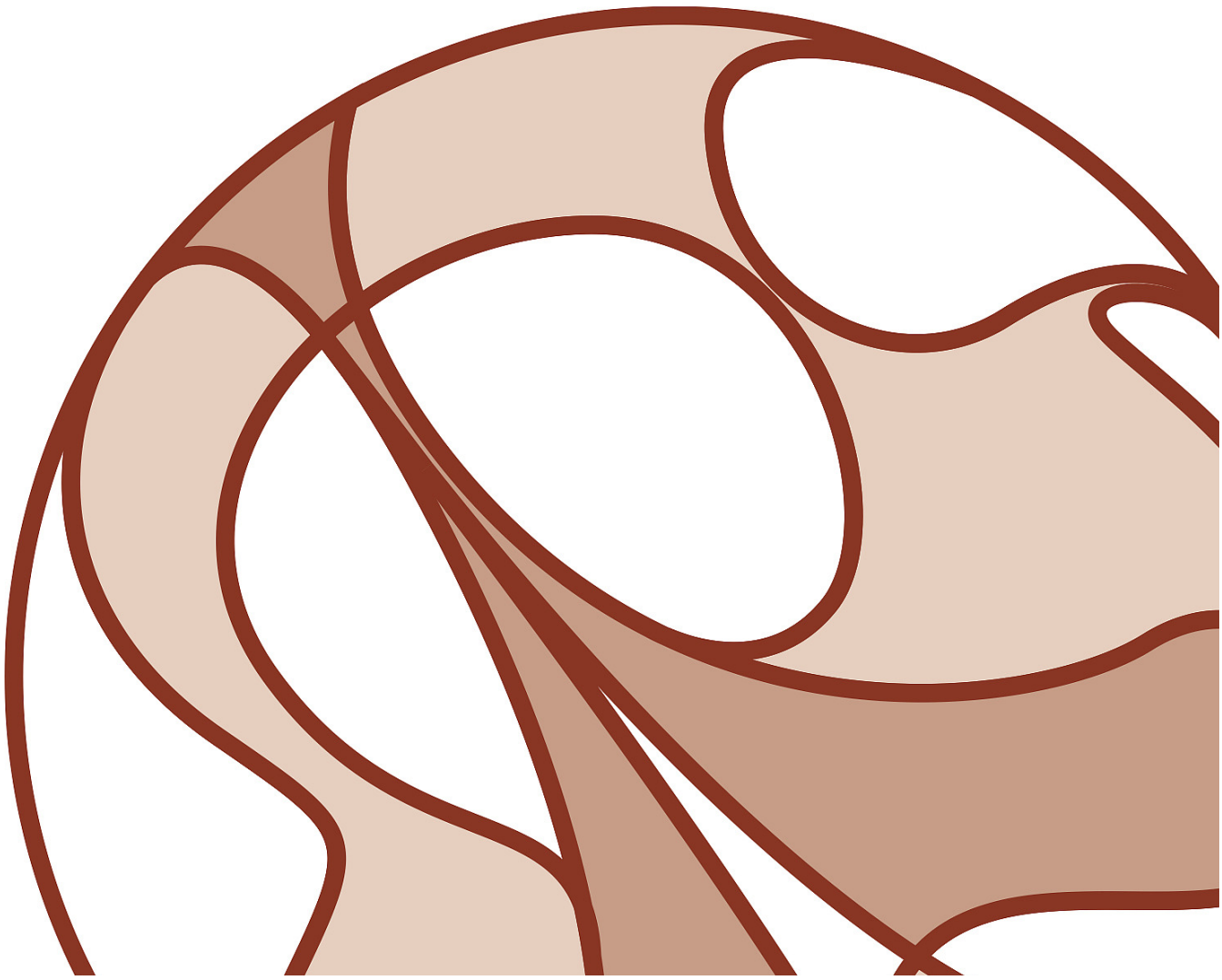
DISSECTION GUIDE

Sydney Endoscopic Ear Surgery
Research Group

First Edition



Who are SEES?

The Sydney Endoscopic Ear Surgery Research Group is dedicated to research, teaching and advancing the technique of Endoscopic Ear Surgery to Otolaryngologists and trainees through online learning and Fellowship opportunities.

