Anatomically, the temporal bone is the most intricate part of the human body. Every good otologist needs to have a high degree of efficiency in managing the diseases located in this region. Cholesteatoma is the most common pathology that affects the temporal bone, primarily in the middle ear and mastoid. This Atlas of Cavityless Cholesteatoma Surgery explains cholesteatoma disease and its management in detail through the path-breaking concept of "cavityless mastoidectomy surgery."

Beautifully illustrated and explained in great detail, with hundreds of high-definition operative photographs in each chapter, the book takes the reader through the journey of managing the earliest invasion of cholesteatoma in the form of retraction pocket to its most extensive form extending up to the petrous apex. It also describes in great detail the management of complications associated with cholesteatoma and cholesteatoma surgery as well as many unusual conditions. Full-color illustrations have been added, wherever necessary, to further simplify the understanding of surgical steps.

Following are some of the remarkable features of this two-volume atlas:

- More than 2,000 high-quality pictures and full-color illustrations that will help surgeons navigate through every possible condition of cholesteatoma disease and its management.
- Volume I comprises all surgical procedures explained in a systematic manner, starting from the management of the earliest stage of the disease to the most extensive spread of cholesteatoma.
- Volume II deals with the management of complications of cholesteatoma disease and the iatrogenic complications in great detail.
- All common conditions have been explained by at least two to three cases.

The present form of the atlas is attributed to decades of experience of operating upon thousands of cases of primary cholesteatoma and revision cholesteatoma. Both new and experienced ENT surgeons will benefit from this comprehensive surgical approach, which covers all possible conditions of cholesteatoma.

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Atlas of Cavityless Cholesteatoma Surgery

Volume I

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Dedicated to our family members, who have always been there with us, all through the journey of the making of this atlas and...

...My son Navroz

Madhuri Mehta
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Preface

This atlas gives me an opportunity to share my experiences of four decades in the management of cholesteatoma. We have come a long way to the present state where the aim of cholesteatoma surgery is to make ears safe and dry, besides ensuring better hearing and, most importantly, no dependence on a doctor. This can be effectively achieved with cavityless mastoid surgery for cholesteatoma.

With years of experience, coupled with better training, equipment, instruments, and understanding, the recurrence or residual rate of cholesteatoma and wet ear has decreased to less than 3%. The ultimate objective is to provide better hearing through single-stage surgery to majority of patients. However, some refinements need to be introduced to consistently bring hearing back to normal in single-stage surgery.

Dr Madhuri Mehta, my coauthor and erstwhile protégé, has excellent surgical skills with perfect understanding of cholesteatoma. The publishing of this atlas has been possible due to her dedication, sincerity, and commitment and the large number of cases she has operated upon whose pictures are featured here.

K. P. Morwani, MS (ENT)
Preface

Two roads diverged in a wood, and I—
I took the one less travelled by,
And that has made all the difference.

—Robert Frost

The moment we choose to take a path less travelled, our life transforms into an unending voyage filled with fascinating events and unexplored treasures of knowledge, learning, and wisdom.

To be able to reach beyond the confines of existing facts and figures is what brings out the novel and new.

And hence, the making of this atlas.

This atlas embodies the collective experience of the authors in the field of “cavityless cholesteatoma surgery.”

The surgical management of cholesteatoma disease, which historically started as drainage or evacuation of postaural abscess by “barber surgeons” in earlier times to today’s function-preserving surgery, has come a long way. Over the years, different surgeons from different parts of the world kept introducing newer techniques and approaches. However, as surgeons, we always look for a comprehensive approach that addresses each aspect of cholesteatoma disease, starting from the earliest stage of retraction pocket to the most extensive form of disease, and also the disease extending beyond middle ear and mastoid.

The positive results obtained by practicing the “cavityless cholesteatoma surgery” technique has prompted us to share our experience. The concept of converting a large-sized cavity, created after complete removal of disease, into a normal-sized and functioning middle ear and external auditory canal postoperatively is what is novel about this approach, and this is being focused in great detail in this atlas.

This atlas aims to provide a description of the step-by-step management of every possible situation in cholesteatoma disease through the pictures that have been assiduously selected from our vast collection of photographs and videos that were clicked during umpteen surgeries. A clear, systematic approach is being presented through this crisp, to-the-point atlas, explaining each step in painstaking detail. I sincerely hope it will help many otologists offer more positive and fruitful results to their patients suffering from cholesteatoma.

Madhuri Mehta, MS (ENT)
Acknowledgments

We would like to thank all our patients for they are the reason and motivation behind this book.

We would also like to thank Dr Amol Patil who spent hours and hours together with us in editing and refining every chapter of this atlas. His bright ideas and inputs are part of every chapter, and we dearly thank him for being a part of this mammoth assignment.

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Thanks to Dr Rahul Agarwal and Dr Sonal Modi for providing us the pictures for the chapter on “Surgical Anatomy of Temporal Bone.”

We are thankful to the trustees of Jindal Institute of Medical Sciences, Hisar, for providing us the most advanced infrastructure, operation theatre, and equipment for the surgical cases described in this atlas.

