Mastoid and Epitympanic Bony Obliteration in Pediatric Cholesteatoma

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Objective: The primary goal of cholesteatoma surgery is complete eradication of the disease. To lower the recurrence rate in the pediatric population in canal wall up techniques and to avoid the disadvantages of canal wall down techniques, the bony obliteration technique with epitympanic and mastoid obliteration has been developed. The objective of this study was to evaluate the long-term surgical outcome and recurrence rate of this technique in children.
Study Design: Retrospective case review.
Setting: Tertiary referral center.
Patients: Fifty-two children (<16 yr) were operated on in 90.4% (n = 47) for a primary or recurrent cholesteatoma and in 9.6% (n = 5) for an unstable cavity.
Intervention: In all cases, we closed the tympanoattical barrier and the posterior tympanotomy with sculpted cortical bone and then completed obliteration of the epitympanum and mastoid with bone pâté. A reconstruction of the middle ear was performed by means of an allograft tympanic membrane including the malleus handle and a sculpted allograft malleus or incus for columellar reconstruction.
Main Outcome Measures: Recurrent rate; residual rate; functional outcome; hygienic status of the ear; long-term safety issues.
Results: The mean follow-up time was 49.5 months (range, 12–101.3 mo). Recurrent cholesteatoma occurred in 1.9% (n = 1). Residual cholesteatoma was detected in 15.4% (n = 8) of the cases. Postoperative hearing results revealed a median gain on pure-tone averages of 14.3 dB and a median postoperative air-bone gap of 25.6 dB.
Conclusion: The mastoid and epitympanic BOT is an effective technique to lower the recurrence rate of cholesteatoma in the pediatric population. Follow-up by magnetic resonance imaging provides a safe, noninvasive method for postoperative detection of residual cholesteatoma. **Key Words:** Bone pâté—Cholesteatoma—Mastoid obliteration—Mastoidectomy.
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The primary goal of the surgical treatment of chronic otitis media with cholesteatoma is the complete eradication of the disease (no residual disease), whereas secondary goals are the prevention of recurrent disease, the improvement of the hygienic status of the ear, and the preservation or improvement of hearing (1). Due to higher rates of recurrent and residual disease, children present a greater challenge than adults (2–6). Various techniques have been advocated in order to reach these goals. The canal wall down (CWD) mastoidectomy provides lower recurrence rates, but it often requires regular cavity cleaning and is associated with recurrent infection, water intolerance, caloric-induced vertigo, and the diminished ability to wear a hearing aid (7,8). The canal wall up (CWU) technique preserves the normal bony anatomy, avoids the disadvantages associated with cavities, and has shown better hearing results, but it has a significantly higher recurrence rate. Retraction pocket formation in CWU ears can lead to recurrent cholesteatoma. The bony obliteration technique (BOT) consists of the meticulous bony reconstruction of the canal wall and of sealing off the middle ear by means of sculpted cortical bone chips and then by a complete obliteration of the drilled-out epitympanum and mastoid with bone pâté. This seems to dramatically lower the incidence of recurrent disease. In this report, we describe our experience with the BOT in a pediatric series of cholesteatoma cases and in cases with an unstable cavity after CWD surgery for cholesteatoma. The indications, the surgical outcome including the recurrence rate, the residual rate, the functional results, and the otoscopic and imaging follow-up, are discussed. Our results should be considered preliminary until the complete 5- and 10-year follow-up results become available.

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MATERIAL AND METHODS

We retrospectively evaluated a series of 52 consecutive children younger than 16 years. All children underwent a CWU-BOT operation at the University ENT Department of the Antwerp St-Augustine Hospital between September 1997 and June 2006. Forty-seven children presented with a primary acquired (n = 16) or recurrent (n = 31) cholesteatoma and five children with a problematic or draining cavity. All surgery was performed by the two senior authors (E. O. and T. S.).

