**); during drilling, using a 45° endoscope, it was possible to see the extension of the cholesteatoma sac into the attic; the facial nerve and the semicircular canal were under endoscopic control (**b**); periantral and attic view using a 45° endoscope after cholesteatoma removal; the 2nd portion of the facial nerve and the semicircular canal were ahead of the surgeon (**c**); final open cavity before reconstruction (**d**); a temporal fascia was positioned with the underlay technique (**e**). Final result; in this case, the temporal fascia was transposed over the antrum (**f**)

When necessary, an ossicular chain reconstruction was performed by a remodeled autologous incus after the cholesteatoma removal steps.

Results

The final study group consisted of 12 patients, 9 males and 3 females, with a mean age of 40 years.

In our chart review, we found that all 12 patients who underwent endoscopic open tympanoplasty had an antral, periantral or mastoid involvement of cholesteatoma with or without posterior canal wall erosion, and had a sclerotic mastoid with the presence of the antrum and in some cases small periantral mastoid cells. In 4/12 patients, the coronal CT scan showed a low middle cranial fossa dura. All patients had an adequate large external ear canal so as to allow endoscopic transcanal procedures. None of the patients had had earlier ear operations.

In 10/12 patients, the cholesteatoma developed in the mesotympanum and epitympanic compartments with periantral mastoid cells and antral involvement. In 2/12 patients, the cholesteatoma also extended posteriorly involving the retrotympanum.

In 10/12 patients, the ossicular chain was eroded. In the 2/12 patients who presented an intact ossicular chain, it was possible to preserve it only in one subject, while in the other patient, it was necessary to remove the incus and malleus in order to access the cholesteatoma matrix extending medially to the ossicles. In 7/12 patients, the superstructure of the stapes was present and an ossicular chain reconstruction with an autologous remodeled incus was performed. In 4/12 patients, no superstructure of the stapes was present and a total ossicular chain reconstruction was performed with an autologous remodeled incus.

In 9/12 patients, external auditory canal was reconstructed by a cartilage graft. In 3/12 patients, a canal reconstruction was not performed.

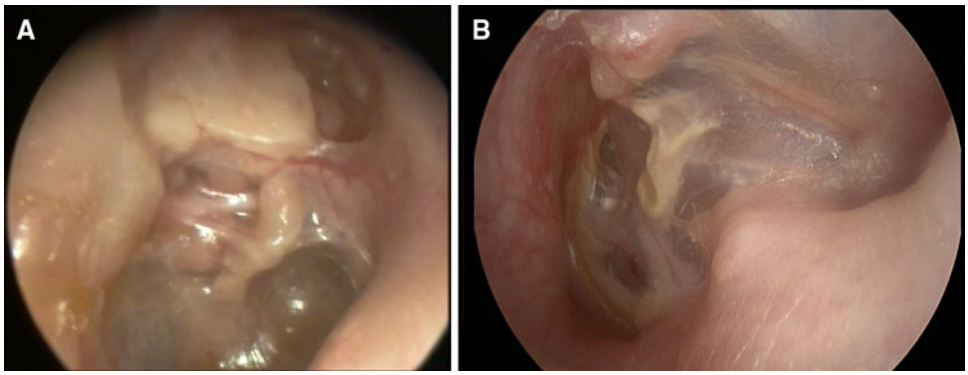

Fig. 5 Results during the follow-up period: reconstruction technique (**a**); patient in whom canal reconstruction was not performed (**b**)

No patient required a meatoplasty of the external auditory canal.

An example of postoperative result is shown in figures below (Fig. 5a, b).

Follow-up

The mean post-operative follow-up period was 15 months.

During the follow-up period, 10 out of 12 patients presented a well-ventilated tympanic cavity, with a self-cleaning mastoid cavity and external ear canal; 3/10 patients presented a moderate retraction of the drum in the isthmus region maintaining a well-ventilated appearance of the mesotympanum. All subjects who underwent the open cavity technique with reconstruction (9/12) presented a stable cartilage graft closure of the external auditory canal. In 1/12 patients (open cavity technique with reconstruction), residual cholesteatoma was found during the follow-up period, and it was necessary to perform a second-stage removal of the pathology. In 1/12 patients (open cavity technique without reconstruction), persistent granulation tissue was found occupying the mastoid and antrum, provoking otorrhea, and this patient required a revision: during this second-look operation, reconstruction of the external ear canal was performed by a perichondrial graft.

