Temporal Bone Dissection Manual

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MIO Temporal Bone and Ear Surgery Course.

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Acknowledgements

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Sponsors
Introduction

Mastery of the anatomy of the temporal bone is an obligation upon all ear surgeons. The surgeon must be fully acquainted with the internal structure of the temporal bone.

It is not enough to gain experience by surgery on the living patient. If we only do that then we will always be tempted to do inadequate surgery because of fear. Unknown structures lying hidden in the bone in positions we are not quite certain about will prevent us giving the patient the best possible result.

Most bones are not affected by ear disease. There will be anatomical variations between bones. It is wise to dissect as many bones as possible in order to appreciate these differences. Look carefully at your colleagues’ dissections as well as our own.

Temporal bones vary in size and pneumatisation. Poorly pneumatised bones are more difficult to dissect but more accurately represent the conditions found in many cholesteatomatous ears.

The consistency of the soft tissues on anatomical specimens is different to that found in life. They tend to be harder stiffer and less fragile, and there is none of the bleeding, which may be even more troublesome in inflamed ears. The lack of oedematous tissues, infected debris, bone erosion etc makes the dissection easier. It is all the more important that you develop a clear mental image of the anatomy and landmarks before operating on patients.

Before undertaking more complex procedures such as surgery of the petrous apex or IAM even experienced surgeons return to the temporal bone laboratory to practice and reacquaint themselves with the anatomical landmarks.

The instruments you are using have to be shared with colleagues. They are delicate and expensive. You must respect them and your colleagues by taking care, as if the equipment were your own. We expect you to keep your dissection station clean and tidy. You will be expected to clean the station after use ready for the next session. An inventory is kept of all equipment, you are personally responsible for the equipment at your station.

Our aim in these modules is to practice the surgical techniques and also to dissect out those parts of the temporal bone that would be ‘no go areas’ during surgery on the living patient. As a means to do this we will do ‘operations’ on the bones according to established methods and then dissect deeper in order to identify major anatomical features.

We will discuss the various surgical techniques available and their advantages and disadvantages. It is important to be familiar with the options, in order to suit each patient best. Our teaching will be aimed at surgeons in training, though more experienced surgeons also appreciate the opportunities to explore the bones and discuss techniques.

Another aim of this course is to familiarise you with the micro-surgical equipment. It is essential that you understand the functioning of this expensive equipment and are able to take good care of it. This will prevent much frustration during surgery.

We hope that you enjoy the modules and wish you every success as you use this knowledge to the benefit of your patients and as you pass it on to others.
Right Temporal Bone

1. Squamous part of temporal bone
2. Mastoid part of temporal bone
3. Petrous part of temporal bone
4. Zygomatic part of temporal bone
5. Styloid process
6. Tympanic part of temporal bone
7. Articular tubercle
8. Glenoid fossa
9. Posterior Glenoid tubercle
10. Tympanic ring, anterior wall of EAC
11. External auditory canal
12. Squamo-tympanic suture
13. Tympano-mastoid suture
14. Petro-tympanic fissure
15. Supra-meatal spine
16. Supra-meatal triangle (Macewen’s)
17. Digastric groove
The dissection station equipment

- **Seating.** Adjust seat height or work surface height until you can sit comfortably with your back straight. If you spend hours at the operating table in a stooped position you will tire quickly, become impatient and suffer back pain.

- **Microscope.** Adjust focus and height. Familiarise yourself with the controls. Do not use any force. If you are uncertain, please ask for help. One of the main reasons for this course is to help you understand the equipment. It may vary at the other dissection tables. When you have the chance, see which you prefer and why.

  **To focus the microscope:**
  1. Set both eyepieces at the zero position.
  2. Adjust the inter-pupillary distance until comfortable and note the angle / distance between eyepieces.
  3. Look through the microscope at something flat on the table e.g. printing on a piece of paper. Move the height of the microscope until your best/dominant eye (usually the right eye) sees clearly. Now close that eye and without moving the microscope look with your other eye. Often you will find that you are not clearly in focus. This is because of slight differences between your eyes and the microscope eyepieces. Turn the eyepiece for this eye until focus becomes sharp again. Now look through both eyes together. You should have good focus and have one eyepiece set to zero. Make a note of the settings on the eyepieces. When magnification is changed the focus should remain sharp.

- **Suction.** Check that your suction is working and that the bottle is not full. (Suction pressure when the tube is occluded should be at about 400 mm Hg).

- **Irrigation.** Check that you have adequate water in the irrigation system and that it is functioning well.

- **Instruments.** Check the inventory list, familiarise yourself with the instrument names and types. Check the drill burr sizes.

- **Drill.** Check the controls. Find the ON/OFF switch. Usually you will not need to touch any tabletop controls such as any speed setting or reversing switches. Check the drill is rotating clockwise (to give maximum effect with cutting burrs). You will control speed by the foot switch. Check the connection of handpiece to drill. Check the method of changing burrs in the handpiece. After each session the burrs must be removed from the handpiece and their teeth cleaned carefully with the tip of a scalpel blade or a small wire brush. The handpiece must be wiped clean. Application of lubricating oil to the handpiece, but not to any motor system may be necessary.
Setting up the Bone

Temporal bones are a precious commodity. They are difficult to obtain and maximum benefit must be obtained from each. The bones are gifted before death or by relatives for medical purposes and must be respected.

Temporal bones are best preserved deep-frozen. Bones kept in Formalin suffer deterioration in texture of the soft tissue and the smell is unpleasant. However it is difficult to obtain and store fresh bones so we may be obliged to use bones in Formalin or occasionally dry bones without soft tissues.

Synthetic bones may be used for familiarisation with the anatomy and for some simpler dissections.

**Soft tissue preparation:**

Rinse the bone in water. Decide whether it is right or left sided.

If the pinna and soft tissues are present, make endaural and postaural incisions. Note tissue depth to the bone. Position of EAM relative to postaural incision. Intrinsic muscles of pinna. Level of temporalis fascia.

Trim off excess soft tissue and periostea overlying the mastoid. Do this by making radial incisions away from the meatus with a scalpel. Scrape off the tissue with scalpel, toothed forceps and a large periosteal elevator. Dispose of tissue in the containers provided. Do not tear out the deep meatal skin.

Notice the extent of the cartilaginous and bony meatus and the thickness of tissues in the superior, posterior, inferior and anterior walls. Note the relationship of the Meatus to the Temporo-Mandibular Joint.