The following outcome measures were analyzed: recurrent rate, residual rate, functional outcome, hygienic status of the ear, and long-term safety issues. For this purpose, a database was created, including age at surgery, sex, side, history of surgery, surgical findings, otoscopic follow-up, and audiological testing results with preoperative and postoperative air conduction (AC), bone conduction (BC), air-bone gaps (ABGs), and pure-tone averages (PTAs). Audiological assessment was conducted every 3 months in the first postoperative year and once yearly in the following postoperative years in a sound-treated room using a Madsen Electronics OB 822 and Interacoustics AC33 Clinical Audiometer, calibrated according to ISO standards. No response to air-conducted sound was coded as 120 dB, and no response to bone-conducted sound was coded as 80 dB. Missing values were coded as such. The postoperative anatomical status of the external auditory canal (EAC) and tympanic membrane (TM) was evaluated by yearly otoscopic control, thus controlling for the presence of retraction pockets, canal wall breakdown, or recurrent cholesteatoma. The presence of residual cholesteatoma was visually evaluated during planned or functional second stage surgery or by the combination of high-resolution computed tomography (HRCT) and magnetic resonance imaging (MRI). Recurrent cholesteatoma is defined as a new cholesteatoma developing from an unsafe, non–self-cleaning retraction pocket. Residual cholesteatoma is defined as keratinizing squamous epithelium left behind during first-stage surgery, which has regrown into a visually identifiable cholesteatoma. Second-look surgery using a retroauricular (n = 23) or transmeatal approach (n = 19) was executed after 12 months. The decision to stage was taken by the surgeon during the first-stage surgery based on the extent and characteristics of the cholesteatoma and on the surgical complexity of the anatomy. Although the bony reconstruction of the canal wall and of the tympanoattical barrier was always performed at the first stage, in 23 cases, the obliteration of the mastoid and attic space with bone pâté was postponed until the second stage for safety reasons, taking into account the possibility of residual disease. During second-look surgery, subsequent bony obliteration and, if needed, functional correction were performed. When we considered the odds for residual disease negligible, no second-stage surgery was performed. However, all patients were regularly followed up by yearly micro-otoscopy and by HRCT and MRI including non–echo-planar diffusion-weighted imaging (non–EPI DWI) sequence at 1 and 5 years after surgery. Adequate long-term imaging follow-up of obliterated mastoids is compulsory to prevent late complications due to residual cholesteatoma. Counts, percentages, histograms, and box plots were used to describe nominal data. Statistical analysis was performed using a t test, and significance was defined as $p < 0.05$.

Surgical Technique

The BOT was applied in two subgroups of the study population. The first group comprised cases with either primary cholesteatoma or recurrent cholesteatoma after previous CWU surgery. The second group comprised cases with an unstable cavity. In both groups, the same surgical principal was applied. Surgery was performed under general hypotensive anesthesia using facial nerve monitoring. A classic retroauricular incision was followed by the elevation of anteriorly based dermal and musculoperiosteal flaps. Cortical bone chips were harvested using a flat chisel and put aside. A bone pâté collector (Bess, Berlin-Zehlendorf, Germany) and a cutting burr were used to collect healthy bone pâté from the cortex of the mastoid and if needed from the squama of the temporal bone. Care was taken not to damage the soft tissues and not to harvest diseased bone. The bone pâté was mixed with an antibiotic solution (rifamycin solution, 500 mg/10 ml) forming a semisolid paste. A cortical mastoidectomy and a wide posterior tympanotomy using the CWU technique were performed. In contrast to the original Mercke technique (9) and the technique described by Gantz et al. (10), the posterior canal wall was left intact during the whole procedure. Our aim was to preserve maximum vitality of the remaining bony canal wall, thus speeding up the healing process. The cholesteatoma, diseased soft tissue, ossicular remnants (eroded incus/malleus), and unhealthy bone were completely removed, and all cell tracts were cleaned.

