OBLITERATION OF MASTOID AIR SYSTEM

Meta-analysis submitted for the partial fulfillment of the Master Degree in Ear, Nose and Throat

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توطئة للحصول على درجة الماجستير فى الأذن والأنف والحنجرة

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The major disadvantages of the CWD procedure claimed to be a prolonged healing time and a high incidence of post-operative otorrhoea. The single most important factor for failure of CWD procedure is poor execution of the open technique. A faulty anatomical cavity was found to be the most important contributing factor to the failure of the primary procedure. High facial ridge, stenotic canal/meatus and bony overhangs act as a mechanical barrier preventing the cavity from being self-cleaning, thereby, promoting the disease process by accumulation of debris.

It is universally agreed that decreasing the size of the cavity enhances healing and diminishes the need for post-operative cavity care and meatoplasty has been used for auto-cleansing and sufficient aeration. The size of a large cavity is reduced by amputation of the mastoid tip and obliteration of the sinodural angle with bone pate, cartilage or other fillers. Rounding of the cavity edges over the tegmen, sinodural angle and sigmoid sinus along with saucerization of the cavity promotes healing and helps in reducing the size of the cavity by prolapse of surrounding soft tissue within the cavity.

An enlarged meatus is an integral part of the CWD procedure and on failure to perform an adequate meatoplasty even the most perfectly performed CWD procedures may fail because of inadequate exteriorization. Anumber of biological and alloplastic materials showing there merits and demerits were revised

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List of abbreviations

CWU	Canal wall up
CWD	Canal wall down
COM	Chronic otitis media
MRM	Modified radical mastoidectomy
CT	Computerized tomography
MRI	Magnetic resonance imaging
HA	Hydroxyapatite
B-TCP	B tri-calcium phosphate
SWR	Soft wall reconstruction
PMC	Post-auricular myocutanous
RCT	Randomized clinical trial
TM	Tympanic membrane
Epith	Epithelisation
HL	Hearing loss
SNHL	Sensorineural hearing loss
CHL	Conductive hearing loss

INTRODUCTION

The goals of the surgical treatment of middle ear cholesteatoma are the complete eradication of the disease, the prevention of residual or recurrent cholesteatoma, the restoration of the hygienic status of the ear, and the preservation or improvement of the hearing. Two basically different techniques have been advocated to reach these goals:

(Table-1): Difference between CWD and CWU

	canal wall-dawn	**canal wall-up**
Definition	Involve taking down of posterior canal wall.	Preserve the posterior canal wall.
Advantage	1) No need for staging 2) A lower rate of residual and recurrent cholesteatoma.	1) A better hygienic status of the ear. 2) A better functional outcome.
Disadvantage	1) 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. 2) A worse functional outcome.	1) The need for staging. 2) The need for long-term follow-up to detect recurrent cholesteatoma. 3) Higher rates of residual and recurrent disease.

(Shirazi et al., 2006) and (Vercruysse et al., 2008).

Open cavity procedures are a standard method of cholesteatoma management, but the creation of a cavity is frequently associated with unacceptable symptoms, such as hearing loss and discharge, the treatment of which often leads to medical dependency. Unfortunately, a wet cavity is unavoidable in many cases, for reasons that are independent of surgical expertise. In fact, in expert hands, this complication can be expected in 10% of cases, with a much higher rate seen when the surgical technique is less than meticulous. if the condition dosenot respond to medical therapy, revision surgery is deemed appropriate **Dornhoffer, 1999.**

Although canal wall down mastoid surgery, an important treatment option in the management of cholesteatoma, usually results in a dry, problem-free ear, even a well-executed surgery can result in a chronically draining cavity. Patients with this condition frequently undergo multiple surgeries in an attempt at cure, but these difficult cavities seem to defy all attempts at conservative management in the office setting. Although the problem cavity is usually not considered life-threatening, the socioeconomic impact of this condition should not be underestimated. Because of the hearing loss (HL) and foul-smelling drainage associated with the chronically draining ear, patients with this condition frequently become socially withdrawn and professionally inhibited. In addition, the costs associated with a draining cavity can be staggering considering the multiple surgeries, frequent clinic visits

for aural toilet, and the plethora of topical medications necessary for treatment **Dornhoffer et al., 2008**.