Identify all the anatomical features as listed below:

**Surface anatomical features of the Temporal bone.**

1. **Lateral view.**
   - Root of Zygoma
   - Linea temporalis
   - Suprameatal spine of Henle, Macewen’s triangle
   - Tympano-Mastoid suture
   - Squamo-Tympanic suture
   - Anterior meatal Spine
   - Mastoid emissary vein
   - Mastoid tip, Sternomastoid tendon insertion, Digastric muscle insertion and Digastric groove, Stylomastoid foramen, Facial nerve
   - Styloid process
• Glenoid Fossa

Other anatomical features may be seen on the wet specimen or require a dry bone without soft tissue cover

• **Postero medial view.**
  
  • Squamous part of temporal bone (1)
  
  • Petrous apex (3)
  
  • Internal Auditory meatus (6)
  
  • Cranial nerves; 7 / 8, (Cochlear, Superior and Inferior Vestibular nerves)
  
  • Vessels of IAC
  
  • Arcuate eminence, Superior Semicircular canal (7)
  
  • Sigmoid sinus (8)
  
  • Jugular foramen
  
  • Impressions by temporal lobe brain convolutions (9)
  
  • Sub-arcuate fossa, small veins (10)
  
  • Superior petrosal sinus (11)
  
  • Inferior petrosal sulcus (12)
  
  • Opening for Vestibular aqueduct (13)
  
  • Cochlear canaliculus (14)
  
  • Dura containing endolymphatic sac
  
  • Roots of cranial nerves; 9/10/11

3. **Supero-Medial view.**

• Tegmen tympani

• Facial hiatus, Greater Superficial Petrosal nerve

• Trigeminal impression
Mounting the bone: -

**IMPORTANT**
The bone must be securely fixed in the operating position. That is, as if the patient were lying on the table with head slightly extended and rolled away from you at an angle of about 60 degrees.

The bone may be mounted in a specialised holder and held with screws, or supported using Plaster of Paris. POP tends to be more stable but prevents access to the rear of the bone, this however is more realistic in surgical terms, though less helpful anatomically.

Wrap the medial part of the bone up to the level of the squamous temporal bone and mastoid in a wet POP bandage. Do not allow any POP to enter the ear canal. Mould POP and bone and fit them into the dissecting dish. Place another POP bandage around the bone.

Adjust the microscope and clean wax from the External Auditory Canal (EAC).

Examine the Tympanic Membrane / TM.
Note all anatomical features, including:-
- size and shape of bony meatus;
- obliquity of drum; malleus handle,
- lateral process and limbus;
- anterior and posterior malleolar folds;
- pars flaccida,
- fibres in drum,
- limits of annulus,
- accessibility of anterior annulus;
any structures visible through the drum e.g. chorda tympani nerve, long process of incus, shadows of the round window, Eustachian tube or hypotympanic air cells.
Tympano-meatal flap, Myringoplasty

Make a perforation in the drum with a straight needle and micro-forceps. Do this by pricking a ring of small holes like the perforations around a postage stamp, then remove the central part with fine crocodile forceps. Practice scarifying the medial surface of the perforation margins with a small (0.5 – 1 mm) 90-degree hook.

Adjust microscope and bone to see the posterior wall of the EAC.

Use a Vertical incision knife (also called a Half moon or Plester knife; some surgeons use a roller knife or a scalpel) to make longitudinal incisions along the most superior and inferior walls of the EAC. Start close to the TM. They should be about 5 – 8 mm long. Note the thickness of the soft tissues in the different parts of the canal. Tissue in the roof is much thicker, that on the posterior wall is very delicate. (This is important when injecting local anaesthetic and also in order to avoid tearing the flap). Retain the skin of the canal laterally.

Use a Canal knife (e.g. Beale’s, Rosen’s, Lumsden’s, Frying pan, round or triangular, horizontal canal incision knife) to make a horizontal incision joining the two longitudinal incisions. This incision should be about 5 mm from the annulus. A round shaped knife is better than triangular because it tears less and can crush the incision margins, reducing bleeding. In life the flaps and their bases may be a little wider because the tissues are more pliable.

Elevate the flap with the Canal knife. Keep the instrument tip firmly against the bone. Protect the flap with the knife while sucking any fluid from between flap and bone. The flap may be tethered to bone inferiorly by fibres entering the obliquely placed Tympano-mastoid suture. These may need to be cut with micro-scissors. Raise the flap down to the annulus. Note that the annulus runs medially inferiorly due to the oblique position of the drum and that there is no annulus in the pars flaccida.

Dislocate the annulus from its bony groove using the Canal knife a curved needle or a small Beale’s elevator. It may be necessary to puncture and tear the middle ear mucosa as it is encountered medial to the annulus. Fold forwards the Tympano-meatal flap. It should be at least 50% of the drum area, otherwise it tends to fall back, or obscure access to the middle ear.

Identify the following structures:

- Umbo
- Malleus handle
- Lateral process of malleus
• Tympano-meatal suture

• Annulus

• Promontory, with Jacobsen’s nerve

• Round window niche

• Chorda tympani (it may be necessary to lift this with a curved needle from where it adheres to the bony margin, just medial to the postero-superior part of the annulus)

• Incudo-stapedial joint (this may be hidden, medial to the bony overhang of the postero-superior annulus)

• Stapedius tendon

• Hypotympanum, with bony septa and air cells

• Facial recess

The procedure as outlined so far is the approach used for permeatal myringoplasty, tympanotomy and stapes procedures.

Take a thin piece of dried fascia and cut a kidney shape of a size that you estimate will slide into the middle ear. Moisten it and attempt to introduce it behind the Tympano-meatal flap. Slide it anteriorly, medial to the malleus handle. It may be helpful to fold the flap posteriorly and observe the graft through the perforation. It must be at least 2 mm larger than the perforation all around. It may be larger than this posteriorly in order to be well anchored in position by the Tympano-meatal flap when it is replaced. The exact shape required for different perforations depends on experience and personal preference. Likewise the shape and position of the flap may sometimes be varied to suit the perforation. The anterior annulus must always be replaced in its correct position, if elevated, in order to prevent blunting of the angle, tension on the drum and consequent conductive hearing loss.

Pack the middle ear anteriorly with Gelatin sponge (e.g. Gelfoam™, Spongostan™). The most difficult area to elevate the graft is the antero-superior part. It may be helpful to place the sponge into the anterior middle ear through the perforation or pushed from behind with an angled needle. Some surgeons use the sponge dry, others soak it with saline or eardrops. Replace the graft and flap against the posterior canal wall and check the graft position.

There are techniques such as anterior tympano-meatal flaps or canal wall buttonholes to help with difficult anterior marginal perforations.
Exposure of Stapes and Stapedectomy

In most people the stapes is partially hidden by the overhang of the postero-superior bony annulus. It is often necessary to see the incudo-stapedial joint well, in order to check continuity and mobility of the ossicular chain. Operations on the stapes demand good exposure. As a guide, before starting any stapes procedure it is wise to have the pyramid and the junction between incus long process and its body, in view.