The group is a not for profit organisation and our website has no industry affiliation. We seek to provide online learning through literature aggregation, online videos and a blog site restricted to emerging field of Endoscopic Ear Surgery. All of the group are active elected members in the International Working Group of Endoscopic Ear Surgery (IWGEES).

Dr Nirmal Patel

Dr Jonathan Kong

Dr Alex Saxby

Dr Nicholas Jufas

We would like to thank:
Karl Storz, for providing a loan of the endoscopic equipment used in this manual
Prof Daniele Marchioni for use of the anatomical diagrams used in this manual

Video otology tutorials: how EES changes the game

BY NICHOLAS JUFAS, ALEXANDER SAXBY, JONATHAN KONG, NIRMAL PATEL

High definition endoscopic ear surgery (EES) redefines traditional middle ear anatomical perspectives. The surgeon can observe in situ anatomical relationships with angled objectives in a way that the traditional microscopic view, with step-wise removal of structures is unable to achieve. The identical surgical view for both operator and observer lends itself to confident teaching.

SYDNEY
ENDOSCOPIC
EAR SURGERY
RESEARCH GROUP

The strength of endoscopic ear surgery (EES) is that it allows high definition visualisation of middle ear anatomy in an in situ and intact way. When compared with the operating microscope, what is truly unique is that the objective lens is placed within the ear canal or middle ear, which allows for an all-encompassing view during surgery. There is a very broad width and depth of field as well as a high optical zoom – allowing even individual clusters of blood cells to be seen coursing through capillaries on the promontory.

The endoscopic perspective redefines and reimagines the surgical anatomy allowing a better understanding of the disease / anatomy relationship. In contrast, the traditional microscopic method relies on removal of significant amounts of normal bone and soft tissue, often with removal of intact structures to fully observe the disease extent. While some cases will continue to suit a microscopic, or combined microscopic-endoscopic approach, this extra dissection can be avoided in many cases.

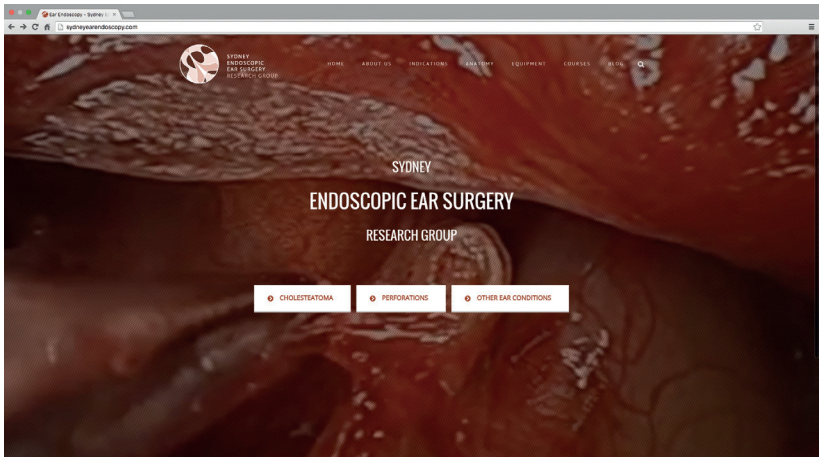
Additionally, the live image used by the surgeon is the same one that everyone else –surgical trainees, medical students, anaesthetic staff and nursing staff – is observing. This simultaneous viewing dramatically increases engagement and interest in the surgical procedure from all present in the operating room.

In the apprenticeship model of surgical training the identical surgical view allows the trainee to visualise the exact steps their mentor is performing. Conversely, when the trainee gains experiential learning through performing a procedure themselves, the mentor is able to supervise and follow their progress closely. The confidence in the view of the surgical anatomy that the mentor can achieve obviates the all too familiar phrase that otology trainees dread: "Let me take over for a second, I can't really see what you're doing".

Furthermore, the ability to record this video allows for retrospective review and reinforcement for those present at the surgery. By extension, this same all-encompassing video can be edited,

Figure 1. SEES Research Group website (sydneyearendoscopy.com), through which the Video Dissection Manual can be accessed.