Cavity problem is characterized by a small meatus, a high facial ridge with incomplete posterior external auditory canal wall removal, a dependent mastoid tip that sequesters debris, persistent discharge from chronic infection, ear drum perforation with weeping mucosa, extensive granulation tissue, mucosalization of the cavity, retained cholesteatoma, and impacted debris **Mehta and Harris, 2006.**

The size of the surgical cavity can be diminished with obliteration to create a small cavity that is self-cleaning and easily maintained. Several authors have demonstrated the usefulness of mastoid obliteration technique and considered it a safe method to diminish a surgical cavity in CWD surgery **Gantz et al., 2005.**

Various autologous materials have been used for mastoid obliteration to reduce the cavity size, such as muscle, fat, cartilage, musculoperiosteal flaps, bone chip and bone pate **Clark and Bottrill, 2007.**

To avoid cavity problem **Mehta and Harris, 2006** suggested the following Surgical pearls; a well-saucerized mastoid cavity with no ridges or cavities, maximal lowering of facial ridge to level of facial nerve, adequate canalplasty to remove anterior canal bulge and drilling out the mastoid tip to allow the flap to lay smoothly into the mastoidectomy defect, adequate meatoplasty, split thickness skin grafting to enhance reepithelialization, complete coverage of the filler with flap or fascia.

A number of materials, both biological and alloplastic have been used for mastoid obliteration. Each of them has its merits and demerits.

(Table-2): Types of fillers

	Biological material	**Alloplastic material**
Type	Cartilage, fat, bone, muscle or fascia.	Hydroxyapatite.
Advantage	Resistant to infection.	Readily available, no resorption and no donor site morbidity.
Disadvantage	Resorption, atrophy, curvature, difficulty in fashioning, and donor site morbidity.	Risk of infection and exposure.

Kakigi et al., 2009.

Mastoid obliteration is an established technique for the treatment of chronic infection of the mastoid bone. A variety of techniques of mastoid obliteration have been described. These are all based on the same principle: the cavity is reduced using either biological tissues or biocompatible materials as fillers and a soft tissue flap is then used to cover the obliteration.

For some of these techniques, the filler and the covering material is a single soft tissue flap. The obliterated cavity must be lined by keratinizing squamous epithelium for it to remain dry and

water resistant. The migration of squamous epithelium over the soft tissue flap begins at the remnant of pre-existing meatal skin or tympanic membrane.

It could be impeded by a number of unfavorable factors, such as localized infection, ischemia, or necrosis of the flap. Theoretically, a healthy vascularized flap should re-epithelialize faster than an ischemic flap. In general, soft tissue flaps used in mastoid obliteration can be categorized into pedicled flaps (e.g., superiorly based musculo-periosteal flap, anteriorly based musculo-periosteal flap) or axial flaps (e.g., mid-temporal pericranial flap, temporoparietal fascial flap) **Yung and Smith, 2007.**

(Table-3): Grading system to assess control of infection after surgery

Grade	Description
0	No episode of otorrhea, and no pus or granulation tissue on otoscopy.
1	One episode of otorrhea of less than 2 wk. duration in a 3 month period or no otorrhea but a subjective feeling of wetness in the ear.
2	More than one episode of otorrhea in a 3 month period, or an episode of otorrhea lasting more than 2 wk, or demonstration of localized granulation tissue/pus that was promptly cured with antibiotic drops, curettage, or silver nitrate therapy.

3	Constant purulent otorrhea on a daily basis, or examination showing extensive granulation tissue, or need for a revision procedure to control infection.

Merchant et al., 1997.

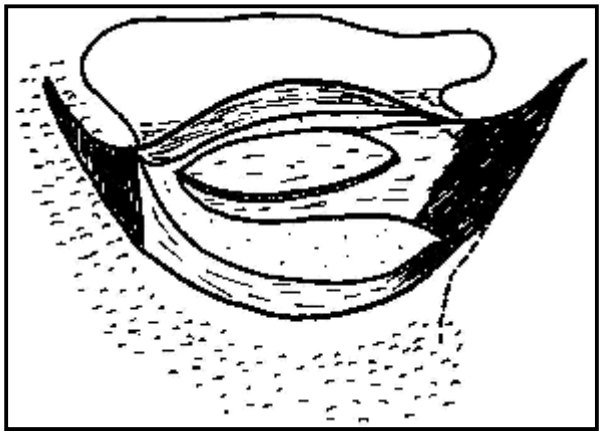
Techniques of Mastoid Obliteration

1- Obliteration using a muscle flap

Surgical Technique:

An elliptical skin incision is made in postauricular sulcus, anterior to the hairline and carried down to the subcutaneous tissue and periosteum. If desired, an approximately 2 cm wide soft tissue and periosteal flap can be created. The anterior skin and periosteal incision is continuous with the postauricular incision to the mastoid cortex. This extends above the ear superiorly and inferiorly over the mastoid tip and along the anterior border of the sternocleidomastoid muscle.