Locate the chorda tympani and cut it. Normally during surgery it is best to try and preserve the nerve, particularly if the patient may need contralateral surgery later. However, a cut nerve gives fewer symptoms than a stretched and traumatised nerve. In the preserved bone the tissues are stiff and may obscure access, so in this case we will cut the nerve at the start.

Remove bone from the medial part of the canal, at the postero-superior bony annulus.

This may be done with a small bone curette (e.g. House curette). Sometimes, if the bone is hard, a small drill bur is more convenient. Remove the bone in thin pieces, always working away from the ossicles (or chorda, if still intact). Diamond paste burs do not tend to ‘run’ across the bone and cause damage and there are no teeth to catch the flap. Always watch the shaft of the drill burr, it may wrap the tympano-meatal flap around itself.

In surgery for suspected otosclerosis it is important to check that the stapes is fixed at an early stage. Do not accidentally mobilise it while removing bone.

Never touch an intact ossicular chain with a burr. It will cause severe sensorineural hearing loss. The damage is particularly severe with cutting (toothed) burrs.

In the normal temporal bone the stapes is mobile. (The bone can be frozen in order to fix the footplate, but this may leave ice to be cleared from the Oval Window Niche) A freely
mobile footplate makes some of the techniques to be described slightly more difficult than in otosclerosis/otospongiosis.

Make a stapedotomy. Use a straight needle or very fine footplate trephine to make a hole in the central, and usually thinnest, part of the footplate. (Sometimes the footplate is not adequately visible until after removal of the stapes arch). Remember the saccule lies only 2 mm medial to the footplate. Dislocate the incudo-stapedial joint with a fine right-angled 1-mm needle. Cut the stapedius tendon with microscissors. Break the stapes crura by pushing the stapes head, or each crus separately, superiorly and inferiorly with a curved needle. It will be necessary to scrape the mucosa away around the base of the crura on the specimen, otherwise the whole footplate may come out with the stapes.

Remove the stapes superstructure. Using very fine stapes hooks e.g. 45 and 90 degree 0.2-0.4 mm hooks, gently enlarge the stapedotomy. You have to make a hole large enough to accommodate a prosthesis. These are usually 0.4 or 0.6 mm in diameter. Remember again the proximity of the saccule in the vestibule. Try not to remove the footplate in part or in whole. If the entire stapes comes free it may be possible to reaffix it with a tiny drop of super-glue.

When sucking fluid from the oval window niche in life, never place the suction in the stapedotomy or vestibule. This will cause severe inner ear damage. Use a very fine suction placed near the footplate. If there is bleeding from mucosal edges, be patient for a few minutes until it stops.

Take a stapes prosthesis, either a Teflon piston or a Teflon and wire piston and place the base on the footplate next to the stapedotomy. Look at the length. You will want the prosthesis tip to lie just inside the vestibule. It should be far enough inside not to fall out, but not deep enough to touch the saccule. Look at the position of the hook on the prosthesis in relation to the long process of the incus (LPI). Remove the prosthesis and trim the piston to length with a scalpel (No. 15 blade). Now refit the prosthesis. If the length is correct, then place it in the stapedotomy and crimp the hook onto the LPI. Repeat this process with a fragment of thin pliable fibrous tissue over the oval window. This tissue may be introduced to the ear on the end of the prosthesis.

In a real case of otospongiosis there are many variations in the state of the footplate. These require individual techniques that cannot easily be practised on a bone.

Remove the prosthesis and any remaining footplate and view the membranous contents of the vestibule through the OW.
Otoendoscopic examination of the Middle ear

If possible straight, 30° and 70° angled otoendoscopes will be made available. These are delicate and expensive and so every care should be taken not to bend them or damage the lenses. Initially use the straight scope to assess the mesotympanum. Progress to the 30° scope and assess the perimeter of the middle ear including facial recess, hypotympanum and Eustachian orifice. Transfer to the 70° scope and view the sinus tympani, and posterior isthmus, i.e. the route for attic and mastoid aeration around the long process and body of incus. These are common areas for retraction pockets and cholesteatomas to spread, out of direct view. Thorough surgical removal of squamous epithelium from these areas is essential.

Note the risk to the ossicles by the endoscope, especially the stapes when present.

Use an instrument in the middle ear e.g. to remove a small foreign body, whilst using the endoscope for visualisation.

If possible try using the endoscope both directly by eye and from the monitor screen.

Later on in the dissections you may wish to return to the endoscopes e.g.:

- to view the aditus and short process of incus in the fossa incudis, through the cortical mastoidectomy,
- to inspect the attic and aditus and suspensory ligaments of the ossicles,
- to view the middle ear through a posterior tympanotomy.

After you are satisfied with the above procedures, you may inject Methylene blue into the vestibule. You would, of course, never do this to a patient. It will help you identify the semicircular canals later in this dissection.
Cortical Mastoidectomy

The extent of aeration of the mastoid is one of the most variable features of the temporal bone. Linked with the size and aeration of the bone are the position of the sigmoid sinus and middle fossa dura. In this dissection the mastoid air cells are extensively removed. This may not be necessary in every patient, but is done here in order to become familiar with the anatomy.

The mastoid antrum has a constant position in relation to Macewen’s triangle. Antral size is fairly constant and independent of the degree of pneumatisation of the mastoid. It is a good landmark and guide to the incus and facial nerve, even in diseased ears.

Anterior Meatal Spine

Linea Temporalis

Spine of Henle

Pitted area of Supra-meatal triangle

Position of Lateral Sinus

Identify Macewen’s triangle.

Macewen’s triangle is an area defined by three lines:

1. A tangent drawn vertically up from the posterior edge of the External Auditory Meatus (EAM).
2. A second tangent drawn horizontally back at a level between the superior edge of the EAM and the temporal line.
3. A third tangent drawn at the postero-superior margin of the EAM.

The area enclosed by these lines is the surface marking for the mastoid antrum, which lies 2-3 cm deep and slightly anterior to it, in the bone.

Begin removal of bone in the triangle using a large (5-6-mm) cutting burr with irrigation and suction. Start by outlining a triangle with the drill on the cortex of the mastoid. One line runs antero-posteriorly at the presumed level of the dura, the second runs as a tangent to the EAM and the third runs postero-superiorly to antero-inferiorly in the presumed direction of the lateral sinus.
As these are deepened, watch carefully for the changes in colour and cellularity of the bone, which indicate approaching dura and sinus. Develop the dissection broadly, remembering that the safest area is to follow the dura and concentrating on gaining depth antero-superiorly. Inferiorly the lateral semicircular canal and posterior genu of the facial nerve are at risk. As you proceed keep the external canal free from bone debris. This will enable you to see the TM, which is at about the same depth as the antrum. Drill parallel to the EAC, to find the antrum antero-medial to Macewen’s triangle. As you drill deeper, widen the lateral part of the hole you are creating, by removing bone from the mastoid cortex. Thus the hole should be funnel shaped, wider laterally than medially.

