**POST OPERATIVE IMAGING OF THE TEMPORAL BONE**

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**Objectives**

- Indications
- Contraindications
- Normal Imaging Findings
- Complications of common temporal bone surgical procedure
  - Chronic Otitis Media with or without cholesteatoma
  - Otospongiosis
  - Severe B/L SNHL - Cochlear Implant
  - Vestibular schwannoma

**Common Procedures for Inflammatory Disease**

- Myringotomy
- Myringoplasty
- Tympanoplasty
- Canalplasty
- Meatoplasty
- Ossiculoplasty
- Mastoidectomy

**Myringotomy**

- Surgical procedure in which a tiny incision is created in the tympanic membrane, for drainage of middle ear effusion
- Followed by placement of pressure equalization (PE) tube (also known as grommet, ear tubes, tympanostomy tube-T tube, myringotomy tubes or ventilation tubes)
- Material - Plastic, metal or Teflon
- Maybe Subannular versus transtympanic

**PE tubes**

- Subannular tube is put between the bony wall of the EAC and the annulus (i.e. lateral to the annulus); used when long term ventilation of the middle ear is needed
- A “regular” transtympanic tube is placed through the TM, i.e., medial (central) to the annulus via myringotomy incision

**Subannular PE Tube**

Axial and coronal CT demonstrate a sub annular PE tube between bony wall of EAC and annulus of TM (arrow)
Myringoplasty refers to reconstruction of a perforation in the tympanic membrane without inspection of the ossicular chain. It assumes normal middle ear mucosa and ossicles.

Material used: temporalis fascia, perichondrium, cartilage, periosteum, and adipose tissue.

Procedure which involves lifting of the TM and removal of middle ear disease followed by TM reconstruction. Unlike myringoplasty, middle ear pathology is also addressed, like cholesteatoma, chronic OM, adhesions, scars, ossicular erosions. If ossicles are also surgically addressed at the same time, it is referred to as Ossiculoplasty or Ossicular Chain Reconstruction (OCR). Tympanoplasty can be performed with or without mastoidectomy.

Canalplasty is widening of the bony portion of the external ear canal. In order to visualise the tympanic annulus, particularly in anterior or subtotal perforations, canalplasty is essential and may be an integral part of myringoplasty or tympanoplasty.
**Meatoplasty**
- Meatoplasty is an operative technique to widen the lateral cartilaginous part of the external auditory canal.
- The aim of a meatoplasty is to enlarge the lumen of the ear canal by removing the obstructing cartilage as well as the underlying soft tissue.

**Meatoplasty Indications**
- As part of other otological procedures:
  - Canal Wall Down Mastoidectomy: Meatoplasty is an essential routine step at the end of CWD to provide easy access for cleaning and to assist with ventilation of the mastoid cavity. Failure to do an adequate meatoplasty will result in a lifelong problem of a chronic draining ear.
  - Tymanoplasty, canalplasty: In these procedures it may be mandatory to perform a meatoplasty to improve intraoperative surgical exposure.
- Stand alone surgery for EAC stenosis

**Ossiculoplasty/Ossicular Chain Reconstruction - OCR**
- Ossiculoplasty is reconstruction of the conductive hearing mechanism using either an autologous graft or prosthesis.
- Restore hearing mechanism between tympanic membrane and oval window
- Addresses ossicular discontinuity due to: erosion, trauma, fixation/tymanosclerosis, adhesions

**Ossicular Chain Reconstruction**
- Grafts: can be modelled and shaped by the surgeon:
  - Autograft- are harvested from patient-incus interposition, tragal cartilage, pinna
  - Homograft- harvested from donor tissue-ossicles, cartilage or TM
- Synthetic material: There are two distinctive parts in an ossicular prosthesis:
  - head (which makes contact with the tympanic membrane or with the handle of the malleus)
  - stem

**Autograft-Incus Interposition**
Axial projections from temporal bone CT demonstrates remodeled incus in the mesotympanum (white arrow) with a notch laterally to articulate with the malleus. At the level of the epitympanum only the malleus head is seen (black arrow). Its appearance on a CT is undistinguishable from a post-traumatic incus dislocation

**Synthetic Prosthesis**
- Titanium
- Combined Titanium/Hydroxyapatite (Dornhoffer, Haberman, etc)
Synthetic Prosthesis

- Applebaum

Hydroxyapatite Prostheses

- Goldberg
- Richards
- Black Oval Top

TORP versus PORP

Partial ossicular reconstructive prosthesis (PORP): Spans from the tympanic membrane to the head of the stapes.

Total ossicular reconstructive prosthesis (TORP): Spans from the tympanic membrane (TM) to the stapes footplate.

Partial Ossicular Reconstruction Prosthesis PORP

Extends from TM to stapes head, malleus and incus are eroded but stapes superstructure intact.

Total Ossicular Reconstruction Prosthesis TORP

Extends from TM to stapes footplate, eroded malleus, incus and stapes superstructure.
Cartilage between prosthesis and TM to decrease extrusion.

