PRACTICE PEARLS

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Reconstruction and Obliteration of Mastoid Cavities Using Autologous Bone Dust and Conchal Cartilage: Restoring a Self-Cleaning, Waterproof and Acoustically Functional Ear

ABSTRACT

Objective: To describe a practical surgical approach for mastoid cavity obliteration and canal wall reconstruction using autologous bone dust and conchal cartilage applied either during primary canal wall up (CWU) surgery or in revision of prior canal wall down (CWD) mastoid cavities, with the aim of restoring a self-cleaning, waterproof ear that retained its natural acoustic resonance.

Methods: The indications, surgical technique, and follow up and imaging surveillance were described, detailing patient selection, harvesting and application of autologous materials, and the key technical steps for cavity obliteration and posterior canal wall reconstruction. The importance of preserving the ear canal's standing wave resonance (~2000–2500 Hz) for optimal hearing was emphasized. Postoperative monitoring with non-echo planar diffusion-weighted imaging (DWI) MRI was recommended at least 1.5 years after surgery to detect residual or recurrent cholesteatoma.

Results: This technique was performed successfully in 88 patients (32 males and 56 females, aged 6–80 years) across four hospitals in Metro Manila from January 2020 to July 2025. All patients had unremarkable postoperative courses and healed within three months. Among the 67 who underwent DWI MRI after 18 months, two required revision mastoidectomies with mastoid obliteration for cholesteatoma recidivism—one with residual and one with recurrent disease.

Conclusion: Mastoid obliteration and reconstruction using autologous bone dust and cartilage has proven to be a safe, effective and cost-efficient technique. It converts problematic open cavities into dry, self-cleaning ears suitable for swimming while preserving the acoustic benefits of a near-normal ear canal. Long-term follow-up with diffusion-weighted imaging (DWI) MRI is essential to ensure durable disease control.

Keywords: *mastoidectomy; reconstructive surgical procedures; bone transplantation; cartilage, auricular; cholesteatoma, middle ear; magnetic resonance imaging, diffusion-weighted; postoperative care; hearing*

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The author declared that this represents original material that is not being considered for publication or has not been published or accepted for publication elsewhere, in full or in part, in print or electronic media; that the manuscript has been read and approved by all the authors, that the requirements for authorship have been met by each author, and that each author believes that the manuscript represents honest work. Verbal consent was obtained from the patient for publication of this case report and accompanying images.

Disclosures: The author signed disclosures that there are no financial or other (including personal) relationships, intellectual passion, political or religious beliefs, and institutional affiliations that might lead to a conflict of interest.

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Cholesteatoma has remained to be a significant otologic challenge and often requires canal wall down (CWD) mastoidectomy in order to achieve complete disease eradication. However, the resulting open cavity frequently leads to lifelong problems, including chronic discharge, the need for periodic cleaning, and strict water precautions that limit daily activities such as swimming.

To address these issues, mastoid cavity obliteration with posterior canal wall reconstruction emerged as an effective strategy for selected patients.[1] When feasible, preservation of the canal wall in primary canal wall up (CWU) surgery, combined with meticulous disease clearance and obliteration of hidden recesses, prevented cavity-related problems altogether. Autologous materials such as bone dust (or bone pâté) and conchal cartilage were practical, cost-free, and biocompatible, making them particularly suitable for both primary and revision mastoid surgeries in resource-limited settings.[2] Beyond creating a self-cleaning, waterproof ear, reconstruction of the external auditory canal also restored its natural resonance function, providing a standing wave boost in the 2000–2500 Hz range that was critical for speech understanding and hearing aid performance.[3]

We describe a practical technique for cavity obliteration and canal wall reconstruction using autologous bone dust and conchal cartilage, with emphasis on both functional and otologic outcomes.