"The endoscopic perspective redefines and reimagines the surgical anatomy allowing a better understanding of the disease / anatomy relationship."



overlayed with descriptors, pointers and information and used for future teaching and education. In the field of video otology tutorials, the identical operative and teaching view with the ability to overlay learning points certainly changes the game. Traditional teaching methods such as temporal bone dissection, concentrate on drilling techniques of the mastoid cavity with relative ignorance of the complex anatomical structures of the middle ear. The endoscopic approach shifts the trainee's focus immediately to the tympanic membrane, ligaments and membranous folds of the attic and hidden spaces of the mesotympanum, instilling the importance of such structures in disease pathogenesis.

The Sydney Endoscopic Ear Surgery (SEES) Research Group (sydneyearendoscopy.com) is an Australian not for profit organisation dedicated to research, teaching and advancing the technique of endoscopic ear surgery to otolaryngologists and trainees. The founding members are Drs Nirmal Patel, Jonathan Kong, Alexander Saxby and Nicholas Jufas. All the founders are members of the International Working Group on Endoscopic Ear Surgery (IWGEES). The SEES Group also offers an International Clinical Fellowship in Endoscopic Ear Surgery and Otology, applications for which can be made through the website.

The SEES Group has recently launched a series of videos, 'A Video Dissection Manual for Endoscopic Ear Surgery'. There are eight videos in total, all recorded in full high-definition 1080p. The videos were recorded using 3mm straight and angled endoscopes with 3-chip camera heads and SPIES system, generously loaned by the Karl Storz company. Both CLARA and CHROMA image enhancement algorithms were applied, rendering crisp and clear images throughout. The videos are further enriched by superb colour illustrations of endoscopic middle ear anatomy, created and kindly provided by Professor Daniele Marchioni (University of Verona, Italy) and available in his new book, 'Endoscopic Ear Surgery: Principles, Indications and Techniques'.

The videos detail, in a step-wise manner, a complete endoscopic approach to cadaveric dissection of the middle and inner ear. This forms the backbone of the Sydney Endoscopic Ear Surgery Dissection Course, which is run annually. Each video succinctly describes the salient anatomy of each region before moving deeper into the dissection. The videos are structured as follows:

Video 1: Tympanomeatal Flap and Prussak's Space
Video 2: Protympanum and Ventilation Pathways
Video 3: Atticotomy and Lateral Epitympanum
Video 4: Retrotympanum and Hypotympanum
Video 5: Extended Atticotomy and Epitympanum
Video 6: Tympanic Plexus and Facial Nerve
Video 7: Major Vessels and Infracochlear Approach
Video 8: The Inner Ear and Internal Auditory Canal

The videos are overlayed with helpful pointers to highlight relevant regions or anatomy, as well as having important didactic points as subtitles. Traditionally the teaching of such complex anatomy has relied on a combination of schematic diagrams, anatomical illustrations and confusing cross-sectional histological slides. Visualising such areas in a video format provides an integrated and vastly improved perspective of these anatomical relationships. Areas such as the sinus tympani, so important in cholesteatoma recidivism, become easily defined. This improved understanding and access may prove to assist significantly in minimising recurrence rates.

The SEES Group is proud to provide these videos online at no cost, allowing unrestricted access to an important resource

