Retrograde mastoidectomy technique - retrospective analysis of results

Original Article

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Abstract

Objective: Analysis of the results of mastoidectomy using the retrograde technique for removal of cholesteatomas in adults.
Methods: Retrospective analysis of cases of mastoidectomy via retrograde technique performed at Centro Hospitalar Tondela-Viseu between January 2018 and December 2021 with collection of demographic data, type of surgery, reconstruction of the posterosuperior wall of the canal, type of tympanoplasty, recurrence, follow-up time and audiometric results.
Results: 45 ears were included in the study, 73.3% of which corresponded to primary surgery. Reconstruction of the posterosuperior wall of the canal was performed in 37.8% and ossiculoplasty was done in 73.3%. The air-bone gap gain, in patients who underwent wall reconstruction was 9.66dB (vs. 1.91 dB without reconstruction). During follow-up, recurrence occurred in 13.3% of cases.
Conclusions: In our series, this technique proved to be safe and effective in cholesteatoma excision. Reconstruction of the EAC wall allowed better audiometric results.
Keywords: Mastoidectomy; Retrograde technique

Introduction

Chronic otitis media with cholesteatoma (COMC) is an inflammatory disease characterized by the accumulation of debris from the keratinized stratified squamous epithelium in the middle ear and/or mastoid.[1] Despite being a benign disease, COMC is locally invasive. Due to the pressure effect of the expanding keratin cysts combined with collagenase-mediated osteoclastic activity, COMC erodes the adjacent bone structures.[2] Tympanic membrane retraction or perforation and ossicular chain and mastoid bone erosion may occur, compromising the hearing acuity and occasionally leading to intratemporal (for example, facial nerve injury or vertigo) or intracranial complications, which are

associated with significant morbidity.[3] Patients with this disease often present with otorrhea, which may have a foul odor, and with hearing loss, but the symptoms depend on the stage of disease progression.[2,3]

COMC is treated surgically, primarily to eradicate the disease, prevent relapses and complications, and preserve or regain the hearing acuity.[2,3] The surgical approach to this disease is based on two types of mastoidectomy, namely canal wall up (CWU) with preservation of the posterosuperior wall of the external auditory canal (EAC) and canal wall down (CWD) without preservation of the posterosuperior wall of the EAC.[4] By preserving the posterosuperior wall of the EAC, CWU mastoidectomy maintains the normal anatomy of the intact EAC, reduces the healing time, avoids limitations resulting from the presence of surgical cavities (requiring protection of the ear from water and entailing difficulties in using hearing aids), and improves the hearing outcomes when compared with the CWD technique. Its disadvantages include limited exposure of the epitympanum, posterior mesotympanum, facial recess, and tympanic sinus, which may lead to residual disease and consequently increase the recurrence rates.[5-7] Therefore, a second-look 6–12 months after surgery or diffusion magnetic resonance imaging should be performed.[3,8]

In contrast, removing the posterosuperior wall of the EAC up to the vertical segment of the facial nerve in CWD mastoidectomy provides adequate exposure for complete cholesteatoma removal, thereby decreasing the risk of residual disease and recurrence rate (lower than 10%[5,9]). However, audiometric outcomes in CWD seem to be worse than in CWU, and the resulting surgical cavity must be cleaned periodically due to the increased risk of recurrent infection in damp cavities. Mitigating this risk of infection requires protecting the EAC from water.[5,10]

This care requires considerable lifestyle changes, especially in pediatric patients. Recurrent infections in the mastoid cavity may cause bone resorption and labyrinthine fistulas.[11] Furthermore, patients with such cavities may experience episodes of vertigo upon changes in the temperature and pressure.[12]

To overcome the limitations of both techniques, the retrograde mastoidectomy technique aims at limited excision of the posterosuperior wall of the EAC for complete cholesteatoma removal, followed by its reconstruction with autologous (bone and cartilage) or alloplastic (hydroxyapatite cement and bone wax) materials when appropriate.[5,7] Retrograde mastoidectomy followed by wall reconstruction was first described by Guilford and subsequently applied by numerous otologic surgeons.[13] This technique enhances exposure and control of the epitympanum, tympanic sinus, and facial recess, where the cholesteatoma is often located and where the risk of residual disease is high.[13] Therefore, this technique combines the advantages of CWD and CWU mastoidectomy.[4,9]

When selecting the surgical technique, the surgeon should consider factors such as the disease location and extent, potential complications, Eustachian tube (ET) function, and the patient's functional capacity and hearing acuity.[1] This study aimed to conduct a retrospective analysis of the functional outcomes of retrograde mastoidectomy for cholesteatoma removal in the adult population at the Tondela-Viseu Hospital Center (*Centro Hospitalar Tondela-Viseu* – CHTV).