METHODS

Indications

This procedure was indicated for patients who had persistent, troublesome open cavities after a prior CWD mastoidectomy, or for those who had undergone a primary CWU mastoidectomy for cholesteatoma in which cavity obliteration minimized hidden recesses. It was performed in the course of routine clinical care on our patients who were motivated to achieve a dry, self-cleaning ear that tolerated swimming and daily water exposure, and who had no evidence of residual cholesteatoma or active infection at the time of reconstruction.

No experimental interventions outside routine clinical care were undertaken. All patients consented to undergo the procedure and have their outcomes reported. Patient data were anonymized and presented in aggregate. The intraoperative images were de-identified and used solely for educational and illustrative purposes. All surgeries were performed by the author.

Preoperative assessment included detailed otomicroscopy and high-resolution computed tomography (HRCT) to determine the extent of revision or preservation. In revision cases, the assessment focused on identifying residual or recurrent disease. Preoperative DWI MRI was sometimes helpful but it did not replace intraoperative inspection.

Surgical technique

Cavity clearance and preparation in primary CWU surgery involved meticulous removal of disease, smoothing of deep pockets, and preparing the cavity for obliteration. In CWD revision, the first step was to widely expose the mastoid cavity through a postauricular approach. All debris, granulation tissue, and any residual cholesteatoma were removed, and the bony cavity margins were saucerized and smoothened.

Harvesting of autologous materials was then performed. Bone dust or pâté was obtained during drilling of the mastoid cortex. Clean dust, free of blood and debris, was collected and mixed with a small amount of sterile saline or the patient's blood to form a cohesive paste. Conchal cartilage was harvested through the same postauricular incision, with perichondrium preserved whenever possible. The cartilage was trimmed to a thickness of 1 mm or less.[4] *(Figure 1)*

Canal wall reconstruction and cavity obliteration began with the use of thinned cartilage pieces to rebuild the posterior canal wall framework. The cartilage segments were layered to restore the natural contour and diameter of the bony external auditory canal. *(Figure 2)* Deeper recesses were packed with cartilage to provide volume and stability, and bone dust or pâté was then molded to fill the remaining spaces and to smooth the transitions between native bone and cartilage. *(Figure 3)* The newly reconstructed canal wall was carefully aligned with the external auditory canal to promote a continuous epithelial surface. The obliterated attic and mastoid cavity supported and held the reconstructed posterior canal wall in place. When required, tympanoplasty was performed using the remaining cartilage, perichondrium, or a temporalis fascia graft. *(Figure 4)*

Closure involved layered reconstruction of the soft tissues followed by the application of a mastoid dressing. Postoperative care required keeping the ear dry and clean until epithelialization was complete. Regular microscopic cleaning was performed during the healing period. Once full healing was achieved, patients were able to safely resume swimming and other normal water activities.

Follow-up and Imaging Surveillance

Residual or recurrent cholesteatoma was always a risk with any obliteration technique, making long-term disease monitoring equally important. Clinical examination alone was not sufficient to rule this out. Non-echo planar DWI MRI had become the gold standard for detecting residual or recurrent cholesteatoma, *(Figure 5)* but it was ideally performed after at least 18 months, as evidence showed that residual pearls were best detected when scans were obtained 1.5 years or more postoperatively.[5] Repeat imaging was considered based on symptoms or any suspicious findings during follow-up.

RESULTS

This technique was used by the author in 88 patients at the Manila Doctors Hospital, Makati Medical Center, Asian Hospital and Medical Center, and East Avenue Medical Center between January 2020 and July 2025. The series included 32 males and 56 females, with ages ranging from 6 to 80 years. Indications for surgery were chronic otitis media in 46 patients (52%), chronic otitis media with cholesteatoma in 41 patients (47%), and tuberculous otitis media in 1 patient (1%).