Another helpful landmark is the Sino-dural angle, the area where bone over the middle fossa dura meets the bone over the lateral sinus. This is an area of relative safety that can be drilled to increase exposure when looking for the antrum. Keep the canal wall intact. Do not remove any part of it laterally. Do not make it paper-thin, in a patient a fistula could develop which may be difficult to repair.

Principal landmarks:

1. EAC
2. Middle Fossa Dura
3. Lateral Sinus
4. Antrum
5. Lateral Semi-circular Canal
6. Short process of Incus, in Fossa Incudis

The antrum will be recognised because it is larger than an air cell and has some spikes of bone and air cell openings in it. Occasionally you will encounter a well-developed Koerner’s septum. This may partially cover the antrum and hide its opening. As you drill deeper you will need to reduce burr size to fit between dural plate superiorly and EAC wall inferiorly. Do not allow the drill to touch the incus.

Always use the largest size of drill burr that is appropriate for that part of an operation. This will be safer, as it is less likely to slip, and you will tend to drill wider areas in layers, rather than developing narrow deep holes. But always keep an eye on the other side of the burr; while one side is delicately drilling the dural plate, the other may be cutting into a semicircular canal or hitting an ossicle. Use the drill in steady, smooth strokes, and not short jabbing movements. A good sharp burr will cut away bone without pressure from your hand. As burrs get older and blunter, you will find you have to press harder. This is tiring and can be unsafe if the burr slips. Always be certain the burr is securely locked in the handpiece, so that it cannot slip out at speed and cause damage in the ear.

Remove air cells widely to outline the sigmoid sinus and middle fossa dura, keeping a thin plate of dense bone in place over these structures. Identify the bony lateral semicircular canal.
Extended Cortical Mastoidectomy

Extend the drilling anteriorly from the Antrum to the Aditus and Short Process of Incus (SPI). You must not remove the posterior canal wall laterally, or make a hole in it.

You have to drill in the narrow space between roof of EAC and bone covering middle fossa dura. This may be even more difficult in a patient. This is because the mastoid may be poorly pneumatised in CSOM. Then the mastoid is small, with low dura and anteriorly placed lateral sinus. It is usually done for mucosal disease without cholesteatoma, to avoid a canal wall down procedure.

In bones with a low dura the access is narrow, notice that it is often wider medially than laterally because the dura tends to be lower laterally.

By continuing to drill forwards, towards the root of the zygoma, it is possible to open the entire attic (epitympanum) up to the anterior wall of the epitympanum. See the heads of the malleus and incus clearly. Remember that you must not touch the intact chain with the burr. As the bone over the ossicles thins, it may be broken out laterally with a micro-curette.

Inspect the ossicles in the attic, notice the membranous attachments and ligaments, most of these are constant and help explain pathways of aeration and the route of spread of disease.
Modified Radical and Radical Mastoidectomy
(Posterior to Anterior method)

A radical mastoidectomy consists of the removal of:

- Mastoid air cells
- Posterior wall and superior wall of EAC
- TM
- Malleus
- Incus

Thus the middle ear, mastoid and EAC become one common cavity.

A modified radical mastoidectomy consists of the same, but with the exception that the malleus handle and any remaining TM are not removed. The malleus head and incus may also be left in place.

These are examples of canal wall down (CWD) mastoidectomies. An extended cortical mastoidectomy with atticotomy or posterior tympanotomy and tympanoplasty would be examples of intact canal wall (ICW) mastoidectomies.

In both cases of CWD mastoidectomy a tympanoplasty should also be done in most cases, to try and reconstruct a middle ear space.

Make an incision in the roof of the EAC just anterior to 12 o’clock (just anterior to the most superior part of the EAC). The incision should run from medially, towards the most lateral part of the EAC, down to bone. Make a second longitudinal incision at 6 o’clock in the floor of the EAC. A No. 15 scalpel blade is adequate for this. These incisions should meet the previously created tympano-metepial flap. Remove the strip of posterior canal skin with a small periosteal elevator. (In life all skin flaps are preserved and laid back in the cavity at the end of the operation, to speed epithelial covering of the bone). Note the petro-tympanic fissure and anterior meatal spine. Fibrous tissue at this point may need sharp dissection in order to lift the edge of the skin flap.

Drill away the posterior and superior external auditory canal walls that have been left standing after cortical mastoidectomy. Come to the point where a ‘bridge’ of bone covers the incus, malleus and epitympanum (attic). In most diseased ears the ossicular chain is broken (usually at the long process of incus), and once this is confirmed, the bridge can be drilled away. If the chain is intact and healthy it may be possible to preserve the bridge or the ossicular chain. In most cases the ossicles are damaged and invaded by cholesteatoma. Now, even if the chain is intact, break out the bridge laterally with a curette. If necessary dislocate the chain at the ISJ with a 1-mm 90 degree hook. Dislocate the incudo-malleal joint in the attic by putting a needle into the joint space. Remove the incus remnant.

The facial nerve is now identified above the oval window niche (OWN). Usually it has a thin bone covering, but this may be dehiscent. It can be seen running back and starting to curve down posterior to the OWN. This is your landmark as you start to drill down the
facial ridge. Drill along the length of the ridge until it is lowered to the level of the annulus medially and EAC floor inferiorly. Occasionally the nerve may be found slightly lateral to the annulus at the level of the hypotympanum.

Remove the malleus head (with malleus nippers placed just superior to the tensor tympani tendon). Remove the anterior buttress of bone at the insertion of the anterior malleolar ligament, so that there is no bony recess. Sometimes the anterior attic is surprisingly large. The cavity should be a smooth round shape with no small narrow corners.

Smooth the cavity with a large diamond or polishing burr. This would also reduce bleeding from small vessels in the bone and fill small cells with bone dust.

Remove the malleus handle by cutting the tendon of tensor tympani, and remove with it the remaining TM.

Identify:

Processus cochleariformis. (Which may be the only remaining landmark for the facial nerve in a very badly diseased ear).

Tunnel for tensor tympani running anteriorly from processus.

Opening of Eustachian tube, just inferior to tensor tympani tunnel. Look at its diameter and pass a probe inside to judge its size.

Anterior annulus. Consider where an underlay temporalis fascia graft would lie, in the case of an anterior perforation.

Lateral Venous Sinus dissection

Further extend your dissection of the lateral sinus plate, as far superiorly as possible.

Drill cells in the mastoid tip, identify the digastric ridge.