We are thankful to the team of anesthetists at the Jindal Institute for providing us complete support during these surgeries, including Dr Shekhar Sinha, Dr Ritu Jasuja, Dr Monika Goel, Dr Varun Gupta, Dr Varuna Singhal, and Dr Shingini Lahiri.

The making of this atlas would have been impossible without the support of the operation theatre staff at Jindal Institute, who patiently assisted us in collecting pictures during surgeries, specially Krishan Kumar, Neeru Rajpoot, Sushila Jangra, Sandeep Sindhu, Jai Narayan, and Amin Khaan, as well as ENT ward staff who helped in the documentation, Ramesh Jakhar, Rajender Singh Rathore, Seema Sodhi, Kanta Sharma, Sushila Devi, Neelam Malik, Pinki Rathore, and Suresh Furrend.

We would also like to thank our family members who have always been there with us, all through the journey of the making of this atlas.

K. P. Morwani
Madhuri Mehta
Few surgical steps are common in almost all the cholesteatoma or middle ear surgery. To avoid repetitiveness, they are described under the following headings.

## Preparation of the Ear

Shampoo and washing of the hair for 2 consecutive days before surgery, is advisable. One must stop applying oil in the hair before surgery (common practice in India). Shaving of postaural area 2 cm behind and superiorly is necessary (Fig. 6.1a).

## Surgical Approaches

The authors mainly use the postaural approach for the mastoid and cholesteatoma surgery, though different surgeons use either postaural or endaural approach according to their convenience and training. According to the authors, this approach gives the maximum access to the middle ear, mastoid, and area around mastoid.

### Postaural Approach

Postaural area is infiltrated with 2% lignocaine with 1:200,000 adrenaline preferably 10 minutes before incision. Skin incision is marked and crosshatches are given before incision (Fig. 6.1b). Postaural skin incision up to subcutaneous tissue is given 3 to 4 mm behind the postaural groove. Superior extent is up to a point above helix and inferior extent is up to mastoid tip (Fig. 6.1c, d). The anterior and posterior skin edges with subcutaneous tissue are then mobilized in their respective directions. (Fig. 6.1e).

### Harvesting of Temporalis Fascia Graft

After lifting skin and subcutaneous tissue, the temporalis area is exposed by blunt dissection with Frayer’s elevator or artery forceps. To expose temporalis fascia, loose areolar tissue over it is mobilized. Around 2 mL of saline or 2% lignocaine is injected underneath the fascia, for hydrodissection of fascia from underlying muscle (Fig. 6.2).

Temporalis fascia graft is harvested by giving horizontal incision on temporalis fascia few millimeters superior to the insertion of temporalis muscle (Fig. 6.3).

Fascia is then elevated from the temporalis muscle without damaging any muscle fibers and an adequate size of fascia graft is harvested keeping in mind that the size of fascia shrinks almost by one-third of its size immediately after harvesting. Any loose areolar tissue or fat has to be removed from the fascia. The fascia is pressed in graft presser with a piece of Gelfoam over it (Fig. 6.4, Fig. 6.5).

In revision cases, the location of harvesting temporalis fascia graft can be posterior, superior, or anterior to the

---

**Fig. 6.1** (a) Shaving of postaural area 2 cm behind and superiorly along with pinning up of rest of the hair. (b) Skin incision given 3 to 4 mm behind postaural groove, cross-hatching of skin incision. (c, d) Superior and inferior extent of incision. (e) Skin and subcutaneous tissue mobilized.
posterior margin of bony external auditory canal (EAC) extending up to floor of canal. The second incision is given horizontally starting from the base of zygoma at the superior point of C-shaped first incision, extending posteriorly between superficial temporal muscle and postaural muscle (Fig. 6.7). Triangular MP flap is elevated posteroinferiorly to expose the mastoid bone (Fig. 6.8, Fig. 6.9). The MP flap thus created can later be used to obliterate or reduce the size of mastoid cavity, if required.

Lifting of Musculoperiosteal Flap

A posteroinferiorly based musculoperiosteal (MP) flap is created (Fig. 6.6). For this two incisions are given. First, C-shaped incision is given along the superior and posterior margin of bony external auditory canal (EAC) extending up to floor of canal. The second incision is given horizontally starting from the base of zygoma at the superior point of C-shaped first incision, extending posteriorly between superficial temporal muscle and postaural muscle (Fig. 6.7). Triangular MP flap is elevated posteroinferiorly to expose the mastoid bone (Fig. 6.8, Fig. 6.9). The MP flap thus created can later be used to obliterate or reduce the size of mastoid cavity, if required.

Mobilization of Canal Skin

The skin of bony EAC is elevated in three-fourths of its circumference up to annulus (Fig. 6.10). It is incised just
Common Steps of Mastoid Surgery

Fig. 6.7 Musculoperiosteal incision: C-shaped incision along circumference of bony margin from base of zygoma to 5 o’clock position and horizontal incision starting from base of zygoma extending posteriorly between superficial temporalis and postaural muscle.