All patients had unremarkable immediate postoperative courses and healed within three months. Of the 88 patients who underwent surgery, 86 remained free of infection and cholesteatoma. Among the 67 patients who underwent MRI after 18 months, wherein the average MRI was done at around 22 months, two demonstrated cholesteatoma recidivism—one with residual cholesteatoma and one with recurrent cholesteatoma. Both required revision mastoidectomies with mastoid obliteration since they also presented with clinical recidivism symptoms such as otorrhea, hearing loss, and ear fullness prior to their subsequent surgery. Aside from these two cases, the remaining patients were clinically well and had unremarkable MRI results. None of the patients exhibited facial ridge exposure, prolonged healing time, remarkable infection, nor posterior canal wall retraction after their surgery. *(Figure 6)* There were only 67 patients who had their MRI done because the rest of the patients included in the set still did not reach their 18 months MRI threshold at the time of writing. None of these patients have exhibited any clinical recidivism symptoms since their surgery.

DISCUSSION

This approach to reconstruction and obliteration of mastoid cavities using autologous bone dust and conchal cartilage provides a practical solution for both revision and primary cholesteatoma surgery in the Philippine context, where cost-effective and accessible materials are essential. The technique is straightforward, relies solely on autologous grafts, and requires no expensive synthetic substitutes.

The benefits are two-fold: first, the procedure restores a self-cleaning, waterproof cavity that reduces chronic discharge and allows patients to swim freely, significantly improving their quality of life;[6,7] and second, it preserves acoustic function by maintaining the natural resonance boost at around 2000–3000 Hz, thereby enhancing speech perception.[8] Meticulous surgical technique and long-term monitoring with DWI MRI are essential to prevent residual disease and to ensure the benefits of obliteration without compromising otologic safety.[9]

The concept of mastoid cavity obliteration was first introduced by Mosher in 1911, when he described filling the excavated mastoid using a flap from the auricle (conchal region).[10] Palva later combined a musculoperiosteal flap with bone pâté and bone chips to obliterate the

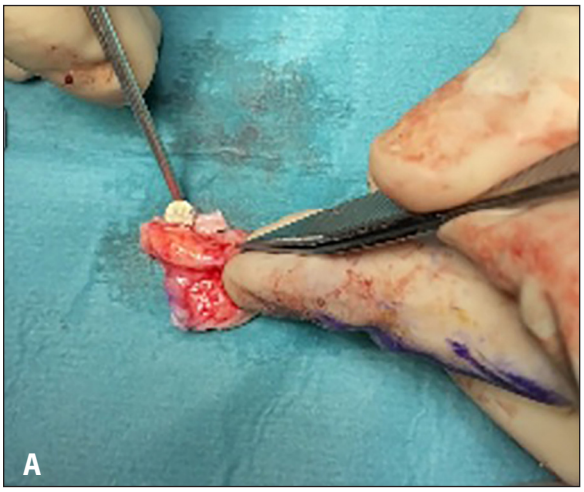

Figure 1A. Separation of the perichondrium from the conchal cartilage

Figure 1B. Slicing and thinning of the conchal cartilage parallel along the plane of the cartilage

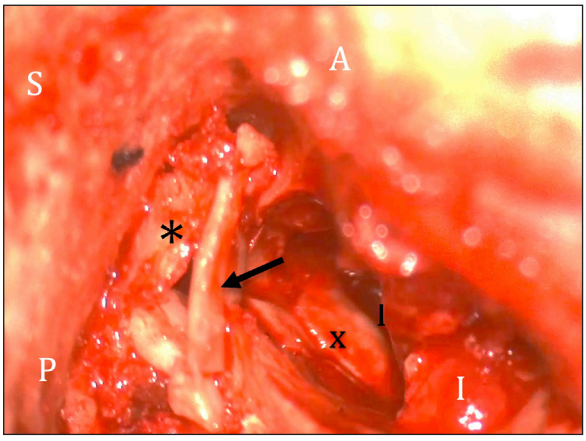

Figure 2. A right reconstructed posterior canal wall using conchal cartilage. Note the reconstructed posterior canal wall (arrow), the reconstructed tympanic membrane (X) and the obliterated attic (asterisk). S=superior, P=posterior, A=anterior, I = inferior.