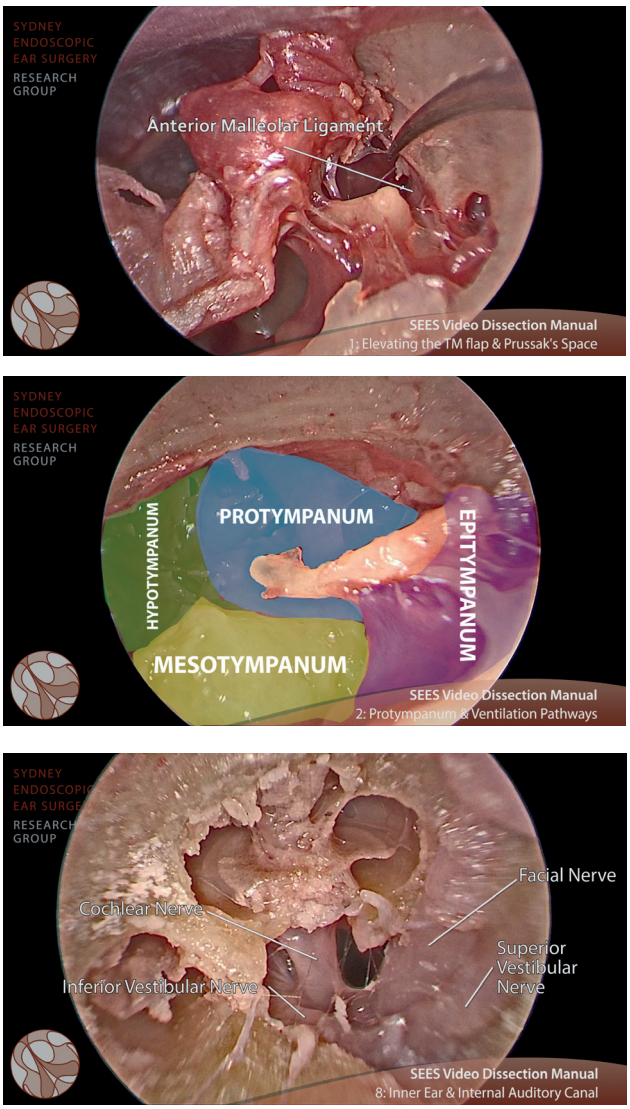


Figure 2a-c. Screenshots from the SEES Video Dissection Manual for Endoscopic Ear Surgery.

on the surgical anatomy of the middle ear from the endoscopic perspective. They can be accessed via links on the SEES Website (sydneyearendoscopy.com).

The anatomical understanding gleaned from using these videos is applicable to all otology. The videos are a clear demonstration of the visualisation capabilities of endoscopic ear surgery which has truly opened up a world of possibilities for otologists and their patients.

"In the field of video otology tutorials, the identical operative and teaching view with the ability to overlay learning points, certainly changes the game."

SUMMARY

- Middle and inner ear anatomy is complex and traditional methods of teaching fail to convey these anatomical relationships in an easily digestible fashion.
- Free access to an invaluable video resource in learning middle ear anatomy utilising an endoscopic approach is now available (sydneyearendoscopy.com), providing an efficient, enjoyable method of familiarisation with this complex anatomy.
- The endoscopic approach to the middle ear has revolutionised the ability to visualise and target disease in difficult to reach areas.
- Better anatomical understanding of this region, combined with improved visualisation and access offers our best chance-improving treatment for patients.

Nicholas Jufas,

BSc(Med), MB BS (Hons), MS, FRACS,
Consultant ENT Surgeon, Clinical Lecturer, University of Sydney, Australia.

E: drnicholasjufas@gmail.com
@drnickENT

Alexander J Saxby,

MB BChir, MA (Cantab), FRACS,
Consultant ENT Surgeon, Royal Prince Alfred Hospital, Sydney;
Senior Lecturer, University of Sydney, Australia.

E: saxbyaj@gmail.com
@SaxbyAlex

Jonathan HK Kong,

FRCS, FRACS, MBBS(USyd), AMusA,
Consultant ENT Surgeon, Sydney University and Macquarie University, Australia.

E: jkong111@gmail.com

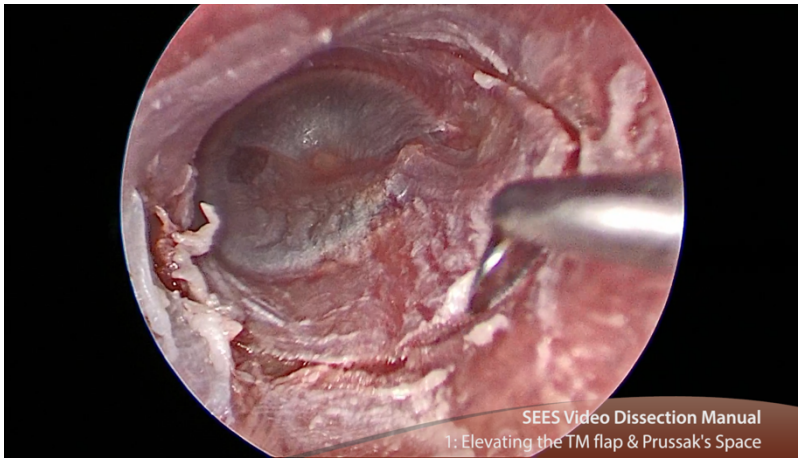
Nirmal Patel,

MBBS (Hons)(USyd), FRACS, MS (UNSW),
Consultant ENT Surgeon, Associate Professor of Surgery, Macquarie University, Australia.