Fig. 6.8 Diagrammatic representation of mobilization of postaural muscle flap.

lateral to fibrous annulus of tympanic membrane (TM) and retracted laterally with a mastoid retractor (Fig. 6.11). In cases of anterior canal wall bulge, the EAC skin is elevated in complete circumference laterally and held in position with mastoid retractor. This maneuver helps in preserving the complete circumference of EAC skin with its blood supply and it also prevents damage to the skin flap while drilling with burr or using suction while performing the inside out mastoidectomy. Besides this, it provides adequate exposure of TM, attic, and bony canal wall in three-fourths or complete circumference.

Bony Canalplasty

Bony canalplasty is an integral part of tympanomastoid surgery. It consists of widening the bony portion of the EAC. The purpose of canaloplasty is to make the TM with its annulus visible in its entire circumference (Fig. 6.12).

Fig. 6.9 Postaural pedicled muscle flap mobilized postero-inferiorly.

Fig. 6.10 External auditory canal skin elevated in three-fourths of circumference up to annulus.

Fig. 6.11 External auditory canal skin separated from tympanic membrane at annulus and elevated laterally and held in mastoid retractor.
Importance of Canalplasty

Canalplasty helps in exteriorizing complete TM along with its fibrous annulus in its complete circumference. Technically speaking, it is much easier to mobilize and preserve TM once fibrous annulus is visible in its whole circumference. Once annulus is elevated, it is easier to find plane between TM and promontory. Adhesion bands between the promontory and TM, should be sharply cut. If the plane between promontory mucosa and TM is obliterated, it is advisable to elevate mucosa of promontory with TM as this will provide adequate vascularity to the epithelium of the TM and every effort should be made to preserve TM which is possible most often. Residual TM has to be reposited over fascia graft to promote epithelialization.

The depth of bony overhang in different quadrants of EAC is assessed with a circular knife, which is drilled initially with a cutting burr and then with a diamond burr to expose the fibrous annulus completely.

Rarely, while performing canalplasty there can be exposure of air cells in posterior canal wall. It has to be either obliterated with bone dust or bone wax. Any damage to the canal leading to a large defect has to be repaired with split-thickness cartilage piece with perichondrium facing toward canal wall skin, snugly fitting into the defect, and excess perichondrium on both sides of cartilage draped over the surrounding bony canal.

Case 1: Canalplasty in right ear (Fig. 6.12, Fig. 6.13, Fig. 6.14, Fig. 6.15, Fig. 6.16, Fig. 6.17, Fig. 6.18, Fig. 6.19, Fig. 6.20)

Fig. 6.12  Diagrammatic representation of anterior and posterior bony overhangs. AH, anterior bony overhang; PH, posterior bony overhang.

Fig. 6.13  Retracted tympanic membrane plastered to stapes head with bony overhang.

Fig. 6.14  Drilling of bony external auditory canal in lateral quadrant.

Fig. 6.15  Canalplasty in progress.
Fig. 6.16  Circular knife demonstrating the bony overhang at 11 o’clock position.

Fig. 6.17  Circular knife demonstrating the bony overhang at 10 o’clock position.

Fig. 6.18  Circular knife demonstrating bony overhang at 8 o’clock position.

Fig. 6.19  Drilling of outer attic wall at annulus level is in progress.

Fig. 6.20  Canalplasty completed with visualization of tympanic membrane and annulus in its complete circumference.
Case 2: Canalplasty in left ear (Fig. 6.21, Fig. 6.22, Fig. 6.23, Fig. 6.24, Fig. 6.25, Fig. 6.26, Fig. 6.27, Fig. 6.28, Fig. 6.29, Fig. 6.30)

Fig. 6.21  Plastered tympanic membrane with bony overhang.

Fig. 6.22  Bony overhang at 1 o’clock position.

Fig. 6.23  Bony overhang at 3 o’clock position.

Fig. 6.24  Bony overhang at 6 o’clock position.

Fig. 6.25  Canalplasty in progress.

Fig. 6.26  Thinned out bone at the level of annulus. Note the depth of canalplasty required.
Harvesting of Bone Dust

Bone dust is collected while performing canalplasty and also while drilling any part of the healthy mastoid bone (noncholesteatoma bearing and nonosteitic bone). Drilling with drop-by-drop irrigation prevents scattering of bone dust. Bone dust is collected with Frayer’s elevator and kept at the edge of the container to allow drainage of saline. Bone dust is used to obliterate bony sockets and also to reduce depth and dimension of the cavity. It can also be used to cover the fistula of lateral semicircular canal (LSC) or any other semicircular canal.
Case 3: Right ear: bone dust harvested while performing canalplasty (Fig. 6.31)

Fig. 6.31  (a) Bone dust is being harvested while performing canalplasty. (b) Drilling with large cutting burr with drop-by-drop irrigation is in progress. (c) Collecting the bone dust with Frayer’s elevator.

Case 4: Right ear: bone dust harvested from healthy mastoid cortex lateral to cholesteatoma disease (Fig. 6.32)

Fig. 6.32  (a) Canal wall-down mastoidectomy has been performed. Bone dust to be harvested from healthy bone of mastoid cortex lateral to cholesteatoma disease.
Fig. 6.32  (b) Bone is drilled with large cutting burr with drop-by-drop irrigation. (c) Collection of bone dust with Frayer’s elevator.