Exposure of Facial nerve

Probably the most important reason for attending this course is this next dissection. You must have a thorough understanding of the route of the facial nerve. Reading anatomy in a book can never replace dissection of a bone and discovering for yourself the exact location of the nerve.

Identify the nerve above the OWN. Follow it forward with the drill up to the anterior genu, just above the processus.

Now follow it back to the posterior genu, below the lateral semicircular canal. Follow it inferiorly as far as the stylomastoid foramen. Note the relationship to the digastric ridge.
Particularly note it’s position from the posterior genu down to the level of EAC floor. Consider this position carefully in antero-posterior and medial-lateral planes. This is the area in which you will come close to it most often.

As you expose it, look for the junction with the chorda tympani. Notice the nerve’s relationship to the pyramid and stapes and the nerve branch to the stapedius muscle.

Identify the greater superficial petrosal nerve at it’s junction with the anterior genu.

Dissection of Semicircular Canals and Saccus Endolymphaticus

Use a 3-mm diamond paste burr to gradually thin the bone of the lateral semi-circular canal. You will see the blue colour of the methylene blue inside the canal showing through the bone. Outline the canal as a blue line, without opening the lumen as yet.

Now find the posterior semi-circular canal. It lies at right angles to the lateral canal. It will probably be more medial than you are expecting. Again try to blue line it, without opening into the canal.

Next find the superior canal. It lies superior to the other two canals and in the plane at right angles to them. The canals lie in planes at right angles to each other, like the three sides at the corner of a cube.

The canals should now stand up in clear relief in the mastoid cavity.

If the canals are not already opened, now gradually open their lumens, following them along their lengths.
The superior limb of the posterior canal joins the medial limb of the superior canal, to become the crus commune. The endolymphatic duct may be seen infero-medial to the crus commune. Follow the duct posteriorly, identify the saccus between bone of posterior fossa and the overlying dura. Incise the saccus to visualise the lumen.

The inferior limb of the posterior canal should be followed medial to the vertical part of the facial nerve to it’s junction with the vestibule.

The anterior limb and ampulla of the lateral canal lie close to the lateral limb of the superior canal as they pass medial to the facial nerve and enter the vestibule.

Carefully note the relationship of the ampullae of anterior and superior canals to the surrounding air cells, if any, and the facial nerve. This can be an area for confusion in cholesteatoma surgery. Follow the Tegmen medially above the horizontal section of the facial nerve, this is one route to the petrous apex which cholesteatoma sometimes follows.

Note the subarcuate artery as it passes through the loop of the superior canal, it may give some troublesome bleeding during surgery.

The space between middle fossa dura and the canals is narrow. The cells in this area and the medial part of the sino-dural angle are often involved in cholesteatoma. It is necessary to be familiar with the normal position of the canals before disease in this area can be safely cleared. It is also important to become experienced in detecting changes in the bone appearance and density as the hard and less cellular bone of the otic capsule is approached.
1. Tegmen Tympani
2. Bone over Lateral sinus
3. Groove for Tympanic membrane annulus
4. Sino-dural angle
5. Posterior semi-circular canal
6. Lateral semi-circular canal
7. Superior semi-circular canal and Arcuate eminence
8. Crus Commune
9. Vestibule, through enlarged Oval Window
10. Vertical segment of Facial nerve (divided at posterior genu)
11. Chorda tympani nerve, cut end
12. Promontory
13. Round Window recess
14. Hypo-Tympanic cells and anteriorly, the opening of the Eustachian Tube
15. Cochleariform process
16. Retro-facial air cells
17. Digastric line in Mastoid Tip
Jugular Bulb

Follow the Sigmoid sinus plate inferiorly and medially, carefully skeletonising. Note the close relationship of the jugular bulb to the posterior hypotympanum. In some cases the bulb may lie in the middle ear close to the annulus. It may have paper thin bone covering or be exposed. It is then at risk when elevating the annulus for myringoplasty.

Trans-labyrinethine approach to Internal Auditory Meatus

Drill away the semicircular canals, as for a labyrinthectomy. Follow each limb as it reaches the vestibule. The thin medial wall of the vestibule is the lateral wall of the Internal Auditory Canal (IAC). Drill the postero-medial wall of the vestibule. Destroying saccule and utricle in the vestibule. Open into the lateral end of the Internal Auditory Canal. Identify the transverse (falciform) crest separating facial and superior vestibular nerves above from cochlear and inferior vestibular nerves below. The vestibular nerves lie lateral to the facial and cochlear nerves and are met first.

Identify Bill’s bar, the vertical crest separating the superior vestibular and facial nerves.

Follow the IAC medially by drilling along the canal in the direction of the sino-dural angle. Locate the coloured material you placed in the Internal auditory Meatus (IAM) / Porus Acousticus before you began the dissection. This simulates an acoustic tumour.

Note the difficulty of avoiding injury to the facial nerve during this procedure.

An alternative technique is to follow the bony IAC making it’s bone eggshell thin right up to the porus so that the canal stands up in relief. This is a nice method if you wish to preserve a dry bone, but does not give an opportunity to examine the contents of the canal.

Trans-tympanic dissection of Cochlea, Internal carotid artery and Eustachian tube

Drill the promontory to enter basal turn of cochlea. Join the oval and round windows and view their contents carefully.

Identify the entrance of the Eustachian tube in the middle ear. Drill the annulus anteriorly to enlarge exposure. Continue forwards to get a clear impression of dimensions and direction of the tube. Observe the peri-tubal air cells if present and the canal of Tensor tympani. Note the relationship of tensor, processus and facial nerve. Drill the medial and
inferior walls of the Eustachian tube to find the ICA. Follow its course and consider its relationship to the middle ear.
Exposure of Ossicles and Atticotomy/Epitympanotomy

Take your second bone. Dispose of the first bone in the container provided.

Drill the roof of the EAC between the spine of Henle posteriorly and the root of the zygoma anteriorly. Carry on until the dural plate is reached. Do not go too far posteriorly and open the antrum at this stage. Remember to drill adequately anteriorly, at the anterior meatal spine area. Continue medially until a shelf of bone is created which represents the lateral attic wall or scutum. A landmark for the correct depth is the lateral process of the malleus. Do not enter the attic with the drill. You will be able to see that the bone is becoming thin. Remove the thin bony plate overlying the attic with a curette.

Examine the ossicles in the attic. In life you may wish only to do a posterior atticotomy, e.g. in order to remove a fixed incus prior to ossiculoplasty, or you may need to open the attic widely and remove a cholesteatoma sac or ossicles fixed by tympanosclerosis. This approach also enables you to follow a cholesteatoma from it’s origin in the attic or posterior mesotympanum and assess it’s extent. It may then be possible to avoid a canal wall down/radical mastoid cavity if the disease is found to be small and not extending back through the aditus.