E: nirmal.p.patel@gmail.com
@drnirmalent

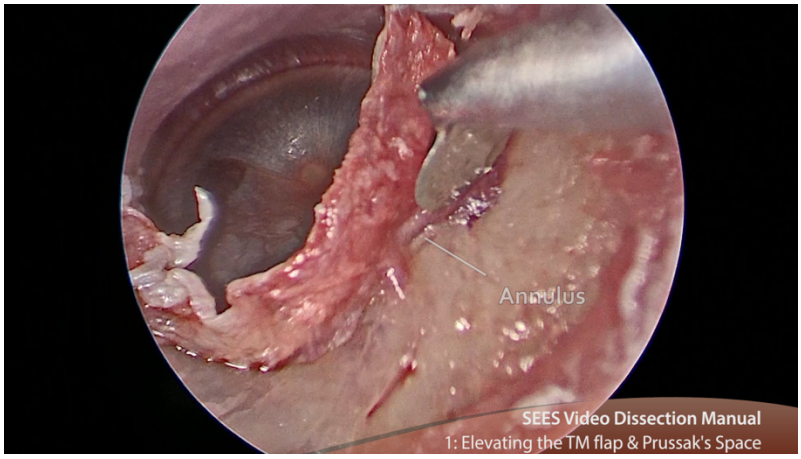
Declaration of Competing Interests: None declared

1.01



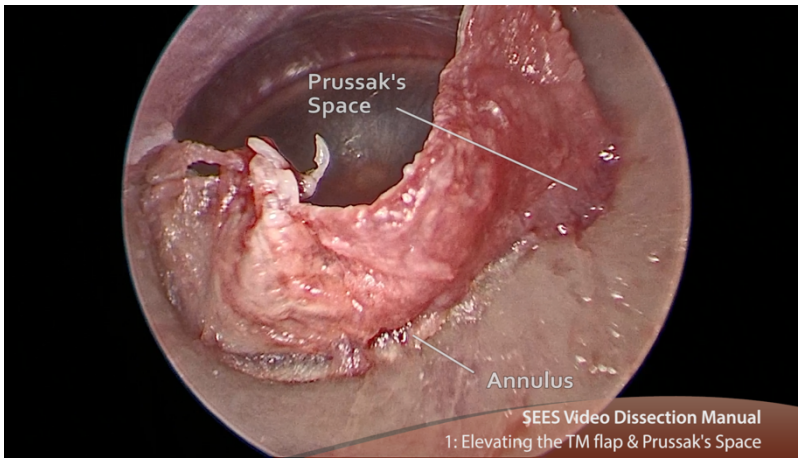
Incise the flap tangential to the annulus at 6 and 10 o'clock, carried to approximately 5mm from the annulus. Elevate flap with a round knife dissecting hard on bone.

1.02



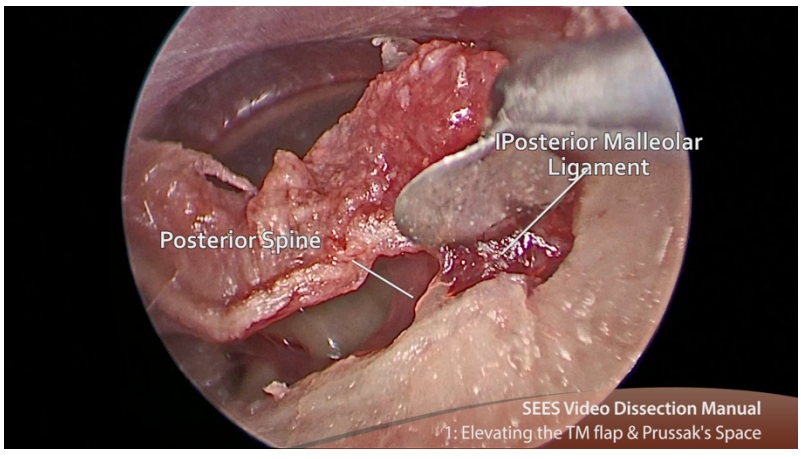
Continue to elevate the tympanomeatal flap near the posterior notch of Rivinus.