Case 5: Right ear: bone dust harvested during canalplasty and from mastoid cortex as well (Fig. 6.33)

Fig. 6.33  (a) Canalplasty with collection of bone dust. (b) Drilling the margin of posterior canal wall. (c) Drilling the mastoid cortex and harvesting bone dust. (d) Collection of bone dust.
Case 6: Right ear: As cholesteatoma has eroded through the mastoid cortex, the bone dust is harvested from healthy mastoid cortex away from the site of cholesteatoma (Fig. 6.34)

Harvesting and Use of Cartilages

Harvesting Tragal, Floor, and Conchal Cartilage

In authors’ technique, the floor cartilage is excised, along with drilling of floor of canal in every case of cholesteatoma, as an integral part of meatoplasty procedure. Cartilage graft may be required either for ossiculoplasty, reconstruction of TM, outer attic, atticoantral wall, or defect in posterior canal wall. Cartilage grafts are also used to obliterate any bony sockets in mastoid cavity, to reduce the depth and dimension of mastoid cavity along with bone dust and occasionally with various MP flaps. Another usage of cartilage grafts is for repairing tegmen defect or to cover exposed sinus and presinus dura. For all these reconstructive procedures, cartilage can be easily harvested from three sites. This cartilage can be used as full-thickness, split-thickness graft or multiple pieces depending on the situation.

Tragal Cartilage

After injecting 2% xylocaine with adrenaline (Fig. 6.35), incision is given in the skin of tragus facing the EAC, few millimeters medial to the tragal margin (Fig. 6.36). This is to avoid the cosmetic disfigurement of tragus. The skin and subcutaneous tissue on the canal surface of tragus is separated from cartilage with the help of scissors or surgical blade (Fig. 6.37). A full-thickness incision is then given in cartilage few millimeters medial to the margin and it is separated on its parotid surface from the surrounding soft tissue (Fig. 6.38). After exposing both the surfaces of cartilage, adequate-sized cartilage with perichondrium at least on one side is excised using surgical blade/scissors. The perichondrium can be separated from the cartilage and used separately, as may be required in some cases (Fig. 6.39, Fig. 6.40).
Fig. 6.35 Local anesthesia is injected into the skin on posterior surface of tragus.

Fig. 6.36 Incision is given few millimeters medial to the tragal margin. The assistant holds the upper part of tragus with plain forceps and the surgeon gives the incision with surgical blade.

Fig. 6.37 (a) Perichondrium is separated from the overlying skin and subcutaneous tissue (black arrow).

Fig. 6.38 Incision is given through the tragal cartilage in a way that the upper margin of cartilage is spared, so as to maintain the natural curvature and shape of tragus.

Fig. 6.39 Tragal cartilage is being harvested.

Fig. 6.40 Harvested piece of tragal cartilage.


**Floor Cartilage**

It is the inferior extension of auricular cartilage and can be easily harvested as it is in the same surgical field and no separate incision is required for harvesting it (Fig. 6.41). To access the floor cartilage, the skin and subcutaneous tissue have to be elevated in inferior part of canal preferably under microscope as skin is firmly adherent to this cartilage (Fig. 6.42, Fig. 6.43). Big-sized cartilage graft can be harvested after separating it from skin and soft tissue on both the sides (Fig. 6.44).

**Conchal Cartilage**

To harvest the conchal cartilage graft, the surgical field remains the same and it has to be dissected from the surrounding soft tissue on either side (Fig. 6.45, Fig. 6.46). As the cartilage is firmly adherent to the skin on its anterior surface, sharp dissection is required to avoid any tear or puncture wound in the skin, as this may lead to its disfigurement in future.

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**Fig. 6.41**  Floor cartilage is being exposed.

**Fig. 6.42**  Cartilage is being dissected from parotid side.

**Fig. 6.43**  Cartilage is mobilized from canal side.

**Fig. 6.44**  Cartilage is mobilized completely.
Harvesting the Perichondrium and Periosteum

After holding the cartilage piece with a plane forceps (Fig. 6.47), the perichondrium is gently peeled off from the surface starting from one margin with a perichondrium elevator and plain forceps (Fig. 6.48). Larger piece of perichondrium can be obtained by elevating it in continuity from the contralateral side as well (Fig. 6.49, Fig. 6.50). If only perichondrium is required, it can be separately harvested by elevating it from the cartilage in situ, or with the tragal cartilage, which can be replaced back after harvesting the perichondrium.

Fig. 6.45 Conchal cartilage is being dissected from skin on its outer side by sharp dissection after clearing the soft tissue.

Fig. 6.46 Harvested piece of cartilage.

Fig. 6.47 Tragal cartilage with perichondrium.

Fig. 6.48 The perichondrium is being peeled off gently from one side of the cartilage piece.