Reconstruct the outer attic wall. This is a wise precaution to prevent retraction pocket formation. It should only be done if you are certain all cholesteatoma matrix has been removed and none could be left hidden under the reconstruction.

The reconstruction is most easily done with cartilage. It is usually easy to find a piece of cartilage about 0.5 x 1 cm in the incision lines. Otherwise it can be taken from the meatoplasty area or from the concha or tragus. Retain perichondrium on at least one surface. If the perichondrium is larger than the cartilage this will be helpful in creating a smooth seal over the attic. Cut the cartilage to a rough semicircle and place it as a new scutum / outer attic wall. It should not touch the facial ridge, ossicles or block the aditus. If there is some clean bone dust (not containing infected material or cholesteatoma pieces), put some as a thin layer of bone paté over the cartilage graft and around it’s edges.
Ossiculoplasty

The ossicles should still be in place in the bone. Stapes should still be in situ.

There are many shapes and materials which have been used for ossiculoplasty.

As a practical and technical exercise try some of the techniques below. Although it is common to use synthetic materials, use of remnant ossicles or cortical bone is often possible and may be a better long term solution, with no propensity to extrude.

Points which are important to the success of your technique include:

- **Stability of the new ossicle.** It should be a firm fit, a little tight, if possible. It is no good balancing it in position and hoping it will not move - it will. The surfaces between which it is to fit should be as stable as possible. Therefore try to avoid cutting the tensor tympani if you expect to do an ossiculoplasty involving the malleus handle.

- **No contact with bone except for another ossicle.** If it touches facial ridge, pyramid, promontory or processus cochleariformis it will fix and become immobile.

- **Leave mucosa on all nearby bony surfaces.** Do not strip all oedematous mucosa, there will be adhesions or bony ankylosis which will immobilise the new ossicle.

- **Staging the procedure.** It may be ideal to create a good middle ear space, perhaps with the use of silastic sheeting or Gelfilm™, and re-operate a year later on a dry ear with an intact drum. At that second stage the influence of scar tissue retraction and inflammatory tissue would be minimised. However, there are advantages in a single stage procedure and little if anything is lost by a primary reconstruction. It is wise to warn the patient pre-operatively that they may need a second procedure to improve hearing.

- **The state of the stapes.** The hearing results of ossiculoplasty when the stapes arch is intact are far better than when the graft has to form a columella onto the footplate. There are obvious reasons for this. It is difficult to construct a graft which sits on the footplate in a stable fashion, without adhering to surrounding bone.

- **Intact canal wall or open cavity.** A middle ear space of normal depth with a drum of normal area suspended at a short distance from the stapes may give better hearing results and more potential for reconstruction. In an open cavity there is often a shallow middle ear with the TM graft adherent at its margins to the nearby facial ridge. In fact the hearing results to date have been much the same. The desire for normal middle ear dimensions and to avoid a mastoid cavity drives attempts to preserve the canal wall.

We will use incus or cortical bone as graft material. Cortical bone is removed from the mastoid process or squamous temporal bone. It is necessary to remove the cellular marrow bearing bone from the medial side of the cortical bone.

Bone is easier to drill to an accurate shape than cartilage, but is more prone to fix to surrounding structures. If there is an undiseased ossicle available this is the best material. Artificial materials are expensive and some tend to extrude through the drum after a few years. All autografts have a slight tendency to re-absorb in the long term. Retention of some periosteum or perichondrium on the graft may prevent this.

**Incus Interposition**

Surgeons debate whether it is best to place a graft from intact stapes head to the malleus handle or direct to drum. We will make a malleus-stapes assembly (in this case an incus interposition) i.e. a bridge from stapes to malleus handle/neck.
Remove the outer attic wall reconstruction if completed in the last session.

Dislocate the ISJ with a hook, notice that the ISJ is medial to the lenticular process of the incus. Insert a needle in the joint between heads of malleus and incus and dislocate the incudo-malleal joint. Hook out the incus.

Hold the incus in an ossicle holding forceps (Derlacki) or fine artery clip. Using diamond paste burrs, drill away the long process (which in most diseased ears is already missing). Cutting burrs tend to flick the ossicle across the room! You can hold the ossicle between gloved fingers if you are careful and use diamond drills, cutting drills easily tear gloves. Be very careful not to injure your fingers!

Shorten the short process of incus by about 0.5-1mm then cut a slot through it. Use a 0.4 - 0.6-mm diamond burr. Hollow out the groove till it will just fit a 1mm burr, this is the size of stapes head. Drill a wider groove (1-1.5mm) across the malleolar joint surface of the incus. This groove should be at about 60-90 degrees to the hollowed out slot in the short process. This groove will fit the malleus handle. At this stage err on the side of keeping the graft too big. Place it in the ear and see where further work is needed to obtain a good fit, with no excess bone that can touch surrounding structures. The slot in short process allows incus to fit onto stapes head and arch. The stapes head can be viewed through the notch. Keeping the tensor tympani tendon intact will allow the incus or bone graft to fit tightly and be stable between malleus and stapes. An intact anterior malleolar ligament or anterior tympanic membrane provides additional support.

This method works best in ears where the interposition slopes up from stapes to malleus at 45 degrees or more. If the malleus handle is too retracted or anterior the mechanics are less efficient.

In the absence of a malleus handle or for preference some surgeons place the malleus head or a bone chip from stapes head to drum. There is a risk that it will lift off and lose contact. A deeper groove to accommodate stapes arch and head is more stable than that seen in diagram.

(A traditional ‘type III’. assembly in an open cavity, where the TM graft is laid directly onto the stapes head, generally gives disappointing hearing results despite occasionally being very effective. Unless accompanied by a cartilage sheet over stapes area it often results in a retraction pocket around stapes).

Harvesting cortical bone from the mastoid is a simple matter if needed. Use a 1-2 mm cutting burr to outline an area about 6-8 mm square. Drill about 3-4 mm deep, undermining the graft piece slightly. Break out the graft with a periosteal elevator.

**Columellar ossiculoplasty**

Drill the cortical bone to a shape that you judge will fit from the stapes footplate to the TM and malleus handle. There are many variations on this.

You will see that there are problems with stability and preventing adherence to the facial ridge, pyramid or margins of the OWN.

When the malleus handle is present and stable; an L shape, notched to lie medial to the handle and with the base of the inverted L against the medial surface of the TM may be successful. However, such a construction is
not inherently stable unless the TM lies across the interposition graft.

Often the incus is sufficiently intact to remove any remnant of the long process then put its short process on the footplate and its body under the malleus handle and TM. The malleo-incudal joint surface on incus body has a natural groove which usually sits nicely under medial surface of malleus handle. The size is often exactly right without any need to reshape the body of incus. Retaining healthy periosteum may reduce chance of ankylosis to surrounding structures.