Materials and Methods

This retrospective study analyzed patients who underwent retrograde mastoidectomy for COMC at CHTV from January 2018 to December 2021. The following data were collected: age, sex, laterality, surgical technique, primary or corrective surgery, reconstruction of the posterosuperior wall of the EAC, type of tympanoplasty according to a modified version of the Wüllstein classification proposed by Merchant, *cholesteatoma recurrence, follow-up period, intraoperative findings, and pre- and postoperative audiometric outcomes*.

The exclusion criteria included pediatric patients (<18 years), antegrade mastoidectomy, postoperative follow-up period shorter than 12 months, and incomplete medical records. After the application of these criteria, the final cohort included 45 ears.

Cases of postoperative residual cholesteatoma and development of a new cholesteatoma resulting from reconstructed tympanic membrane retraction were deemed as cholesteatoma recurrence.[4]

The last audiogram before the surgery and the first audiogram after the surgery were considered the pre- and postoperative pure-tone audiograms, respectively, which were usually performed between 3 and 6 months from the surgery. The mean pre- and postoperative air-bone gap (ABG) was calculated based on the air (AC) and bone (BC) conduction pure-tone averages (PTAs) at 500, 1000, 2000, and 4000 Hz frequency. The audiometric gain corresponded to the difference between the pre- and postoperative ABGs. The Wüllstein classification of tympanoplasty defines five types. In this study, we used a modified version of this classification proposed by Merchant[14] for type III tympanoplasty as follows:

-Type III: Tympanic membrane reconstruction requiring associated ossiculoplasty, subdivided into (i) **minor columella** tympanoplasty, which is performed when the malleus or incus are damaged, but the stapes remains intact and mobile, and involves ossicular reconstruction with a titanium partial ossicular replacement prosthesis (PORP) or autologous bone materials; (ii) **Major columella** tympanoplasty, which is performed when there is no stapes suprastructure or mobile footplate, and involves ossicular reconstruction with an alloplastic, titanium total ossicular replacement prosthesis (TORP), and (iii) **Stapes columella** tympanoplasty, which is performed when the stapes is intact and mobile, and involves ossicular reconstruction with cartilage and temporal fascia over the stapes head. The data were statistically analyzed using IBM SPSS software version 28 .0. Pre- and postoperative audiometric outcomes were compared by ANOVA. Differences were considered significant when the *p*-value was < 0.05.

The surgery was performed by different surgeons, under general anesthesia and microscopic visualization. Whenever necessary, the middle ear, more specifically the sinus tympani, was evaluated by otoendoscopy. The decision to maintain the mastoidectomy cavity or reconstruct the posterosuperior wall of the EAC was made depending on the extent of the cholesteatoma, age, and expected treatment adherence.

Results

This study included 45 ears (22 right ears and 23 left ears) of 44 patients who underwent retrograde mastoidectomy. Most patients were women, accounting for 25 ears, and the remaining 20 ears were from men. The mean age at surgery was 51.58 years, with a 95% confidence interval (CI)= [46.30; 56.85] and standard deviation σ = 17.55 years. On otoscopy, the patients showed tympanic membrane perforation and/or grade IV attic retraction according to the findings of Tos & Poulsen [15], epidermal lamellae, and purulent otorrhea with a foul odor. Primary surgery was performed in 73.3% (n=33) cases and corrective surgery in 26.7% (n=12) cases. After retrograde mastoidectomy, the posterosuperior wall of the EAC was reconstructed in 37.8% of the ears. In this study, the mean follow-up period was 28.31 ± 14.19 months. The minimum and maximum follow-up periods were 12 and 56 months, respectively. Table 1 summarizes the characteristics of the study sample.