Fig. 6.49 Perichondrium is separated from cartilage.
Harvesting of Periosteum

Periosteum can be easily harvested from surface of mastoid cortex or from squamous portion of the temporal bone (Fig. 6.51, Fig. 6.52).

Trimming/Thinning of Cartilage

Cartilage is at times used to reinforce thin or plastered TM. In revision cases, certain surgeons prefer to use split-thickness cartilage instead of fascia graft. The split cartilage graft is also used to reconstruct outer attic or atticofacial wall.

This cartilage can be split with surgical blade, sickle knife, or cartilage slicer (Fig. 6.53). Thickness of the cartilage used for reconstruction of TM also varies from surgeon to surgeon. The thickness of different cartilages varies, floor being thickest followed by tragal and conchal, respectively.

Trimming of the cartilage can be achieved either by holding cartilage in plain forceps, after making a slit with the help of scalpel. Splitting the cartilage by this method may give it an irregular thickness (Fig. 6.54). While reconstructing TM, irregular surface should be facing the middle ear and smooth surface with perichondrium should be facing the TM, this is to give smooth surface to neotympanum and for nourishment of cartilage.

For uniformity in thickness, cartilage slicer is used (Fig. 6.55, Fig. 6.56, Fig. 6.57, Fig. 6.58, Fig. 6.59, Fig. 6.60, Fig. 6.61, Fig. 6.62, Fig. 6.63).
Fig. 6.54 Splitting of cartilage, note irregular thickness of cartilage.

Fig. 6.55 The base of cartilage slicer has a crisscrossed rectangular platform.

Fig. 6.56 Three disks of size 0.1, 0.2, and 0.3 mm are available. One of the three disks is placed with cartilage depending on the thickness of cartilage required. For example, size 3 disk would reduce the thickness of cartilage by 0.3 mm if placed with cartilage. Similarly, the size 2 disk reduces the thickness by 0.2 mm, and size 1 by 0.1 mm.

Fig. 6.57 Disk of size no. 3 is placed in slicer.

Fig. 6.58 Cartilage piece placed over disk.

Fig. 6.59 The second part of slicer is fixed on the first one with the help of screw.
Reconstruction of Outer Attic, Atticoantral, or Posterosuperior Canal Wall

In cases of minimal retraction pocket, with partial thickness drilling of outer attic wall if one can elevate the sac, reconstruction of the wall may not be required. However, in cases of atticotomy, where a fair amount of lateral attic wall is drilled to exteriorize the retraction pocket or sac, then the outer attic wall has to be reconstructed with partial thickness of cartilage. The important thing is not to obliterate the attic completely. Adequate ventilation pathway under the medial margin of cartilage should be preserved and adequate attic space should be provided to permit ventilation through attic to aditus, antrum, and mastoid air cell system.

Reconstruction of outer attic wall in right ear is demonstrated in Fig. 6.64, Fig. 6.65, Fig. 6.66, Fig. 6.67, Fig. 6.68, Fig. 6.69.

Reconstruction of outer atticoantral wall in left ear is demonstrated in Fig. 6.70 and Fig. 6.71.

In revision cases or cases where surgeon drills away or damages the lateral part of bony canal wall, it should be reconstructed with piece of cartilage either snuggly fitting into defect (Fig. 6.72, Fig. 6.73). This can be achieved by splitting the cartilage along its edges in a way that the split edges fit around the drilled bony margins (Fig. 6.74).
Fig. 6.64 Defect in attic after inside out atticotomy with simple mastoidectomy.

Fig. 6.65 A groove is drilled in anterior attic wall for placing the anterior edge of cartilage.

Fig. 6.66 Groove is being drilled in posterior canal.

Fig. 6.67 Sockets in anterior and posterior canal wall. Width and depth of sockets can be adjusted to fit cartilage snugly.

Fig. 6.68 Piece of tragal cartilage, thickness and dimension can be adjusted.

Fig. 6.69 Cartilage in situ after performing autoincus ossiculoplasty.
Fig. 6.70  (a) The defect in posterosuperior bony canal wall. Grooves drilled in anterior and posterior edges of bony defect (black arrows). (b) Cartilage graft is prepared with extra perichondrium on both sides.

Fig. 6.71  (a) The extra perichondrium drapes on surrounding bony canal wall to give better stability. (b) Ball probe is passed medial to cartilage graft to demonstrate ventilation pathway medial to the graft for aeration of antrum and mastoid cavity.

Fig. 6.72  Defect in lateral margin of posterior canal wall (black arrows).

Fig. 6.73  Splitting the edges of cartilage.
Partial Obliteration of the Cavity

Nondoctor-dependent dry and safe cavity is the ultimate end result expected after mastoidectomy surgery. The mastoid cavity created after mastoidectomy must be smooth and circular in depth and circumference. To achieve this, all the bony sockets are to be obliterated with bone dust or cartilages (Fig. 6.75, Fig. 6.76). The bone dust or cartilage pieces are always covered with fascia graft and Gelfoam is placed lateral to graft to stabilize bone dust and cartilage (Fig. 6.77). Floor cartilage is always excised as a part of meatoplasty procedure. Similarly, the floor of the canal is always drilled to align with the floor of the cavity. In cases where floor of cavity is marginally deeper, authors use bone dust or cartilage to fill the defect. Occasionally, in very extensive cholesteatoma cases, after clearance of disease, mastoid tip may be much lower than the floor of canal. In those cases, authors excise the mastoid tip. For faster healing, it is important not to have any bare bone or bare cartilage. In view of this, authors preserve the complete canal skin as described earlier and occasionally if this canal skin is not adequate to cover the raw bone, they place split-thickness skin graft to cover the bare bone.