In the absence of a malleus, an ‘umbrella’ shape where the shaft sits on the footplate between the base of the stapes crura and the flat top lies medial to the TM and fascial graft may be effective.

Malleo-stapedotomy (optional)

In the absence of an incus long process, stapedotomy for otosclerosis or tympanosclerosis can still be done, where indicated.

Ensure that the malleus is mobile. Create a tunnel between TM and malleus handle just inferior to the lateral process of malleus. Do stapedotomy or stapedectomy. Measure for prosthesis length and judge possible angulation of shaft. Attach a stapes prosthesis to malleus handle. Notice that the malleus handle is thicker than an incus long process, the hook may need appropriate adjustment.

Ossicular prostheses

Various PORPs and TORPs may be available for you to trial.

Some can be sized by inserting mock prostheses of various sizes into the ear, then selecting a device of the measured size and type.

Some can be adjusted for length with specific jigs.

Differing materials may require alternative techniques to shape or cut to size.
Attico-antrostomy and reconstruction of outer attic wall

Extend the atticotomy backwards to reach the aditus and then antrum. Follow the dural plate back. Drill from the aditus medially to the outer surface of the temporal bone laterally. No harm is done by exposing dura over a small area. You must not make a hole in the dura. This would cause a CSF leak, could cause intracranial infection, and predisposes to brain herniation. You may notice a change in sound of the drill as the dural bone plate thins.

There are small vessels in the dura which can give troublesome bleeding per-operatively. This can be controlled by use of a large diamond burr, without irrigation, on the adjacent bone, application of a cotton ball soaked in adrenaline for a few minutes while you work on another area or very brief diathermy - preferably bipolar. Other means of control include bone wax or insertion of a piece of cartilage in the bony defect, pushed under the bone margins.

Keep following the dural plate back until the antrum is opened. At this point it is still possible to reconstruct the defect with cartilage and bone pate, avoiding an open cavity. Only do this if you are certain there is no cholesteatoma going on back into the mastoid. It would be a very serious mistake to leave cholesteatoma in the mastoid out of sight until complications develop later.

You may wish to avoid an open cavity e.g. a child with well pneumatised mastoid on X-ray. You are not 100% certain you have removed all the sac or you can see bad mucosal disease in the antrum. Then you can do a separate cortical mastoidectomy, without removing any posterior canal wall. Access will be narrow. If there is any cholesteatoma then you must remove the canal wall and make an open cavity mastoidectomy.

Observe the relations of the aditus.

- facial nerve
- horizontal / lateral semicircular canal
- fossa incudis

Drill anterior to the head of the malleus. The anterior epitympanum is a common site of residual and recurrent cholesteatoma. Observe the course of the chorda tympani in relation to the neck of malleus and anterior malleolar ligament. Observe their relationship to the squamo-tympanic suture. Remove the head of the malleus. This may be done with a House-Dieter malleus nipper, the tips of a pair of fine pointed iris scissors or, with great care, a very fine drill burr. Observe:

- processus cochleariformis
- tendon of tensor tympani
- canal of tensor tympani
- mucosal fold joining this canal to the anterior malleolar ligament. It is this fold which limits aeration of the attic by an anterior route. Thus aeration of the attic has to occur by the
posterior route around the LPI. This is an area prone to 
obstruction by mucosal oedema and already narrow due to the 
presence of the incus, facial nerve and chorda tympani.

• recess running down into the Eustachian tube
Antrostomy and Modified Radical Mastoidectomy (Anterior to Posterior method)

The older technique of MRM, which began with a cortical mastoidectomy and led to removal of the ‘bridge’ of bone over the incus, as the posterior canal wall was taken down, dates from the use of hammer and gouge. It is still appropriate where there is known to be a large cholesteatoma. For example in cases of postauricular fistula or cholesteatoma eroding out through the mastoid cortex. In general it is now better to approach most cholesteatomas from their source in the middle ear and follow them back. Although this takes a little more time, it can sometimes avoid the creation of a mastoid cavity, or allow the cavity to be smaller in size.

Continue drilling back to reach the sino-dural angle. Remove cells over the lateral sinus so that it stands out clearly, covered by only a thin plate of bone. Carry this down to the level of the digastric ridge.

Identify the horizontal part of the facial canal. With this in mind start to lower the facial ridge. Always use large burrs here. They do not dig in and you will not be tempted to drill small holes. Remove bone on a broad front all along the ridge. Use the drill in a direction running down the ridge along the anticipated line of the vertical part of the facial canal. Never drill across the line of the nerve. In life there are small vessels in the bone immediately overlying the nerve and just inferior to the posterior genu. These often provide a warning that the nerve is close. The bleeding can be stopped with a diamond burr. In a well pneumatised bone you may be confused by mucosa in the cells, thinking it is the nerve. You can distinguish the two by careful drilling around these cells and then lifting off the thinned bone with a needle or small curette. You will then see if the soft tissue is running in a line that could be facial nerve.

Never use a curette in a direction, which if it slipped, would cause it to hit the facial nerve.

You may also encounter soft tissue in the line of the tympano-mastoid suture and at the stapedius muscle.

If you expose nerve, do not panic. If the sheath is undamaged and no flakes of bone have been pushed into it then there will be no problem. If you think the sheath has been traumatised, you must decompress the nerve for about 1 cm each side. This is quite easily done with a diamond burr until the bone of the canal is very thin and the vessels of the nerve sheath are visible through the bone. Then flake off the bone with a needle.

Always keep the drill well irrigated when working near the facial nerve or semicircular canals. This will prevent damage by heat.
Thin the bone until you can follow the line of the nerve clearly down to the level of the hypotympanum. This will not always be necessary surgically, but is a good exercise in understanding the line of the nerve in the bone.

Drill away bone in the region of the bony annulus, opening the facial recess and following the chorda tympani into the bone.

Take a large right angle needle and probe the Sinus Tympani (ST). This is very variable in depth. It is a frequent site of residual cholesteatoma in the middle ear. It is essential to understand its position and importance. Go and look at the sinus tympani in the other student’s bones. Only when you are confident working close to the facial nerve will you feel happy to drill in this area and obtain good exposure of the ST.

Michael Angelo the famous Italian sculptor and artist said that when he looked at a block of stone he did not see a block of stone. He saw the shape of the statue locked inside, he only had to cut away the stone and find it. In the same way, we need to develop a picture in our minds of the internal structures of the temporal bone and the shape that we have to create around these important structures in order to give the best functional result for the patient. Do not forget that there may be variations from the usual anatomy, therefore we have to modify that shape according to the findings in each individual patient, but there are some basic rules that need to be followed:

• The final cavity should be round, not kidney shaped due to a high facial ridge.