If the malleus handle was favorably positioned for columellar reconstruction to the head of the stapes or to the footplate, the head of the malleus was removed using a malleus nipper. Bone chips were sculpted and placed at the tympanoattical barrier and posterior tympanotomy to completely seal off the epitympanum and mastoid from the middle ear cavity. Lesions of the scutum and the bony canal wall were carefully reconstructed with sculpted solid cortical bone. In case of a radical cavity, the epithelial lining and all pathological remnants were first removed, and the remaining mastoid cavity was adequately checked and drilled to remove mucosal remnants. Harvested cortical bone was sculpted to form a new bony canal wall in continuity with the complete closure of the tympanoattical barrier. The paratympanic space was thus completely isolated from the middle ear cavity by a solid bony partition. It was then progressively and completely filled up with bone pâté, up to the level of the cortex. An M-meatoplasty according to Mirck (11) was often performed to optimize the size of the external meatus, thus stimulating the self-cleaning capacity of the outer ear canal. The middle ear reconstruction was performed using a tympano-ossicular allograft (TOA) (12). The allograft consisted of a meatal periosteal cuff in continuity with the TM and malleus handle. The malleus head was removed with a malleus nipper at the level of the lateral process of the malleus. The allograft TM (with malleus handle) was rotated clockwise (left ear) or counterclockwise (right ear) to place the malleus handle in an advantageous position, perpendicularly centered above the oval window. This allows for the most effective columellar energy transduction between the implanted malleus handle and the stapes or stapes footplate. The ossicular reconstruction was executed using a remodeled allograft incus or malleus. If needed, a thin silastic sheet (0.5 mm) was placed extending from the protympanum to the retrotympanum, to avoid fibrous adhesions and to promote the regrowth of healthy middle ear mucosa during postoperative healing. Perioperative intravenous antibiotics (cefazoline) were continued for 24 hours. Patients were sent home with amoxicillin-clavulanate or cefuroxim in case of penicillin allergy for 5 days. TOA are harvested and prepared at the tissue bank of the St-Augustine Hospital, according to the standards of the Belgian law (Belgisch Staatsblad 13.6.86). Immediately after removal from the cadaver, the grafts are fixed for at least 2 weeks in a solution of 4.5% buffered formaldehyde. After dissection, tissues are preserved

TABLE 1. *General patients characteristics (n = 52)*

Mean age	11.6 years (range, 5–16 yr; SD, 2.81)
Sex (M/F)	34:18
History of surgery	36 patients (69.2%)
Mean postoperative follow-up	49.6 months (range, 12–101 mo)

in Cialit (15,000 aqueous solution of a sodium salt of an organomercuric compound) for a period of 3 weeks to 2 months. This study does not address the alleged risk of transfer of infectious diseases, such as Creutzfeldt-Jacob disease (CJD) and human immunodeficiency virus (HIV) infections. Transmission of CJD has been reported after implantation of dura mater (13) or corneal grafts (14). It has, however, never been reported after transplantation of tissues other than brain, cadaveric dura matter, or corneal grafts. In addition, the incidence of CJD is extremely low (1: 1,000,000), and the applied stringent criteria for donor selection exclude donors at risk for CJD. No reports of transmission of HIV by nonvital allograft material have appeared in the literature. Formaldehyde, used in the preservation of allografts, is known to inactivate HIV readily (15).

RESULTS

Fifty-two children underwent the BOT. Thirty-four (65%) were males and 18 (35%) were females. One child had a cleft palate. The mean age was 11.6 years (range, 5–15 yr). Thirty-six patients (69.2%) had a history of ear surgery. The mean postoperative follow-up period was 49.6 months (range, 12–101.3 mo; Table 1). Twenty-one (40.4%) of the children had a follow-up period of 5 years. Three patients were followed for more than 8 years. At latest follow-up, a safe, dry, and trouble-free graft was present in 46 children (88.5%). One patient developed a perforation after an acute otitis media during the sixth postoperative year. In five patients, otoscopic follow-up revealed the presence of a self-cleaning mesotympanic retraction pocket, one of which progressively evolved toward a recurrent

cholesteatoma in the third year of otoscopic follow-up (Figs. 1 and 2). In this case, revision surgery revealed the presence of a mesotympanic atelectatic TM, partial resorption of the tympanoattical barrier with extension of the retraction into the attic, and presence of cholesteatoma (Fig. 3). Reclosure of the epitympanum by means of bone chips and pâté, in combination with cartilage tympanoplasty, was performed. During subsequent follow-up, no new recurrence developed. In three other patients, the self-cleaning retraction was surgically corrected using cartilage reinforcement during planned functional surgery. The fifth retraction pocket remained self-cleaning and stable during follow-up. The percentage of ears that remained without recurrent disease was 98.1% (n = 51). In 52% (n = 27) of all cases, a preliminary (n = 6), first-stage (n = 20) or second-stage (n = 1) M-meatoplasty has been performed to widen the external meatus, thus enhancing the self-cleaning capacity of the outer ear canal. Second staging by means of second look tympanotomy (n = 42) or imaging follow-up (HRCT and non–EPI DWI; n = 31) revealed in eight cases the presence of a residual cholesteatoma pearl, each of which was present in the tympanic cavity (15.4%). No residual cholesteatoma within the bony obliteration was detected to date.