No intraoperative complications were reported in our case series.

Discussion

Most microscopic middle ear procedures have been codified over many decades, and this is particularly true for CWD tympanoplasty. In fact, although the results have improved over the years through technical modifications suggested by several authors, the procedure has remained almost the same. As accepted nowadays by the majority of ear surgeons, CWD tympanoplasties have a low rate of recurrence and residual cholesteatoma compared with canal wall up procedures, allowing a better control of some regions such as the anterior epitympanum and sinus tympani [7]. Nonetheless, it cannot be denied by experienced otologists that a considerable percentage of patients complain of vertigo while swimming, and in some cases, the mastoid cavity is not self-cleaning, requiring periodic office-based cleaning. Moreover, a wide meatoplasty may provoke an unpleasant esthetic impact. Although in some cases CWD is strongly recommended, in particular in the case of mastoid involvement of cholesteatoma, to avoid leaving pathology residuals, from the present authors' experience, some exceptions can be made in the surgical indications for CWD tympanoplasty. In selected patients with sclerotic mastoid and antral or periantral involvement of cholesteatoma, an endoscopic tympanoplasty should be considered as an alternative, particularly by surgeons with sufficient expertise in endoscopic techniques [8–10]. The endoscopic approach would guarantee some advantages. First of all, the absence of wide external incisions, since surgery is performed completely transcanally (a 2-cm incision would be necessary only to harvest the temporalis fascia when required for a cartilaginous graft). Moreover, a meatoplasty would not be necessary, since even in cases of non-reconstructed endoscopic open tympanoplasty, the mastoid cavity would remain sufficiently small so as to guarantee a self-cleaning ear. The endoscopic view may also guarantee the around-the-corner view of some hidden areas such as the sinus tympani, anterior epitympanic spaces and hypotympanum; in particular, in cases of deep sinus tympani, even a CWD approach may not give a complete exposure of the whole sinus. Moreover, in the case of a low middle cranial dura plane, as present in four patients in our case series, the endoscope allowed a quite comfortable visualization of the most superior portion of the epitympanum, whereas the authors feel that this would be quite difficult with microscopic CWD tympanoplasty. Using the endoscope, anatomical structures such as the facial nerve and the lateral semicircular canal were ahead of the surgeon, permitting removal of the posterior auditory bony wall canal and avoiding the risk of injury to these structures. Of course with endoscopic open tympanoplasty, much unnecessary

bone removal is avoided compared with CWD procedures, leaving most of the bony mastoid tissues in place.

As mentioned earlier, we would define endoscopic open tympanoplasty as "centrifugal": this is to emphasize that cholesteatoma in this technique is followed from the middle ear cleft toward a more external site such the mastoid and to differentiate it from the classic posterior transmastoid approach toward the pathology (so rather "centripetal" or "anterograde"), adopted by microscopic techniques.

Of course, the presence of a sclerotic mastoid is a fundamental prerequisite for endoscopic open tympanoplasty; we would not recommend performing an endoscopic tympanoplasty in the case of well-pneumatized mastoids, since in the case of absence of reconstruction, the air cells of the mastoids would suffer a blockage of ventilation due to the exclusion of the mastoid cavity from the middle ear cleft. Even though reconstruction of the external canal might be planned, this would be particularly difficult in the case of large defects, very likely in the case of pneumatized mastoids.

As reported in the results section, 16.7% (2/12) of our case series underwent to revision surgery, at 15 months of mean follow-up. With the obvious differences in terms of follow-up length and pathology extension and staging, these results could be approximately compared with literature data which report a residua rate presence of 20–25% incidence with CWU tympanoplasty [11] and a 14.6% incidence with the CWD and open tympanoplasty [11].

Although the present authors are very confident about the technique described, the follow-up period at present is short, and must be confirmed by long-term results.

Conclusion

Endoscopic "centrifuge" open techniques can be an option in the surgical management of middle ear cholesteatoma involving antral and periantral mastoid cells, in the case of sclerotic mastoids. More time will be needed to confirm the endoscopic "centrifuge" open techniques with long-term results.

Conflict of interest None.

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