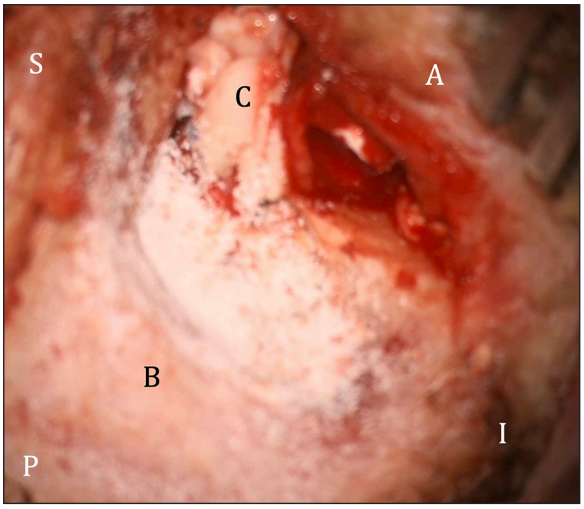

Figure 3. An obliterated mastoid cavity using conchal cartilage and bone pâté (right ear); C = cartilage, B= bone pâté. S=superior, P=posterior, A=anterior, I = inferior

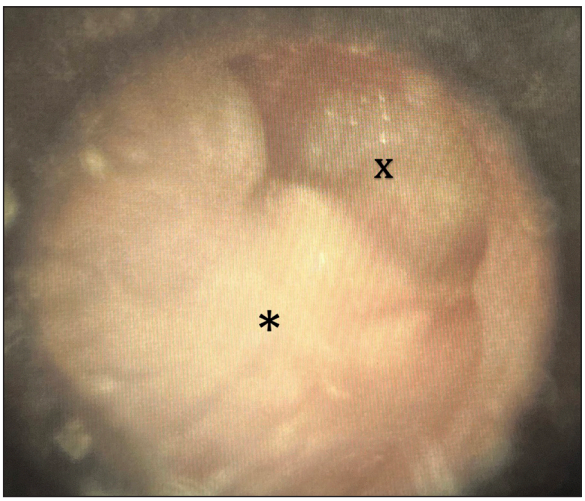

Figure 6. An otoscopic view showing a reconstructed posterior canal wall (asterisk) with a partial view of a tympanoplasty (X) done on the right ear 5 years before

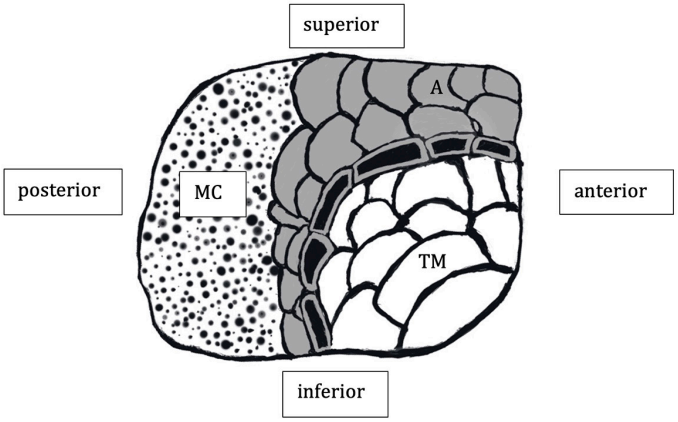

Figure 4. Schematic diagram showing a surgical (lateral) view of a right ear using sliced conchal cartilage for tympanoplasty (shaded in white), posterior canal reconstruction (shaded in black), mastoid and attic obliteration (shaded in grey) combined with bone pâté (stippled area); TM = area of the reconstructed tympanic membrane. A = area of the obliterated attic. MC = area of the obliterated mastoid cavity.