Cases with still larger mastoid cavity can be obliterated with pedicle vascularized postaural muscle flaps besides bone dust and cartilage. Similarly, small pieces of free muscle graft with periosteum can be used for partial obliteration (Fig. 6.78, Fig. 6.79, Fig. 6.80, Fig. 6.81, Fig. 6.82, Fig. 6.83, Fig. 6.84, Fig. 6.85, Fig. 6.86, Fig. 6.87).

Fig. 6.74 Cartilage is anchored in the defect.

Fig. 6.75 Partial obliteration by placing the bone dust.

Fig. 6.76 Piece of cartilage is used to reduce depth and dimension of cavity posteroinferiorly.

Fig. 6.77 Fascia graft is used to reconstruct the tympanic membrane and cover bone dust and cartilage.
Fig. 6.78  Partial obliteration of anterior attic and area of solid angle, antrum, and aditus, with pieces of tragal cartilage.

Fig. 6.79  Further obliteration of depth of cavity, sinodural angle with bone dust. Note the smooth circular cavity in depth and circumference.

Fig. 6.80  Placement of temporalis fascia graft to reconstruct the tympanic membrane and also to cover bone dust, cartilage, and bone of mastoid cavity with reposition of residual tympanic membrane over graft.

Fig. 6.81  Postaural muscle is being mobilized from skin and subcutaneous tissue.

Fig. 6.82  Elevation of postaural muscle with periosteum from underlying bone.

Fig. 6.83  Postaural pedicled muscle flap.
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Fig. 6.84  Drilling of burr hole in posterior margin of cavity.

Fig. 6.85  Drilling of burr hole in inferior margin of cavity.

Fig. 6.86  (a, b) Anchoring suture between inferiorly created bony socket and postaural muscle flap.

Fig. 6.87  Postaural muscle flap is placed covering lower part of mastoid cavity, for partial obliteration to reduce depth and dimension of the cavity. Note anchoring suture between posterior burr hole and postaural muscle (white arrow).
Complete Obliteration of Cavity

Before completely obliterating the cavity, the middle ear work must be completed i.e. removal of the disease, necessary ossiculoplasty, and reposition of the temporalis fascia graft. Complete obliteration of cavity can be performed by mobilizing and lengthening the pedicled temporalis and postaural muscle flap besides bone dust and cartilage (Fig. 6.88, Fig. 6.89, Fig. 6.90, Fig. 6.91, Fig. 6.92, Fig. 6.93, Fig. 6.94, Fig. 6.95, Fig. 6.96, Fig. 6.97, Fig. 6.98, Fig. 6.99).

3.5 to 4 cm width of postaural muscle flap is mobilized. Posterior margin of flap is separated with the help of coagulation cautery.

The blood supply of this muscle flap is from antero-inferior margin. Inferiorly the posterior half of the flap is separated with the help of coagulation cautery. This flap is then split vertically starting from medial most point of inferior margin going vertically about 1cm short of superior free end of the flap thus converting the width of the flap into length. The muscle flap is sutured in position by making small burr holes in posterior and inferior margins of mastoid cavity.

Similarly superficial temporal muscle is used to obliterate complete cavity or superior part of cavity. Again the width of muscle flap is converted into length, the pedicle will be based in the inferior part of extended flap.

Length and breadth of flap will depend upon size of cavity to be obliterated. Inferior incision is extension of the earlier incision as described for every case of mastoidectomy. Posterior margin of muscle is incised vertically and superior incision is parallel to inferior incision.

Upper half of superior flap is incised vertically in anterior part and lower limit of this incision, the horizontal incision is given between upper and lower incision to split the muscle width into two. This incision is about 1 1/2-2 cm lesser than the superior horizontal incision thus to maintain the blood supply of upper and lower flap in continuity.

After placing the pedicled muscle flap the skin of the EAC is reposited back overlying the muscle flap. Muscle flaps have to be larger than cavity dimension with part of it obliterating the canal, because over the period of time the muscle is going to atrophy and shrink in size.

Fig. 6.88  (a) Right ear, canal wall mastoidectomy with temporalis fascia graft covering middle ear and mastoid cavity. (b) Postaural muscle flap of 3.5 cm width is mobilized.

Fig. 6.89  Inferior horizontal incision in posterior half and vertical splitting of postaural muscle.

Fig. 6.90  Vertical splitting of post aur al muscle (orange arrow) in progress
**Fig. 6.91** Lenghtened postaural pedicle flap in position to obliterate posteroinferior part of the cavity.

