Reconstruction of lateral attic wall in acquired cholesteatoma

Rekonstrukcija lateralnog zida atika kod stečenog holesteatoma

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Abstract

Background/Aim. Attic cholesteatoma is an epithelial cystic pseudotumor which arises in the top compartment of the middle ear. Surgery is the only therapeutic treatment for attic cholesteatoma. The aim of this study was to analyze the surgical and audiological results in tympanoplasties that use a logical application of several techniques for the management of attic cholesteatoma. Our hypothesis was that the tympanoplasty technique with cartilage/bone reconstruction of the attic wall reconstruction leads to good anatomical and audiological results. A significant hearing improvement was obtained in both the types of lateral attic wall reconstructions in this study. Reconstruction with cartilage or mastoid cortical bone showed favorably long-term functional and anatomical results compared to primary tympanoplasty using only temporal fascia for lateral attic wall reconstruction.

Methods. This retrospective clinical study included 80 patients, aged 16–65 years, with attic cholesteatoma undergoing canal “wall up” tympanoplasty with lateral attic wall reconstruction, under general anesthesia in the Ear, Nose and Throat Clinic, Military Medical Academy in Belgrade between 2006 and 2010. The patients were divided into two groups according to the type of lateral attic wall reconstruction: the group I of 60 patients with cartilage/bone plus temporalis fascia lateral attic wall reconstruction and the group II of 20 patients with only temporal fascia lateral attic wall reconstruction. Postoperative follow-up examinations were done at least 5 years after the surgery. The χ²-test was used to compare postoperative sequelae for two groups of operated patients with lateral attic wall reconstruction.

Results. The independent and paired samples t-test of air conduction and air-bone gap were used to compare the results of preoperative and postoperative hearing tests. Results. The differences between hearing measurements of the two groups according to preoperative and postoperative auditory thresholds of the air conduction and the air-bone gap were considered statistically significant. The difference between the two groups regarding to recurrent attic retraction pocket appearance and recurrence of cholesteatoma was considered statistically significant and the results were much better in the group I of the operated patients with cartilage/bone lateral attic wall reconstruction. Conclusion. “Wall up” tympanoplasty for attic cholesteatoma with lateral attic wall reconstruction leads to good anatomical and audiological results. A significant hearing improvement was obtained in both the types of lateral attic wall reconstructions in this study. Reconstruction with cartilage or mastoid cortical bone showed favorably long-term functional and anatomical results compared to primary tympanoplasty using only temporal fascia for lateral attic wall reconstruction in cases of attic cholesteatoma.

Key words: cholesteatoma, middle ear; tympanoplasty; otologic surgical procedures; recurrence; hearing; treatment outcome.

Ključne reči: uvo, srednje, holesteatom; timpanoplastika; hirurgija, otološka, procedure; recidiv; sluhi; lečenje, ishod.

Introduction

Attic cholesteatoma is keratin-producing squamous epithelium cyst (sac) in the epitympanum with or without spread in the mastoid or in the other parts of the middle ear. Attic cholesteatoma is a chronic disease of the middle ear which resors bone. Attic holesteatoma can damage hearing and vestibular function and sometimes leads to egzocranial and endocranial life-threatening complications. Not a single theory has been able to explain the clinical characteristics of all cholesteatoma types including attic holesteatoma: uncoordinated hyperproliferation, invasion, migration, altered differentiation, aggressiveness and recidivism. According to invagination theory of primary acquired holesteatoma development, the pathogenesis of attic holesteatoma has the following characteristics: Eustachian tube dysfunction; poor aeration of the epitympanic space; retraction of the pars flaccida; normal migratory pattern altered; accumulation of keratin, enlargement of the sac.

The early attic retraction pocket appearance signifies the beginning of attic holesteatoma. Mirko Tos published “Classification of the attic retraction pocket” in 1980 and it is still valid nowadays. Tos and Poulsen, and Sudhoff and Tos established four stages of pars flaccida retraction development. The stages are: stage I (pars flaccida is not adherent to the malleus); stage II (pars flaccida is adherent to the malleus); stage III (hidden retraction pocket); stage IV (hidden retraction pocket with erosion of outer attic wall-scutum).

For all these stages in classification of the attic retraction pocket, especially for the stage IV, we can say that there is a possibility for attic holesteatoma occurrence, known as „potential“ holesteatoma. The next step in attic holesteatoma development is the accumulation of keratin (debris) in the attic retraction pocketed with the possibility to clean it. If it is not possible to clean the debris (debridment) from the middle ear, then we can say that it is „dry“ holesteatoma. „Wet“ holesteatoma with periodical or constant otorrhea on the sick ear appears after infection with germs on „dry“ holesteatoma. How to manage early attic retraction pocket and prevent attic holesteatoma occurrence is still an unsolvable task for otologists. Retraction pocket is a precursor for recurrence of holesteatoma, too.