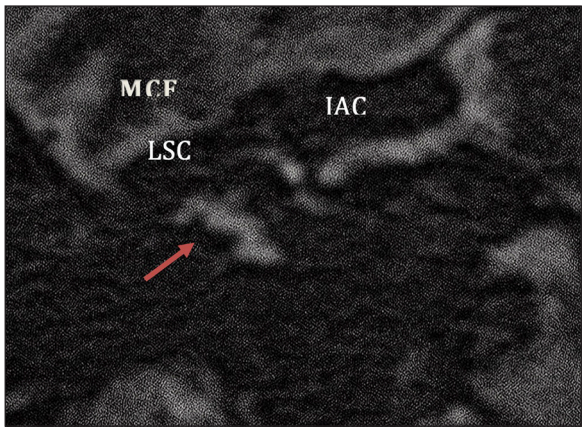

Figure 5. A diffusion-weighted MRI coronal section of a right ear that showed cholesteatoma recidivism (recurrent cholesteatoma) adjacent to the right lateral semicircular canal; a focal hyperintense area marked by the arrow. MCF= middle cranial fossa, LSC=lateral semicircular canal, IAC= internal auditory canal.

mastoid cavity.[11] Mehta and Harris published a comprehensive review of mastoid obliteration methods, emphasizing the role of autologous materials in reconstructive approaches.[12] Successful outcomes were reported with bone dust, cartilage grafts, and combined methods, demonstrating cavity dryness, improved hearing, and low recurrence rates.[13]

Mastoid obliteration using cartilage and bone pâté proved to be effective in preventing cholesteatoma recidivism among the patients who underwent this procedure. Of the 88 patients, 86 remained free of infection and cholesteatoma while two required revision mastoidectomies. One case involved a residual cholesteatoma (1.1%), and another involved a recurrent cholesteatoma (1.1%). In a systematic review, Van der Toom *et al.* reported recurrence rates of 4.6% and residual disease rates of 5.4%.[14] Cholesteatoma recidivism was defined as a collective term encompassing both recurrent and residual disease.[15] In 1977, Sheehy, Brackman and Graham clearly distinguished these two forms, describing residual cholesteatoma as disease left behind by the surgeon, while recurrent cholesteatoma referred to a new lesion arising from a retraction pocket. They emphasized that the underlying causes, prevention, and treatment differed between the two.[16]

Reconstructing the external auditory canal does more than eliminate cavity problems; it also restores the canal's natural resonator function.[17] The EAC acts as a quarter-wave resonator, producing a standing wave boost that peaks around 2000–2500 Hz and enhances speech perception by amplifying consonant sounds crucial for clarity and intelligibility.[18] When the posterior canal wall is absent, this natural resonance is disrupted, leading to reduced high-frequency gain and compromised hearing aid performance. By restoring the canal wall with cartilage and bone dust, surgeons help preserve this natural acoustic

advantage, thereby supporting better functional hearing outcomes.

Mastoid obliteration in chronic otitis media and cholesteatoma surgery carries several potential disadvantages and limitations. Entrapment of residual or recurrent disease can occur, as obliteration sometimes masks residual keratin or cholesteatoma, leading to 'silent' disease that becomes apparent only later. This underscores the need for meticulous disease removal prior to obliteration and long-term imaging follow-up.[19] Delayed epithelialization and poor healing also occurs in some cases. Compared with synthetic materials such as bioactive glass, bone pâté often showed slower epithelial healing and, at times, incomplete cavity healing.[19] Resorption of autologous material is another limitation, as bone pâté is subject to shrinkage over time. In some instances, the obliterated cavity partially reopened, occasionally exposing the facial ridge within months of surgery.[19] There is also the risk of infection and donor-site morbidity, since autologous grafts could lead to wound infections[19] and complications at the harvest site.[20] Structural instability of the reconstructed canal wall is another concern, as cartilage and bone reconstruction sometimes resulted in postoperative retraction of the canal wall.[21] In terms of overall complication rates, a systematic review comparing different obliteration materials found that the autologous group had a 14.8% overall complication rate, consisting of 7.9% minor and 6.8% major complications, including residual disease and the need for revision surgery.[22] On the other hand, allogenic materials led to an overall complication rate of 24%, with 18.5% minor complications and 5.6% major complications. The use of synthetic materials led to a 16.6% complication rate, with 8% minor complications and 7.6% major complications.[23] Another limitation of this series is the lack of documentation regarding the restoration of acoustic function, which future studies should address more clearly.