**Fig. 6.92** Exposure of superficial temporal muscle.

**Fig. 6.93** Vertical incision on posterior margin of muscle flap (orange line).

**Fig. 6.94** Incised posterior margin of muscle flap (orange arrows).

**Fig. 6.95** Muscle flap is being split in width by giving a horizontal incision.
Fig. 6.96  (a) Diagrammatic representation of incision to be given. (b) Upper half of muscle flap mobilized by giving vertical incision anteriorly (white arrows) and horizontal incision superiorly (black arrows).

Fig. 6.97  Mobilized upper half of muscle flap.

Fig. 6.98  Notice lengthened muscle flap with intact pedicle.

Fig. 6.99  Both pedicled flaps are rotated to completely obliterate the mastoid cavity.
Repair of Tegmen Defect and Exposed Sinus and Presigmoid Dura

Before repairing any defect, granulation over exposed dura or sigmoid sinus should be bipolarised with lower voltage current and continuous irrigation. Smaller defect should be repaired with cartilage piece and larger defect needs bone piece. Elevate dura in complete circumference around the margin of defect for few millimeters around as cartilage has to be pushed under bony margin on all sides. Small areas of exposed sigmoid sinus with intact bone around it can be repaired in similar fashion as the tegmen defect. Larger area of exposed sigmoid sinus and presigmoid dura should be covered with pedicled muscle flap. In case of extensive destruction of tegmen, defect should be repaired with extended temporal muscle flap to obliterate the cavity.

Case 7: Right ear: canal wall-up mastoidectomy with defect in tegmen bone (Fig. 6.100, Fig. 6.101, Fig. 6.102, Fig. 6.103, Fig. 6.104, Fig. 6.105)

Fig. 6.100 Defect in tegmen of the size 1 x 1.5 cm².

Fig. 6.101 (a) Tragal cartilage graft bigger than the size of defect shown.

Fig. 6.101 (b) Dura is being separated from the tegmen margin all around for placement of cartilage graft.

Fig. 6.102 Cartilage graft is gently pushed into the defect.
Fig. 6.103  Tucking the cartilage in anterior part of defect with the help of elevator.

Fig. 6.104  Tucking the cartilage in posterior part of defect.

Fig. 6.105  Cartilage is snuggly fitting into the defect.
Case 8: Left ear: erosion of tegmen secondary to cholesteatoma
(Fig. 6.106, Fig. 6.107, Fig. 6.108, Fig. 6.109)

Fig. 6.106  Granulation tissue over exposed sigmoid sinus
and tegmen (black arrow) is being bipolarized.

Fig. 6.107  Dura is being separated gently from under
the bony margin of tegmen defect after bipolarising the
granulations over exposed dura.

Fig. 6.108  Piece of floor cartilage is placed under bony
margins of tegmen defect.

Fig. 6.109  Pedicled postaural muscle flap is used to protect
exposed sigmoid sinus and obliterate posteroinferior part of
mastoid cavity (white arrows).
Placement of Graft

Graft should be placed on bony canal wall in three-fourths or complete circumference. Graft should cover cartilage piece used for reconstruction of attic or atticoantral wall. In cases where bone dust and cartilage pieces have been used for partial obliteration of cavity in canal wall-down mastoidectomy, the temporalis fascia graft should be covering that as well. It should also be covering the exposed bony surfaces of mastoid cavity. Residual TM, which is usually preserved during initial steps of surgery, should be reposited back over fascia to strengthen the graft (Fig. 6.110, Fig. 6.111, Fig. 6.112, Fig. 6.113, Fig. 6.114, Fig. 6.115, Fig. 6.116, Fig. 6.117, Fig. 6.118, Fig. 6.119, Fig. 6.120, Fig. 6.121).

Fig. 6.110 Ossiculoplasty with lateral attic wall reconstruction.

Fig. 6.111 The temporalis fascia graft is being placed. This is usually done by stabilizing the graft with fine suction cannula in one hand and sliding the graft with sickle knife in the other hand.

Fig. 6.112 Fascia graft is placed to reconstruct the tympanic membrane and covers the cartilage used for reconstruction of attic wall as well.

Fig. 6.113 Residual tympanic membrane is reposited over the graft.
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**Fig. 6.114** Piece of floor cartilage to reconstruct posterior superior canal wall, leaving enough space for ventilation pathway medial to it; chorda tympani is intact.

**Fig. 6.115** Temporalis fascia graft is placed to reconstruct the tympanic membrane (TM) and to cover cartilage. The residual TM is repositioned on fascia graft.

**Fig. 6.116** Bone dust is placed to obliterate bony sockets and reduce depth of cavity.

**Fig. 6.117** Temporalis fascia graft is used to reconstruct tympanic membrane (TM), cover bone dust, and part of mastoid cavity. Residual TM is reposited.

**Fig. 6.118** Fascia graft is used to reconstruct the tympanic membrane and to cover the part of the mastoid cavity.

**Fig. 6.119** Split-thickness skin graft over the fascia graft in anterior compartment.
Fig. 6.120 Placement of large temporalis fascia graft to reconstruct the tympanic membrane and cover bone dust along with mastoid cavity.