One case of the studied population needed readmission for wound infection, which was treated with intravenous antibiotics. This case was one of the first cases in our series and did not receive preoperative and postoperative antibiotics. Following this event, antibiotics became the rule. No other complications (facial nerve, SNHL, bone resorption, or canal wall breakdown) occurred in this studied population. A list of complications is summarized in Table 2.

A reconstruction of the ossicular chain was attempted during primary surgery in all patients. One of the reconstructive advantages of TOAs is that they allow a stable positioning of the TM. The fibrous annulus is anchored in the patient's bony annulus, and the periosteal cuff of
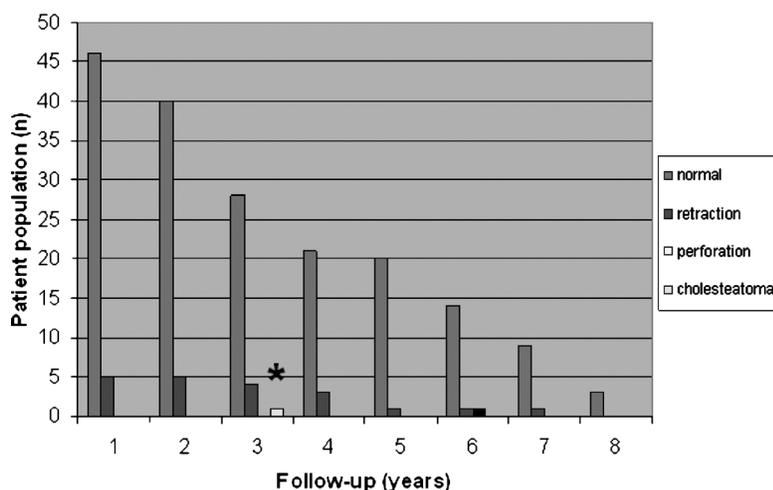
FIG. 1. Histogram showing population follow-up data (n): Aspect of the tympanic membrane (TM); normal, retraction, perforation TM, or cholesteatoma. An asterisk shows the occurrence of a recurrent cholesteatoma after 3 years of follow-up (*see text for further details*).
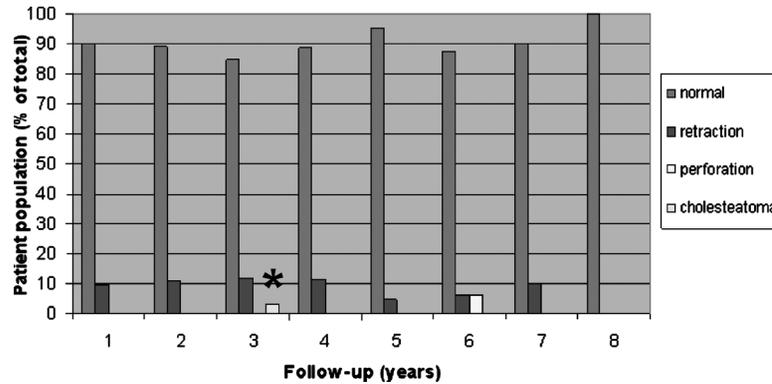
FIG. 2. Histogram showing population follow-up data (% of total population): Aspect of the tympanic membrane (TM): normal TM, retraction TM, perforation TM, or cholesteatoma. An asterisk shows the occurrence of a recurrent cholesteatoma (*see text for further details*).

the graft is securely glued in place in the bony EAC. The implanted malleus handle forms an integral part of the graft and allows for stable anchoring of the remodeled allograft ossicle as a columellar reconstruction to stapes or stapes footplate. If a residual cholesteatoma pearl is detected at second stage or by follow-up MRI, the columella can be removed with the pearl and a new ossicular reconstruction can be made.