The intraoperative analysis of the COMC location and extent showed isolated involvement of the attic in nine cases (20.0%); involvement of the attic and mastoid in 12 cases (26.6%); involvement of the attic, mastoid, and tympanic cavity in 13 cases (28.9%); involvement of the attic, mastoid, tympanic cavity, and sinus tympani in two cases (4.4%); involvement of the attic and tympanic cavity in six cases (13.3%); and involvement of the attic, tympanic cavity, and sinus tympani or

Table 1
Sample characterization

Sample	N= 45 ears
Sex	25 Women (55,6%) 20 Men (44,4%)
Mean age (min-max)	51,58 years (19-78 years)
Laterality	Right: 22 (48,9%) Left: 23 (51,1%)
Surgery	Primary: 33 (73,3%) Corrective: 12 (26,7%)
Reconstruction of the posterosuperior wall of the EAC	Yes: 17 (37,8%) No: 28 (62,2%)
Mean follow-up (min-max)	28,31 months (12-56 months)

protympanum in three cases (6.7%). Facial nerve dehiscence was observed in four ears, and lateral semicircular canal dehiscence was recorded in two ears. Table 2 categorizes the study sample into stages, according to the European Academy of Otology and Neurotology/ Japanese Otological Society (EAONO/JOS) criteria [16].

Preoperatively, the AC-PTA was 58.30 ± 24.03 dB and BC-PTA was 29.46 ± 20.88 dB. Thus, the preoperative ABG was 28.83 ± 11.25 dB. Postoperatively, AC-PTA was 55.56± 24.78 dB and BC-PTA was 31.56 ± 21.58dB. Thus, the postoperative ABG was 24.00 ± 11.28 dB.

In the subgroup of patients who underwent primary surgery, the preoperative ABG was 28.31± 9.33 dB, while the postoperative ABG was 21.7 ± 10.83 dB; consequently, the ABG gain was 6.61 dB. In contrast, the patients who underwent corrective surgery showed a preoperative ABG of 30.29 ± 15.83 dB, postoperative ABG of 30.29 ± 10.42 dB, and, hence, no ABG gain. Despite significant (p=0.022) differences between the pre- and postoperative ABGs, no significant difference in the audiometric gain was found between patients who underwent primary surgery and those who underwent corrective surgery.

In cases of reconstruction of the posterosuperior wall of the EAC, the preoperative ABG was 26.65 ± 11.22 dB, and postoperative ABG was 16.99 ± 1126 dB, with an ABG gain of 9.66 dB. Conversely, when the posterosuperior wall of the EAC was not reconstructed, the preoperative ABG was 30.17± 11.26 dB, postoperative ABG was 28.26 ± 9.07 dB, and the ABG gain was 1.91 dB. The audiometric gains significantly (p=0.037) differed between the two subgroups of patients. Table 3 summarizes the audiometric outcomes regarding pre- and postoperative ABG. Based on the classification used in this study, type III tympanoplasty minor columella with PORP was performed in 12 (26.7%) ears; type III tympanoplasty major columella with TORP in six (13.3%) ears; type III tympanoplasty stapes columella with cartilage interposition between the stapes suprastructure and tympanic membrane in 15 (33.3%) ears; type IV tympanoplasty in eight (17.8%) ears; and type I tympanoplasty in four (8.9%) ears with an intact and mobile ossicular chain.

In cases who underwent type III tympanoplasty minor (PORP) and major (TORP) columella, the audiometric gains were 10,96 dB and 10,04 dB, respectively. In cases of type III tympanoplasty

Table 2
Study sample staging

Stage	N	Difficult-to-access site (S)* (%)	Tympanic cavity (T) (%)	Attic (A) (%)	Mastoid (M) (%)
I	9	0	0	9 (100%)	0
II	34	5 (14,7%)	23 (67,6 %)	34 (100%)	25 (73,5%)
III	2	0	1 (50%)	2 (100%)	2 (100%)
IV	0	0	0	0	0
Total	**45**	**5**	**24**	**45**	**27**

* Difficult-to-access site: sinus tympani and protympanum

Table 3
Pre- and postoperative ABG and audiometric gain

	Preoperative ABG	Postoperative ABG	Audiometric gain
Primary surgery	28,31 dB	21,7 dB	6,61 dB
Corrective Surgery	30,29 dB	30,29 dB	0 dB
With reconstruction of the posterosuperior wall of the EAC	26,65 dB	16,99 dB	9,66dB
Without reconstruction of the posterosuperior wall of the EAC	30,17 dB	28,26 dB	1,91 dB

ABG, air-bone gap; EAC, external auditory canal

stapes columella, the audiometric gain was 2.15 dB. Type IV tympanoplasty led to a hearing loss of 3.75 dB. Significant differences in the audiometric gain were found only between type III tympanoplasty minor columella and type IV tympanoplasty (p=0.007), and between type III tympanoplasty major columella and type IV tympanoplasty (p=0.031). Figure 1 shows the variation in the pre- and postoperative ABG and audiometric gain as a function of the type of tympanoplasty.