Fig. 6.121 Reposition of residual tympanic membrane over graft.

Fig. 6.122 Skin of external auditory canal is brought back toward cavity.

Fig. 6.123 Vertical incision in canal skin is being given.

Meatoplasty

Dimension of meatus should be symmetrical from opening to the depth of cavity. Complete circumference of canal skin, preserved during initial steps of surgery is released from mastoid retractor and brought back in cavity. Skin with subcutaneous tissue is mobilized from surrounding soft tissue up to conchal cartilage in three-fourth circumference. Floor cartilage should be excised, if not excised earlier. Large suction cannula is placed in canal. Vertical splitting incision is given in mid of this skin tube up to conchal cartilage in a direction from below upward. Then superior and inferior horizontal incisions are given at the level of conchal cartilage to create superior and inferior skin flaps (this step will open the canal like a book), which are sutured to superficial temporal muscle and postaural muscle and subcutaneous tissue, respectively (Fig. 6.122, Fig. 6.123, Fig. 6.124, Fig. 6.125, Fig. 6.126, Fig. 6.127, Fig. 6.128, Fig. 6.129, Fig. 6.130, Fig. 6.131, Fig. 6.132, Fig. 6.133, Fig. 6.134, Fig. 6.135).

Postoperative pictures in Fig. 6.136, Fig. 6.137, and Fig. 6.138 show adequate meatoplasty.

The neomeatus should be smooth and circular from external opening till the depth of the cavity and TM. This cavity which becomes almost of the size of widened EAC will be self-cleaning, nondoctor dependent, and patient can take part in water sports as well.

Disfiguring Conchoplasty

Authors don’t believe in giving disfigured meatus, so it is advised to avoid excision of conchal cartilage whenever possible. Trauma to the cartilage is responsible for disfiguring of opening of external auditory meatus (Fig. 6.139).
**Fig. 6.124** Vertical splitting of canal skin up to conchal cartilage.

**Fig. 6.125** Dimension of available skin for meatoplasty demonstrated.

**Fig. 6.126** Superior horizontal incision is being given at the level of conchal cartilage.

**Fig. 6.127** Inferior horizontal incision is being given at the level of conchal cartilage.

**Fig. 6.128** Superior and inferior flaps are demonstrated.

**Fig. 6.129** Postaural and superficial temporal muscles are being sutured. Superior and inferior flaps are to be sutured to superficial temporal muscle and post aural muscle respectively.
Fig. 6.130  Postaural muscle is being sutured to temporalis muscle.

Fig. 6.131  Superior meatal flap is being sutured to superficial temporalis muscle.

Fig. 6.132  Inferior flap is being sutured to subcutaneous tissue and postaural muscle.

Fig. 6.133  Flaps are sutured, notice more than three-quarters of circumference of cavity is covered with the skin.

Fig. 6.134  Index finger is passed through the meatus to demonstrate adequate opening without excising any part of conchal cartilage.

Fig. 6.135  Canal is packed with Gelfoam and adequate meatus opening is demonstrated.
Fig. 6.136  Left ear postoperative picture is showing normal contour of external auditory canal.

Fig. 6.137  Moving further medially with endoscope is showing the dimension of external auditory canal is proportionate to the dimension of mastoid cavity. This is a single smooth small cavity less widened canal.

Fig. 6.138  (a) Further closer view of external meatus and cavity. Notice small circular cavity marginally wider than the normal canal. (b) Postoperative CT scan showing bone dust used for reducing size of cavity (red arrow), neo tympanic membrane, and tragal cartilage used as ossiculoplasty graft (yellow arrow). Note that the size of cavity is slightly wider than the size of external auditory canal.

Fig. 6.139  (a, b) Showing disfigured meatus if meatoplasty is performed by excising part of conchal cartilage.
Role of Skin Grafting

In few cases, there is extensive erosion of the bony canal along with loss of skin or in cases of revision mastoidectomy, in which there maybe loss of skin or the skin may not be healthy. Authors strongly recommend, that there should not be any bare bone in the mastoid cavity; it should be covered either by fascia graft or where there is loss of fair amount of skin, those areas should be covered with split-thickness skin graft, as it promotes faster healing. This further helps in achieving dry healed cavity, thereby reducing follow-up period and most often giving self-cleaning cavity.

Self-cleaning cavity is one, which is smooth and circular in complete dimension and does not have any sockets or pockets and does not have any bulges. Most importantly it has adequate skin lining, thus no accumulation of wax, so avoiding the follow up to doctor for rest of the life.

Harvesting of split-thickness skin graft is from postaural non-hair-bearing area. It is performed with new surgical blade, no. 23. The skin is stretched posterosuperiorly and anteroinferiorly by assistant and a split-thickness graft of required size is harvested. In case of a thicker graft has been harvested, the subcutaneous tissue can be trimmed by placing it on a glass slide. Skin graft can also be collected from thigh using Humby’s knife. Location of harvesting of skin should be left to the patient’s choice. It is better to use multiple small grafts than one very big large piece. At times, authors leave a Merocel pack to stabilize the skin graft.