At primary surgery, the stapes superstructure was absent in 61.5% (n = 32) due to destruction by primary
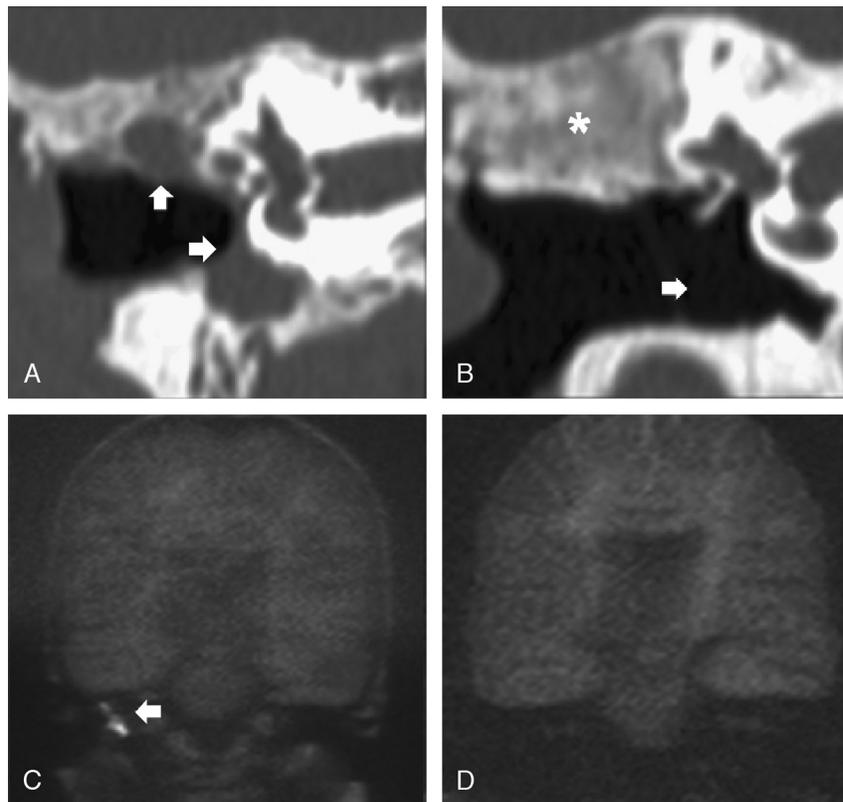
FIG. 3. Postoperative imaging performed after primary bony obliteration. *A*, Coronal reformation HRCT image of a patient showing the presence of an atelectatic tympanic membrane with an attical soft tissue lesion causing a partial destruction of the attico-tympanal barrier, suggestive for the presence of a recurrent cholesteatoma (*arrows*) of the right ear. *B*, Coronal reformation HRCT images of a patient with normal postoperative bony obliteration with an homogeneous obliteration (*asterisk*) and middle ear aeration (*arrow*). *C*, Coronal non echo-planar diffusion weighted image (same patient as Fig A) showing a nodular hyperintense lesion on the right side (*arrow*), characteristics for the presence of a recurrent cholesteatoma. *D*, Coronal non echo-planar diffusion weighted image (same patient as Fig D) showing no clear nodular hyperintensity.

TABLE 2. *Postoperative complications after using the BOT (see text for further details)*

Postoperative wound infection	1
Perforation	1
Mesotympanic self-cleaning retraction	4 (5)
Residual cholesteatoma	8
Recurrent cholesteatoma	1

TABLE 3. *Detailed summary of the postoperative hearing levels of 52 children for whom full audiometric data were available 1 year postoperatively*

	Percentage ABG closures (n = 52)
0–10 dB	13.4% (n = 7)
11–20 dB	30.8% (n = 16)
21–30 dB	25% (n = 13)
>31 dB	30.8% (n = 16)

The hearing results (PTA) are expressed in percentages of ABG closures.

or recurrent cholesteatoma. A fixed footplate was found in 5.7% of the patients (n = 3). The median preoperative PTA-AC was 51.67 dB with a median preoperative PTA-ABG of 43.32 dB. Postoperative hearing results were assessed after 1 year and revealed a median gain on PTA of 15 dB and median postoperative ABG of 25.6 dB. The postoperative ABG closure after ossicular reconstruction is presented in Figure 4 and Table 3. No statistically significant difference was found between preoperative and postoperative bone conduction ($p > 0.05$; t test). In 44% (n = 23/52) of the patients, a functional correction was attempted during second-look surgery, using a remodeled malleus (n = 18) or incus allograft (n = 5). In several children, a conductive hearing loss

persisted because of the lack of middle ear aeration or because of a fixed footplate (n = 3).