The posterior incision is taken down to the subcutaneous tissue. The periosteal incisions flare posteriorly and inferiorly over the mastoid into the sternocleidomastoid muscle, creating a wider soft tissue pedicle for the flap. The flap is created by elevating the skin, soft tissue, and periosteum off of the mastoid cortex. The sternocleidomastoid and its aponeurosis at the mastoid tip are elevated as a base of the flap(fig-1). The flap is folded posteriorly or inferiorly while the mastoid operation is done. An extensive mastoid cavity is created with removal of all mastoid air cells.



(fig-1) Postauricular incisions are extended down to periosteum. Skin and soft tissue are elevated off mastoid periosteum. Periosteal incisions are then extended inferiorly into sterno-mastoid muscle. Skin, periosteum, and sternocleidomastoid muscle are elevated from mastoid cortex creating PMC flap.

The mastoid tip, floor of the ear canal, and facial ridge are lowered down to the digastric muscle and vertical facial nerve. After the tympanic membrane and middle ear have been reconstructed, the cavity is ready for placement of the PMC flap. The inferior epithelium and subcutaneous tissue of the tip of the PMC flap are carefully elevated approximately 1.5 cm off the periosteum and sternocleidomastoid muscle. The posterior canal (skin flap) is split in conjunction with the meatoplasty. After hemostasis is achieved, the superior pole of the PMC flap is rotated into the sinodural angle. The inferior apex of the flap is rotated into the incision in the posterior canal skin and tacked to the meatus. Additional sutures are used to anchor the flap to the superior and inferior canal skin flaps. Heavy 3-0 or 4-0 absorbable sutures are used to support the sternocleidomastoid pedicle to the concha and meatus. The superior canal skin flap is sutured to the temporalis muscle, creating a large meatus. The meatus is packed to hold the PMC flap and canal skin flaps in position while the

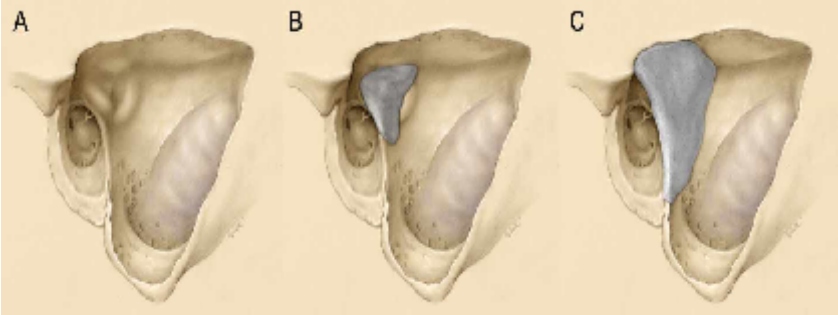
skin incision and soft tissue defect are closed in layers Farrior, 1998.

2- Use of bone chips and bone pate'

Surgical Technique:

In revision cases after doing complete mastoidectomy (Fig. 2A) healthy cortical bone pate which was filtered, mixed, and soaked with a povidone-iodine solution for an hour and then dried. The pre-collected autogenous bone pate was applied to the epitympanic space posterior to the cochleariform process and superior to the tympanic segment of the facial nerve (Fig. 2B). Next, Lee et al, made an entire posterior canal wall with pre-collected autogenous bone pate above the facial ridge, is done maintaining the height at the level of the mastoid bone outer cortex (Fig. 2C, Fig. 3A).

The bone pate is applied in abroad-based, narrow top fashion above the facial ridge for stability. A thin silastic sheet is inserted into the middle ear space and tympanoplasty with temporalis fascia is performed, which entirely covers the new canal wall (Fig. 3B).The isolated mastoid cavity is obliterated with 3-5 mm sized allogenous cancellous bone chips (ACBCs; ReadiGRAFT, Lifenet, Virginia Beach, VA, USA) (Fig. 3C). For the last step, reposition of the designed healthy skin flap and finished by packing the external auditory canal with Gelfoam (Upjohn Co., Kalamazoo, MI, USA).



(Fig.2) Schematic drawings of the procedure for posterior canal wall reconstruction using autogenous bone pate. Complete revision mastoidectomy is performed (A). Autogenous bone pate is applied to the epitympanic space posterior to the cochleariform process and superior to the tympanic segment of the facial nerve (B). Next, the bone pate is applied in a broad-based, narrow top fashion above the facial ridge for stability, maintaining the height at the level of the mastoid bone outer cortex (C).

To prevent the recurrence of infection or cholesteatoma, bone pate used for canal wall reconstruction should be obtained only from normal cortical bone and pathologic lesions such as diseased mucosa, granulation or cholesteatoma in the mastoid bowl and the middle ear must be completely removed before reconstruction and obliteration Lee et al., 2009.