Intraoperatively, a case with cerebrospinal fluid (CSF) leak due to disrupted integrity of the dura mater was promptly corrected with Surgicel® and bone wax. Postoperatively, the patient presented with vertigo and nausea. No facial nerve complications were recorded in this study.

During the follow-up period, cholesteatoma recurrence occurred in six (13.3%) patients, of whom two had undergone reconstruction of the posterosuperior wall of the EAC. In addition, 83.3% patients underwent primary surgery. No significant associations were found between disease recurrence and whether reconstruction of the posterosuperior wall of the EAC was performed, type of tympanoplasty, or even primary or corrective surgery. Regarding the site of origin of the cholesteatoma, two cases involved the attic, mastoid, and tympanic cavity; two cases involved the attic and tympanic cavity; and two cases involved the attic, tympanic cavity, mastoid, and sinus tympani. Figure 2 shows the distribution of the recurrence cases with and without reconstruction of the posterosuperior wall of the EAC.

Figure 1
Pre- and postoperative air-bone gap (ABG) and audiometric gain

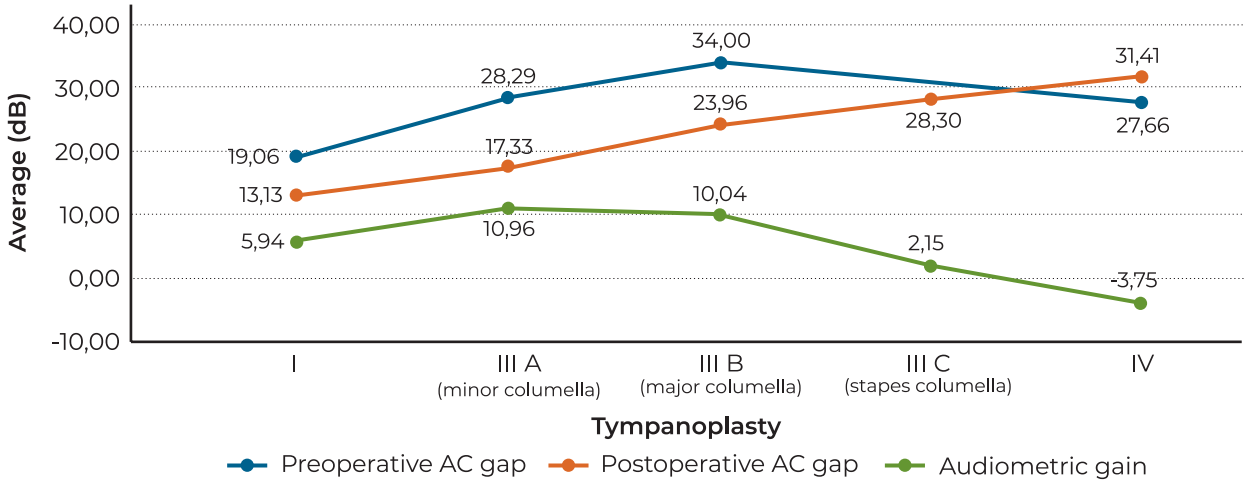
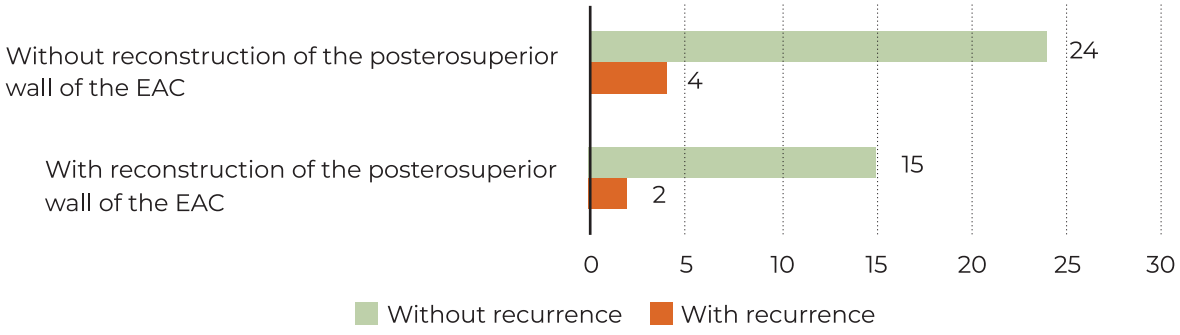