DISCUSSION

The goals of the surgical treatment of middle ear cholesteatoma are the complete eradication of the disease, the prevention of recurrent cholesteatoma, the restoration of the hygienic status of the ear, and the preservation or improvement of the hearing (1). Two basically different
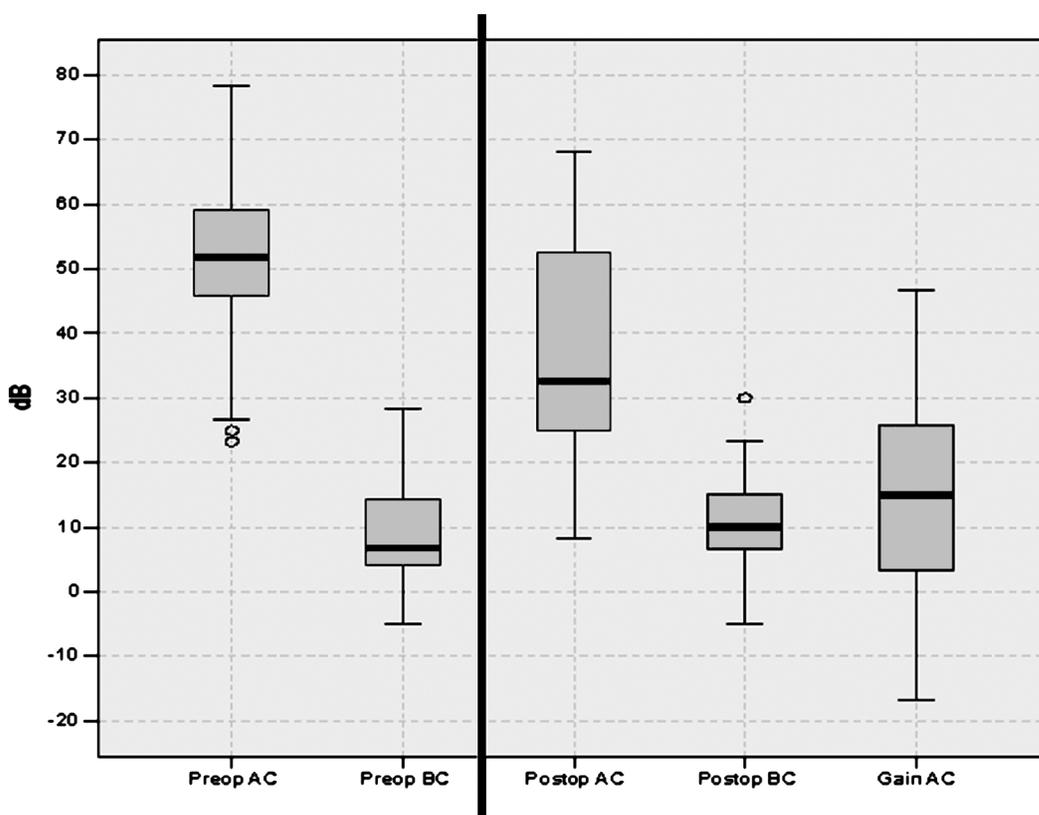
FIG. 4. Pre- and postoperative hearing levels in 52 children for whom full audiometric data were available 1 year postoperatively. Box and Whisker plots showing pre- and postoperative hearing thresholds (PTA). *Preop BC,* preoperative bone conduction threshold; *Preop AC,* preoperative air conduction threshold; *Postop AC:* postoperative air conduction threshold; *Postop BC,* postoperative bone conduction threshold; *Gain AC,* difference between Preop AC and Postop AC. *Whiskers,* minimum values; *Large rectangles,* 25th–75th percentile; *Small horizontal black bars,* median values; *Dots,* outlying value.