Aside from the two cases of cholesteatoma recidivism that appeared several months after surgery, no other major complications - such as poor/prolonged healing, resorption of autologous material, exposure of the facial ridge, major infection, nor retraction of the canal wall were encountered in this series of patients. Meticulous inspection and cleaning of the subsites of the middle ear and mastoid cavity during surgery may have accounted for the low rate of residual disease. Harvesting bone pâté from the cortical bone lateral to the mastoid air cells and obtaining a large yield of conchal cartilage may also have contributed to disease-free obliterated mastoid cavities. The use of these materials likely increased the strength and integrity of the reconstructed posterior canal wall and may have reduced postoperative complications such as posterior retraction pockets. During closure of the postauricular incision site, skin staples or an interlocking suture technique were often used to provide greater strength in an area subject to tension during head and neck movements. Retaining sutures for at least 10 days, along with sustained support from a mastoid pressure dressing for at least one week, may have further contributed to the success of the surgeries despite obliteration of the mastoid cavities.

Whenever mastoid obliteration is performed using autologous grafts such as cartilage, bone pâté, and bone chips, it is essential that the material be completely disease-free since it will be buried beneath skin, muscle and soft tissue. Meticulous inspection of the subsites of the mastoid cavity—including the mastoid antrum, epitympanum, sinodural angle, mastoid tip, sinus tympani, hypotympanum, middle ear space, and Eustachian tube—under adequate binocular magnification with microscopy should be carried out to ensure a disease-free cavity before obliteration. The mastoid cavity has to be clean and in near-perfect condition before placing the autologous materials. In this series, the use of fibrin glue, such as Tiseel (Tissucol Baxter, Deerfield, IL, USA), for posterior canal wall reconstruction, tympanoplasty, and mastoid obliteration was not necessary, provided that the autologous materials were properly sized and positioned to minimize movement or displacement. This technique resembled ancient masonry practices such as Ashlar,[23] Cyclopean,[24] or Polygonal masonry.[25] Avoiding fibrin glue during the reconstructive phase also prevented potential complications from foreign body reactions and significantly reduced surgical costs. A #10 scalpel blade was used to thin and divide the harvested cartilage into several pieces for posterior canal reconstruction, tympanoplasty and mastoid obliteration. Traditional methods of thinning cartilage require a costly cartilage cutter such as the Kurz Precise Cartilage Knife (Heinz Kurz GmbH, Dusslingen, Germany), which necessitates a new blade for each use. Approximating cartilage into submillimeter slices with a commonly available #10 scalpel blade reduced operating room costs while ensuring the materials remained readily accessible in every surgical setting. Mastoid obliteration and posterior canal wall reconstruction likely prevented retraction pocket formation, contributing to the very low number of recurrent cholesteatomas in this series of patients.

In summary, mastoid cavity obliteration and canal wall reconstruction using autologous bone dust and conchal cartilage has proven to be a safe, practical and cost-effective technique that reduced cholesteatoma recidivism. It transforms a troublesome open cavity into a dry, self-cleaning, and waterproof ear while restoring the natural resonance of the external auditory canal and enhancing hearing in the critical speech frequency range. Surgeons who adopt this technique are advised to commit to long-term follow-up with DWI MRI, ideally performed at least 1.5 years postoperatively, to ensure durable disease control and patient safety.

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