Figure 2
Distribution of the recurrence cases



EAC, external auditory canal

Discussion

The treatment of choice for COMC is surgery with curative intent through total cholesteatoma removal. Whether or not to preserve the posterosuperior wall of the EAC remains a topic of debate.

In our retrograde mastoidectomy series, the posterosuperior wall of the EAC was reconstructed with conchal cartilage. Conchal cartilage from the superior cymba is considered ideal for reconstruction because of its thickness and concavity. However, many studies have described the use of the tragal cartilage.[4,12] Ideally, the cartilage used to reconstruct the posterosuperior wall of the EAC should remain in contact with the reconstructed tympanic membrane to prevent tympanic membrane retraction. *Hatano et al.* described the use of soft tissues (EAC skin and temporal fascia) to reconstruct the posterosuperior wall of the EAC in children.[6] Postoperative care is similar to that performed in CWU mastoidectomy.[13]

The decision to preserve the mastoidectomy cavity or reconstruct the posterosuperior wall was based on the surgeon's confidence in completely removing the cholesteatoma matrix, extent of the disease, patient's age and functional capacity, and the hearing reserve. The sinus tympani was examined by otoendoscopy because exposure is difficult even with retrograde mastoidectomy.[4] In our study, we did not perform a "second-look", but diffusion magnetic resonance imaging was performed when in doubt about recurrent or residual disease. The recurrence rate was 13.3%, similar to that reported in the literature. Among the cases who underwent reconstruction of the posterosuperior wall of the EAC, recurrence occurred in 11.8% patients. Conversely, in the subgroup that maintained an open cavity, recurrence occurred in 14.3% patients. Nevertheless, this difference was not statistically significant.

After eliminating the disease and restoring the anatomy of the EAC when indicated, the surgery aims to restore the patient's hearing acuity. In patients who underwent reconstruction of the posterosuperior wall of the EAC, the audiometric gain was significantly higher than in patients in whom an open cavity was maintained. Therefore, the reconstruction of the posterosuperior wall is recommended for improving the audiometric outcomes and facilitating postoperative recovery.[4]

During the surgery, ossicular reconstruction was performed in most (73.3%) patients. The use of titanium prostheses and, whenever possible, preservation of the malleus handle preserves the space of the tympanic cavity and helps to reconstruct the tympanic membrane. An intact stapes suprastructure is a favorable prognostic factor for adequate audiometric outcomes.[9] We observed a slight difference between the audiometric gain of patients who underwent ossicular reconstruction with alloplastic prostheses, with and without the stapes suprastructure,

albeit nonsignificant. During the follow-up, in all six cases of recurrence, the primary site of the cholesteatoma included the tympanic cavity. This may reflect the role of the ET in the etiology of COMC and the need to evaluate its function preoperatively.[5]

The limitations of our study stem from its retrospective design, small sample size, and relatively short follow-up period. A follow-up period ranging from 5 to 10 years would be more reliable for evaluating the number of recurrences because retraction pockets may develop in the long term.[12]

Conclusion

Based on our experience at CHTV, the retrograde mastoidectomy technique is a safe and effective technique for optimal intraoperative exposure for complete cholesteatoma removal, while simultaneously enabling the reconstruction of the posterosuperior wall with better audiometric outcomes. Furthermore, the COMC recurrence rate was not higher in the group of patients with reconstruction of the posterosuperior wall, but a longer follow-up period may show different results.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

Data Confidentiality

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

Protection of humans and animals

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the 2013 Helsinki Declaration of the World Medical Association.

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There are no datasets available, publicly related to this work.

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