• All areas of squamous epithelium which lie in the middle ear or under a graft site must be cleared.

• Careful attention to any pockets in the facial recess, sinus tympani or hypotympanum.

• Removal of the anterior bony buttress at the insertion of the anterior malleolar ligament. There must not be any small recesses or residual cholesteatoma in the anterior attic.

• Attention to the Eustachian tube. Remove any polypoid tissue in the lumen. Do not strip all mucosa. Carefully dissect out any cholesteatoma sac or atelectatic pockets.

• It is not possible to remove all the cells in the mastoid. However it is necessary to clear all cells containing cholesteatoma, cholesterol granuloma or badly diseased mucosa. All remaining cells must be covered by soft tissue. This may mean a very large temporalis fascia graft, muscle and periosteal flaps or meatal skin flaps. Without this the exposed cells will create a mucosal lining in the cavity. This will always be wet and prone to infection.

• In the case of very large cavities, the size can be reduced by extensive saucerisation, removal of the mastoid tip laterally and use of soft tissue flaps and fragments of conchal cartilage or bone pate.
• Always do a tympanoplasty to reconstruct a middle ear. If no graft is placed over the middle ear a permanently wet and recurrently discharging middle ear is guaranteed. Even in those cases where residual cholesteatoma remains in the middle ear, it will not cause serious complications. A pearl will develop which can often be removed in OPD or by a simple tympanotomy. Nothing is lost by the attempt to reconstruct the drum, it is almost always successful and when combined with an ossiculoplasty can often provide useful hearing.

• The meatoplasty must be of a size proportional to the size of the mastoid cavity. This will ensure a dry ear and an ear which can be cleaned easily. This is particularly important when long term follow up for cleaning of the cavity every few months is not practical.

Exposure of Sigmoid Sinus and Jugular Bulb

It is well worth repeating this dissection on this new bone.

Again remove cells overlying the sigmoid / lateral sinus. Make the bone paper thin over the sinus so that it stands up in relief. Follow the sinus up to the level of the middle fossa dura.

Now follow the sinus inferiorly, medial to the facial nerve. The sinus turns abruptly superiorly, to form the jugular bulb. The level of the bulb is very variable in relation to the hypotympanum. Occasionally the superior edge of the bulb lies within the hypotympanum, near the postero-inferior annulus.

Decompression of Facial Nerve

Again follow the course of the facial nerve throughout its course in the temporal bone. Start by identifying it above the OWN. Then drill the posterior annulus area until the sinus tympani is exposed as much as is possible without damaging the nerve. Now follow the nerve inferiorly to the mastoid tip.

Drill the area of the processus cochleariformis to expose the anterior genu of the facial nerve and the tensor tympani muscle. Note the relationship of these two soft tissue structures in the bone.
Dissection of Cochlea, Eustachian Tube and Internal Carotid Artery via Middle Ear and TMJ

Cut the tensor tympani tendon with micro-scissors. Dislocate the anterior fibrous annulus from the bony annulus. Remove the TM with malleus handle, dividing the anterior canal skin.

Remove the bony overhang of the Round Window Niche (RWN), with a 1 mm diamond burr. See the underlying Round Window Membrane. Note that it lies at approximate right angles to the oval window / footplate. Make a Cochleotomy - drill infero-anteriorly from the OWN towards the centre of the promontory to open the basal turn of the cochlea.

Connect oval and round windows, exposing the vestibule.

Drill superiorly to the basal turn to open the apical turn and helicotrema. You have entered the Scala Vestibuli and can see the osseous spiral lamina and basilar membrane. Remove part of these structures to see into the Scala Tympani.

Examine the relationships of:

- oval window
- vestibule
- scala vestibuli
- helicotrema, and direction of modiolus
- scala tympani
- round window membrane

The internal carotid artery can be found anterior to the cochlea and infero-medial to the Eustachian tube.

Continue the dissection anteriorly, through the Temporo-mandibular joint.

If there is time you may wish to proceed to the following optional dissections:-

Membranous and then Bony Labyrinthectomies

Trans labyrinthine and or Trans cochlear exposure of IAC
Intact Canal Wall Mastoidectomy

1. Extended Cortical Mastoidectomy
2. Posterior Tympanotomy

3. Cochlear Implantation

4. Facial Nerve Decompression with intact canal wall
5. Posterior canal occlusion
6. Semi-circular canal skeletonisation
1. Middle cranial fossa approach to the facial nerve and internal auditory canal

Identify the Greater Superficial Petrosal nerve and its Foramen Spinosum and the Petrous ridge with Superior Petrosal sinus.

Identify the Arcuate Eminence, drill onto this in order to blue line the superior semicircular canal and follow forward to the ampulla.

Follow Greater Superficial Petrosal nerve to the Geniculate ganglion.

Then follow the facial nerve back to the IAC.

Widely clear bone in front and behind IAC, avoiding the cochlea and ampulla of superior canal.

Skeletonise IAC over its upper ½.

Flake off bone over IAC to expose dura and identify Bill’s bar laterally.

Open the dura posteriorly and reflect forward to expose contents of IAC:
- Bill’s bar
- Superior vestibular nerve
- Meatal foramen
- Transverse crest
- Inferior vestibular nerve
- Singular nerve
- Cochlear nerve
- Labyrinthine artery

Open the attic to visualise the posterior middle ear and Eustachian tube areas.

Identify Tensor Tympani.

Skeletonise the Internal Carotid artery.

Expose the Cochlea and note the relationship between the basal turn and the Facial nerve.

Turn the bone to expose its lateral surface.

Drill away the Tympanic Ring and Styloid Process.

Expose the Jugular Bulb and Internal Carotid artery without opening the Cochlea.

Note the relationships of these structures to the lower cranial nerves.
2. Trans-labyrinthine and trans-cochlear approaches to Internal Auditory Canal, and Facial nerve mobilisation

Make a trans-mastoid bony labyrinthectomy, remove the neuro-epithelium from each ampulla, then open the vestibule and remove otolith organs (Saccule and Utricle), noting their orientation

Keep the facial nerve and external auditory canal wall intact

Make the bone eggshell thin over the posterior fossa dura and IAC

Expose the Facial nerve in its horizontal and vertical parts, divide the Greater Superficial Petrosal nerve at the Geniculate Ganglion and mobilise the Facial nerve posteriorly (via extended cortical mastoid cavity from behind and above if possible, otherwise after removing canal wall and ossicles)

Open the cochlea through the promontory noting its internal anatomy and develop dissection until IAC and its contents can be seen

Make the bone over Internal Carotid artery eggshell thin, noting relation to Eustachian tube
References


Sponsors

The principal support for this course comes through the Midland Institute of Otorhinolaryngology, UK.

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