Otomicroscopy finding is almost enough to diagnosticate attic cholesteatoma. Several diagnostic procedures can also help to establish the final diagnosis of attic cholesteatoma: ear endoscopy, hearing tests, imaging – Schuller’s view X ray, temporal bone computed tomography (CT), cone beam CT. Surgery is still the only therapeutic treatment for attic holesteatoma. The objectives of attic holesteatoma surgery are to: remove the holesteatoma for cured dry ear; restore or maintain functional capacity of the ear; maintain normal anatomy (if possible); manage complications as priority.

Each case should be treated individually according to the extent/location of holesteatoma and preoperative counseling. Preoperative counseling with a patient about the advantages and disadvantages of various types of surgery is necessary. There are two types of attic holesteatoma surgery: canal “wall down” tympanoplasty; canal “wall up” tympanoplasty with the reconstruction of lateral attic wall “mur de loger”.

There are many disadvantages of canal “wall up” tympanoplasty. It is technically more difficult, staged operation is often necessary, residual holesteatoma is harder to detect, but this type of tympanoplasty maintains normal anatomy and restores function of the operated ear without water precaution. If it is necessary to wear hearing aid, it is easier to fit it in the canal “wall up” than in the canal “wall down” operated ears.

The aim of this study was to analyze the surgical and audiological results in tympanoplasties that use a logical application of several techniques for the management of attic holesteatoma.

Methods

This retrospective clinical study included 80 patients, aged 16–65 years, with attic holesteatoma (Figure 1) undergoing canal “wall up” tympanoplasty with lateral attic wall reconstruction under general anesthesia in the Ear, Nose and Throat (ENT) Clinic, Military Medical Academy (MMA) in Belgrade, between 2006 and 2010. A modification of the lateral attic wall reconstruction in cases of attic holesteatoma was accompanied by ossiculoplasty when it was necessary. A computerized otologic database and patient charts were used to obtain the necessary data. There were different kinds of at
tic cholesteatoma extension in the middle ear. Among 80 operated patients, 19 had attic cholesteatoma localized in the epitympanic space with or without expansion in the antrum or in the Prussak's space with complete ossicular chain with or without ossicular fixation. In the other cases (61/80) attic cholesteatoma spreaded from the attic to the antrum, mastoid process or in the cavum tympani causing ossicular interruption. The most common was the damage of the long process of the incus or the damage of the other part of the incus (59/80), followed by the damage of the stapes (26/80) and the damage of the malleus (8/80). We made ossiculoplasty in the most of the operated patients (61/80) to reconstruct the sound conducting mechanism. We performed one of the types of the ossiculoplasty: incus interposition (37/80), malleostapedopexy (12/80), malleolaplatonopexy (4/80), partial ossicular replacement prosthesis (PORP) (6/80) and total ossicular replacement prosthesis (TORP) (2/80). In all the cases with cholesteatoma affected incus, we used remodeling head of the malleus (4/37), interposed mastoid cortex bone (4/37), or interposed auricular cartilage (2/37) for the collumela effect instead of the incus.

The patients were divided into two groups according to the types of lateral attic wall reconstruction. Modification of one piece or the palisade technique was utilized for lateral attic wall reconstruction in cases of attic cholesteatoma (the group 1) (Figure 2): 1a) tragus perichondrium/cartilage island flap or; 1b) auricular cartilage with temporal fascia or 1c) mastoid cortex bone with temporalis fascia or the group 2: only temporal fascia. Postoperative follow-up examinations were done at least 5 years after the surgery. The first follow-up examination was two weeks after the surgery, then a month later and continued every three months during two years, and twice a year later on, if the postoperative period was neat. Our study was based on the otomicroscopy findings and a hearing test: audiometry with/without tympanometry and cone beam computed tomography (CT) of the temporal bones if necessary (Figure 3). Normal postoperative otomicroscopy finding or recurrent attic retraction pocket appearance or recurrence of cholesteatoma were recorded for each patient. The $\chi^2$-test was used to compare postoperative sequelae for the two groups of the operated patients with lateral attic wall reconstruction. Hearing results were reported using four-frequency (500, 1000, 2000, 4000 Hz) pure-tone auditory thresholds and air-bone gap (PTA-ABG). The independent and paired samples $t$-test were used to compare the results of preoperative and postoperative air conduction and air-bone gap.