Dislocated TORP

Complications
Chronic otorrhea refractory to medical therapy

Obtain access to middle ear to correct middle ear pathology (e.g., ossicular discontinuity causing a conductive hearing loss)

Obtain access to remove a cholesteatoma

**Mastopectomy: Indications in Chronic Otitis Media**

- Chronic otorrhea refractory to medical therapy
- Obtain access to middle ear to correct middle ear pathology (e.g., ossicular discontinuity causing a conductive hearing loss)
- Obtain access to remove a cholesteatoma

**Mastoidectomy Classification**

Two major types
- Canal wall up (CWU)
- Canal wall down (CWD)

Some other terms that we may come across:
- Cortical MastoideCTomy - a form of CWU, consists of opening the mastoid cortex and identifying the aditus ad antrum.
- Radical Mastoidectomy - a form of CWD, involves removal of ossicles
- Modified radical mastoidectomy - the most common form of CWD, CWD except the middle ear space and native tympanic membrane are not manipulated
- Tympanomastoidectomy - Term used when tympanoplasty and mastoidectomy are performed together

**CWU Mastoidectomy**

- Removal of all of the mastoid air cells along the tegmen, sigmoid sinus, presigmoid dural plate, and posterior wall of the external auditory canal. Koerner’s septum removed. The posterior wall of the external auditory canal is preserved.

**CWD Mastoidectomy**

- A canal wall down mastoidectomy - CWU + removal of the posterior and superior osseous external auditory canal.
- Mastoplasty is essential part of the surgery
- External auditory canal, mastoid, and epitympanum become one common cavity - Mastoid Bowl
- The tympanic membrane is reconstructed to separate the mucosal lined middle ear space from the mastoid cavity and ear canal.

**CW UP**

**ADVANTAGE**
- Rapid healing
- Easier long term care
- No water precautions

**DISADVANTAGE**
- Technically difficult
- Recurrent disease
- 2nd look needed
- Residual disease harder to detect
CW DOWN

**ADVANTAGE**
- Recurrent disease rare
- Residual disease easy to detect

**DISADVANTAGE**
- Longer healing time
- Open cavity
- Water precautions
- Ossicular chain reconstruction difficult

CWD Clinical Exam: Large mastoid bowl communicating with a surgically enlarged EAC via meatoplasty.

Preop CT Checklist

- Dz confined to Prussak Space/lateral attic - Anterior atticotomy
- Extends beyond attic, healthy well pneumatized mastoid - Canal Wall Up with planned second look
- Extends beyond attic, unhealthy/sclerotic mastoid, EAC erosion - Canal Wall Down
- Status of Ossicles - determines type of Tympanoplasty

Preop CT-Surgical Landmines

- High riding jugular bulb
- Position of sigmoid with respect to the posterior wall of the EAC
- Erosion of tegmen
- Dehiscent VII nerve
- Lateral semicircular canal dehiscence
### Post Op MRI

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- **Fenestral Otosclerosis-Oval Window Closure-Stapes Fixation-CHL**

- Teflon
- Silicon
- Stainless steel
- Homograft
- Tantalum
- Nitinol
- Titanium
- Combined Nitinol/Fluoroplastic

All metallic stapes prosthesis are MRI compatible, with the exception of 1987 accidental mismanufacture of CHL.

Complications
1. A microphone, which picks up sound from the environment.

2. A speech processor, which selects and arranges sounds picked up by the microphone.

3. A transmitter and receiver/stimulator, which receive signals from the speech processor and convert them into electric impulses.

4. An electrode array, which is a group of electrodes that collects the impulses from the stimulator and sends them to different regions of the cochlear nerve.

The absolute requirements for cochlear implantation are the presence of a cochlea (either normal or malformed) and of a cochlear nerve.

Absence of cochlea is best seen on temporal bone ct.

Absence of cochlear nerve is best seen on sagittal MRI images through the IAC.

Cochlear Implant Surgery

- 1) A “well” is created in the parietal occipetal bone for the receiver-stimulator complex
- 2) Simple Canal Wall Up mastoidectomy
- 3) Electrode enters middle ear through facial nerve recess
- 4) Electrode enters cochlea through round window/cochleostomy and makes 1.5 turns in scala tympani.

Cochlear Implant Parts

Contraindications

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Contraindication to CI
The Baha (bone anchored hearing aid) works on a principle of efficient coupling of the sound processor to the underlying bone through:

1) a small connector across the skin,
2) an implant that directly bonds with the underlying bone.

This allows the bone to transfer sound directly to a functioning cochlea rather than via the middle ear.

Indication: Conductive and mixed hearing loss (EAC atresia/chronic infection of the middle ear).

Surgery for Vestibular Schwannoma

- Middle cranial Fossa approach
- Suboccipital
- Translabyrinthine

Osteointegrated cochlear stimulator-Baha

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Suboccipital (Retrosigmoid) Approach

- Post wall IAC removed
- No size limitation
- Greater access to the cerebellopontine angle while maintaining the option of hearing preservation.
- Better facial exposure
- Limited access to the lateral IAC
- Cerebellum retracted

Adv:
- Widespread exposure, lowest tumor recurrence rate
- Addresses tumors in cochlea and vestibule
- Eliminates hearing

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http://radiographics.rsna.org/content/29/7/1955.full

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The translabyrinthine approach

- Mastoidectomy, removal of post wall IAC, sagittal plate, SCC, labyrinthectomy
- Fat packing to eliminate CSF leak
- Widest exposure, lowest tumor recurrence rate
- Addresses tumors in cochlea and vestibule
- Eliminates hearing

http://radiographics.rsna.org/content/29/7/1955.full
Mastoidectomy and Tympanoplasty with ossicular chain reconstruction (Incus interposition/PORP/TORP for COM)

- Stapes Prosthesis for Fenestral Otosclerosis
- Presence of Cochlear Nerve is absolute indication for CI
- Translabyrinthine approach for VS eliminates hearing and should be used in patients with large tumors and no hearing