techniques have been advocated to reach these goals: CWU and CWD techniques. The advantages of the CWD technique are as follows: no need for staging, a lower rate of residual cholesteatoma, and a lower rate of recurrent cholesteatoma. On the other hand, the advantages of the CWU technique are as follows: a better hygienic status of the ear and a better functional outcome (2–5). The disadvantages of the CWD technique are associated higher morbidity, such as the need for regular cleaning, recurrent infections, water intolerance, caloric-induced vertigo, and the difficulty to wear a hearing aid if needed; and a worse functional outcome. The disadvantages of the CWU technique are the need for second and potentially further staging, the need for long-term follow-up to detect recurrent cholesteatoma, higher rates of residual disease, and higher rates of recurrent disease (1–8).

In 1997, we decided to find out whether it is possible to combine the advantages and, at the same time, avoid the disadvantages of both the CWU and CWD techniques: the mastoid and epitympanic bony obliteration. As a comparison basis for our study, we used our previously published results of the conventional CWU with TOA reconstruction (16) and the results of the CWU and CWD techniques available in the literature.

Many materials have been used to obliterate the mastoid cavity (17) including autologous material as fascia, fat, vascularized musculoperiosteal flaps, cortical bone chips, cartilage and bone pâté, and other biocompatible materials such as hydroxyapatite granules/cement (18–19) and demineralized bone matrix (20). Preservation and/or reconstruction of a normal anatomy of the EAC and TM are possible in most patients. The presence of a solid bony barrier and obliteration of the mastoid with bone pâté close off the epitympanum and mastoid from the middle ear cavity and seem to lower the incidence of new retractions of the TM.

Rate of Recurrent and Residual Cholesteatoma

In our study, the recurrence rate was 1.9% after a mean follow-up of 49.6 months (range, 12–101.3 mo). This compares very favorably to the outcome of our previously published series of the CWU technique in a pediatric population, which showed a recurrence rate of 18% after a mean follow-up of 54 months (range, 12–191 mo) (16). It seems safe to infer that bony obliteration enhances the biological stability of the ear, probably by reducing the size of the middle ear cell system, thus decreasing the total surface of mucosal lining and diminishing its capacity for gas absorption and/or inflammation. Our results confirm the lower recurrence rates of the BOT in a pediatric population reported by Gantz et al. (10). Other reports on complete bony obliteration showed similar results in an adult and childhood cholesteatoma population (9,10,17–23). The results also compare favorably to the outcome of other papers reporting on the results of the conventional CWU technique in pediatric cholesteatoma (3–5).

Moreover, our results are not inferior to the recurrence rate reported by authors using the CWD technique (3,6–8). It must be emphasized that our results must be considered preliminary until the full 5- and 10-year follow-up results of the presented series have become available. Therefore, it is obvious that long-term, yearly otoscopic follow-up remains the criterion standard in cholesteatoma surgery. The residual rate in our study was 15.4%, as evaluated by the combination of staging and postoperative imaging. It is lower in comparison with the results of our previously published conventional CWU study on pediatric cholesteatoma, which showed a residual rate of 27% (16). To date, no residual cholesteatoma has been detected within the obliterated paratympanic spaces. However, given the nonnegligible rate of residual disease, it remains compulsory to apply a very strict follow-up. In all our cases nowadays, a non–EPI DWI control is executed or planned at 5 years after surgery (Long-Term Safety Issues).

Functional Outcome

The functional outcome at 1 year of this series seems somewhat poorer or similar than those reported by some others in CWU surgery (1,3,5,7,16) but comparable to those reported by Gantz et al. (10) after pediatric bony mastoid obliteration. Despite the fact that these children experienced poor hearing with a median preoperative PTA-AC of 51.67 dB and median preoperative PTA-ABG of 43.3 dB, postoperative measurements revealed a marked improvement with acceptable hearing results with a median postoperative PTA-ABG of 25.6 dB, a median postoperative PTA-AC of 32.5 dB, and PTA-ABG closure 20 dB or less in 30.9% (Table 3).