**Results**

We performed combined approach tympanoplasty with lateral attic wall reconstruction into 80 of the patients with histopathology verified attic cholesteatoma. The patients were divided in two groups according to the type of lateral attic wall reconstruction. The group I of 60 patients was operated with tragus perichondrium/cartilage island flap (10 patients), auricular cartilage with temporal fascia (42 patients), and mastoid cortex bone with temporal fascia (8 patients). All 60 samples show almost similar hearing benefit and postoperative sequelae (Table 1). The group II of 20 patients was operated with only temporal fascia lateral attic wall re-
construction. The average duration of the follow-up period was 72 months (ranging from 60–88 months). A total of 8 (13%) cases with recurrent attic retraction pocket and 9 (15%) cases with recurrence of cholesteatomas were noted in the group I, tympanoplasty with cartilage/bone lateral attic wall reconstruction during the follow-up. A total of 6 (30%) cases with recurrent attic retraction pockets and 8 (40%) cases with recurrence of cholesteatoma were noted in the group II, tympanoplasty with only temporal fascia lateral attic wall reconstruction (Table 1). The difference between the two groups according to recurrent attic retraction appearance was considered no statistically significant ($p = 0.090, p > 0.05$), but the difference between the two groups according to recurrence of cholesteatoma was considered statistically significant ($p = 0.023, p < 0.05$). The preoperative mean air conduction was 43.75 dB and the air-bone gap was 21.24 decibels (dB) including all the patients. The postoperative mean air conduction was 22.46 dB and the air-bone gap was 7.94 dB including all the patients. The preoperative mean air conduction in the group I tympanoplasty with cartilage or bone reconstruction of lateral attic wall was 46.30 dB, $SD = \pm 8.00$ and air-bone gap was 21.72 dB, $SD = \pm 1.93$ and the postoperative results were 24.29 dB, $SD = \pm 4.25$, 8.54 dB, $SD = \pm 0.82$, and respectively. The preoperative mean air conduction in the group II tympanoplasty with only temporal fascia reconstruction of lateral attic wall was 41.20 dB, $SD = \pm 2.28$, the air-bone gap was 20.76 dB, $SD = \pm 2.27$ and the postoperative results were 20.63 dB, $SD = \pm 1.46$, and 7.33 dB, $SD = \pm 1.13$ respectively (Table 2). The difference between preoperative and postoperative mean auditory thresholds of the air conduction and the air-bone gap were considered, no statistically significant ($p > 0.05$). There was no statistically significant difference in auditory improvement ($p = 0.305$) between group 1 (mean = 22.01dB, $SD = \pm 4.07$) and the group 2 (mean = 20.57dB, $SD = \pm 1.09$). There was no statistically significant difference in air-bone gap improvement ($p = 0.683$) between group 1 (mean = 13.18dB, $SD = \pm 1.26$) and the group 2 (mean = 13.43dB, $SD = \pm 1.36$).

## Discussion

The incidence of recurrence of attic cholesteatoma is reported to vary (5–57%) according to data from the literature. Canal “wall up” tympanoplasty with lateral attic wall reconstruction provides a good anatomical and hearing result for solving attic cholesteatoma, according to many surgeons. Many surgeons agree that lateral attic wall reconstruction with cartilage gives better anatomical result than lateral attic wall reconstruction with only temporal fascia according to the appearances of recurrence of attic cholesteatoma in a long period of time. Actually, in our study, recurrence of cholesteatoma was rarely noted in a 5-year time in patients with cartilage lateral attic wall reconstruction (15%), contrary to only temporal fascia lateral attic wall reconstruction (40%). We used mastoid cortex bone for lateral attic wall reconstruction, except tragus or auricular cartilage, with equally good results. Whatever we use (cartilage or bone) for lateral attic wall reconstruction, the most important is to make it precisely to be fit for “mur de loget” reconstruction (Figure 4). There are no experiences with bone lateral attic wall reconstruction record in the “Pub Med” as we did with mastoid cortex bone.

### Table 1

<table>
<thead>
<tr>
<th>Recurrent/recidivism of disease</th>
<th>Lateral attic wall reconstruction (number of operated patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tragus cartilage (10)</td>
</tr>
<tr>
<td>Recurrent attic retraction pocket</td>
<td>2</td>
</tr>
<tr>
<td>Recurrent/recidivism of cholesteatoma</td>
<td>2</td>
</tr>
</tbody>
</table>

### Table 2

<table>
<thead>
<tr>
<th>Group of patients</th>
<th>Hearing test</th>
<th>Air conduction (db), mean ± SD</th>
<th>Mean air-bone gap (db), mean ± SD</th>
<th>Statistical significance within the group</th>
<th>Statistical significance between the groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>Preoperative</td>
<td>46.30 ± 8.00</td>
<td>21.72 ± 1.93</td>
<td>$p &lt; 0.000$</td>
<td>$p &gt; 0.05$</td>
</tr>
<tr>
<td></td>
<td>Postoperative</td>
<td>24.29 ± 4.25</td>
<td>8.54 ± 0.82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group II</td>
<td>Preoperative</td>
<td>41.20 ± 2.28</td>
<td>20.76 ± 2.27</td>
<td>$p &lt; 0.000$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Postoperative</td>
<td>20.63 ± 1.46</td>
<td>7.33 ± 1.13</td>
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Group I – patients with cartilage/bone lateral attic wall reconstruction; Group II – patients with only temporalis fascia lateral attic wall reconstruction.

Fig. 4 – Postoperative otomicroscopy finding with a shaped piece of auricular cartilage for attic wall reconstruction of the middle ear.

A special issue is whether there is any chance to manage early attic retraction pocket before it becomes a surgery problem. Deep attic retraction pocket is an indication for surgery nowadays, according to some surgeons 10, bearing in mind the fact that attic retraction pocket eventually leads to attic cholesteatoma appearance. How to manage the attic retraction pocket?

The Eustachian tube, epitympanic compartments and the anatomy of the atticotympanic diaphragm were examined to solve the problem of attic retraction pocket occurrence 11, 12. Eustachian tube dysfunction has been linked with the middle ear pathology and attic cholesteatoma. One of the Eustachian tube dysfunction sequelae seen is *pars flaccida* retraction of the tympanic membrane. The findings confirmed that Prussak's space has a wide connection with the mesotympanum through the posterior pouch of Troeltsch's space and may have an additional narrow passage in its roof to the lateral malleal space 13. The lateral incudomallear fold regularly separates the upper lateral attic from the lower lateral attic and the mesotympanum. The medial incudal fold as a rule is atrophic already at birth. The anterior tympanic isthmus thus extends from the tensor tympani tendon to the posterior incudal liga- ment and is the main passage for epitympanic and mastoid aeration. Openings in the tensor fold area, when present, are also important 11. Otherwise, tensor fold resection together with the lateral incudomallear fold can be used in the canal “wall up” tympanoplasty to improve attic aeration 14.

In some ears, the posterior tympanic isthmus may form an auxiliary narrow route for aeration via the incudal fossa. Concern occurs when the unregulated middle ear and mastoid aeration with Eustachian tube dysfunction and atticotympanic blockade becomes a chronic problem, leading to the attic retraction pocket followed by debris collection and fulminate attic cholesteatoma.

In order to prevent attic retraction pocket, nowadays otologists can do the following: observation (frequent control, debridement); diagnostic procedures (ear endoscopy with 0° and 30° angle, hearing tests – audiometry and tympanometry, imaging – especially cone beam CT with quite good visualisation of the temporal bones and 1,000 times less radiation dose comparing to multislice computed tomography (MSCT) 15 (Figure 2); aeration tube (T-tube maybe?) with N₂O insufflations (no statistical difference of attic cholesteatoma occurrence with or without implantation of aeration tube) 16; endonasal dilatation/tuboplasty of the Eustachian tube. Preliminary results suggest that laser Eustachian tuboplasty is safe and efficient in the treatment of intractable Eustachian tube dysfunction according to some authors 16, 17. Only a few otologists can say that a balloon Eustachian tuboplasty (BET) is a safe and effective treatment for improving Eustachian tube function and ear ventilation, but it remains to be seen in the future if it would help to prevent attic cholesteatoma occurrence 16, 18; surgery for deep attic retraction pocket. Tympanoplasty for the correction of a retraction pocket if the *pars flaccida* can prevent further attic retraction and cholesteatoma development 8. The question remains of is it necessary to operate deep attic retraction pocket if hearing is good and there is no otorrhea?

Conclusion

The attic cholesteatoma with a retraction pocket of the *pars flaccida* remains a difficult problem for the otologists to treat. It may lead to ossicular erosion and the interruption of ossicular chain causing difficult hearing loss. The type of tympanoplasty depends on the extent/location of cholesteatoma. A modification of the lateral attic wall reconstruction in cases of attic cholesteatoma was accompanied by ossiculoplasty when it was necessary. Tympanoplasty with lateral attic wall reconstruction leads to good anatomical and audiological results. A significant hearing improvement was accomplished in all the types of the lateral attic wall reconstructions. In attic cholesteatoma, tympanoplasty with lateral attic wall reconstruction using only one piece of cartilage or bone or the palisade technique resulted in precise reconstruction of the lateral attic wall, can prevent recurrent attic retraction development and help reduce recurrence of cholesteatoma. Reconstruction with cartilage or mastoid cortex bone showed better anatomical results compared to primary tympanoplasty using only temporal fascia for lateral attic wall reconstruction in cases of attic cholesteatoma. Postoperative hearing results were encouraging, too.

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