The improvement is probably due to the fact that we now position the malleus handle of the TOA in a more advantageous position, as compared to the conventional position of the monobloc TOA. In the latter case, a full-monobloc TOA, consisting in a TM, malleus, incus, and the anterior stapedial crus with half a footplate, is used for the reconstruction of the middle ear. In our actual series, we used a columellar reconstruction between the malleus handle and the stapes head or footplate. However, by a slight rotation of the graft, the malleus handle is placed in a more favorable position, perpendicular to the center of the oval window. This allows for the most effective energy transduction. Although a columellar reconstruction seems to achieve better functional results, the conventional drawbacks are its long-term instability and its tendency toward extrusion. The use of TOAs for columellar reconstruction offers a distinct advantage. The malleus handle is firmly incorporated in the allograft TM and, as such, forms a stable anchor point for the columella, while at the same time, it protects against columellar extrusion. The functional outcome of our series compares poorly to the results of noncholesteatoma chronic otitis surgery. This is due to the high percentage of cases in which the stapes

superstructure was absent (61.5%), to the fixed footplate in 3 cases, and to the fact that, in cholesteatoma ears, an essential precondition for functional success, that is, normal middle ear aeration, is often lacking.

Hygienic Status of the Ear

At latest follow-up, a safe, dry, and trouble-free graft was observed in 46 children (88.5%). All patients are still followed up by yearly otoscopic control. With the exception of the perforated case, all ears are dry, self-cleaning, and water-resistant to date. The combined presence of a normal-sized external meatus, achieved in 52% of the cases by means of an M-meatoplasty, of a normal-sized ear canal protected by a solid bony wall, and of a TM well placed in its normal position seems to provide the ideal basis for a stable hygienic condition of the ear.

Long-Term Safety Issues

The long-term safety of the ear is a primary concern in cholesteatoma surgery, especially in children. Therefore, surgical staging to detect residual cholesteatoma has been advocated by most authors (1–5,9,10). Adequate imaging follow-up of obliterated mastoids is necessary to prevent late complications when residual cholesteatoma remains buried in the bony obliterated mastoid. HRCT has been shown to be very effective in excluding and detecting small pearls in obliterated mastoids, presenting as punched-out lesions in the dens bone (24,25). However, in the case of associated opacified lesions, further characterization of the lesion by MRI will be necessary. Until recently, small residual pearls (<5 mm) could not be detected using DWI (24,26).

The recent availability of the non–EPI DWI MRI sequence offers a safe, noninvasive, selective, sensitive, and comparatively cheap alternative to exploratory staged surgery. It allows for the detection of cholesteatoma pearls down to a size of 2 mm (27–29). Because we allow for the possibility that it takes more than 1 year for a residual pearl to develop into a detectable lesion, we now routinely image all our cholesteatoma cases at 1 and 5 years postoperatively. MRI thus effectively replaces second-stage surgery in our department for 2 years. Offsetting the cost of surgical staging to the cost of twice-repeated MRI, this protocol is not only less burdening to the patient on a practical and emotional level but also compares most favorably on the budgetary level for both the patient and the public health system. Our analysis showed that the full HRCT and MRI protocol, repeated twice, is six times cheaper than exploratory surgery within the Belgian context. We recently completed the validation process of the non–EPI DWI MRI sequence (29). Therefore, we now use only this sequence in the follow-up screening for residual cholesteatoma. For screening purposes, we deem the use of HRCT and the use of the MRI sequence 45 minutes after injection with gadolinium no longer necessary. The advantages are evident. 1) The non–EPI DWI sequence by itself takes less than 5 minutes to execute. On the logistic level, this optimizes patient put-through in the radiology department.

2) The cost of the expensive gadolinium is avoided. 3) The examination becomes much less burdening for the patient on the emotional level. In conclusion, the financial and emotional cost of follow-up screening for residual disease of cholesteatoma becomes negligible in comparison with the cost of exploratory surgery in cases without residual disease.

CONCLUSION

Our results indicate that the BOT, performed in children with primary/recurrent cholesteatoma or unstable cavities reconstruction of cavities, is a very useful technique to deal with the higher rates of residual and recurrent cholesteatoma in the pediatric population. The results show that the incidence of recurrent cholesteatoma has dramatically declined. Acceptable functional results have been achieved. The problem of residual cholesteatoma can be safely dealt with by staging and/or postoperative imaging, using a combination of CT and new MRI techniques including non–EPI DWI MRI. We are using this surgical technique in the majority of cholesteatoma cases.

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