1.03



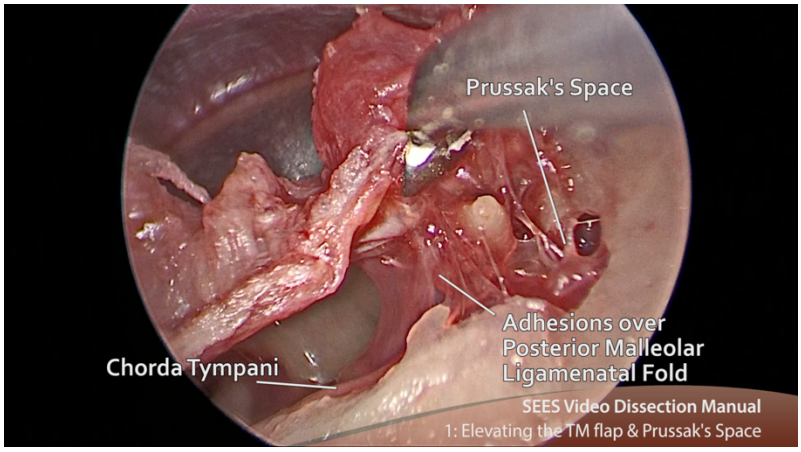
Ensure the entire ennulus is elevated and on view, as well as Prussak's space

1.04



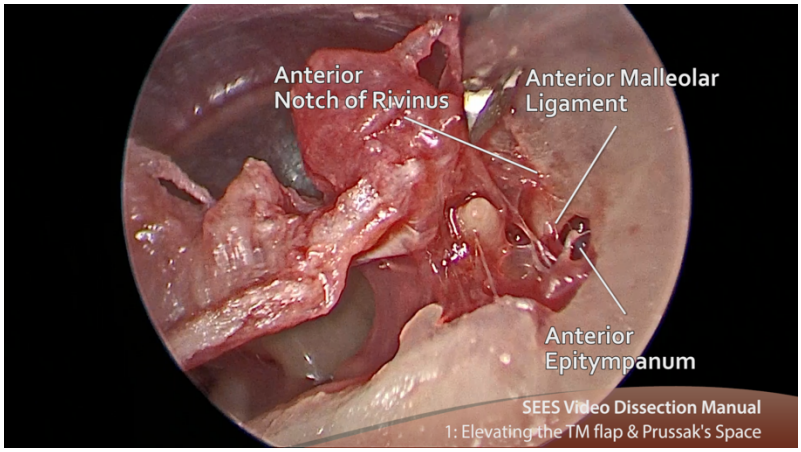
Attempt to identify the posterior malleolar ligament, which runs lateral to the chorda tympani

1.05



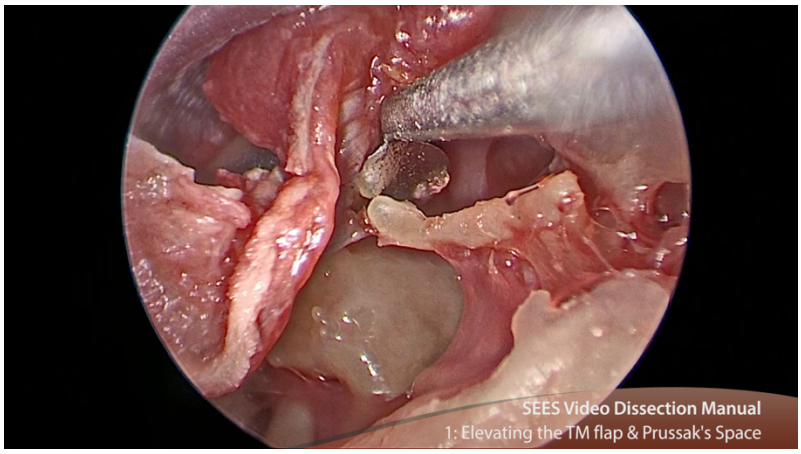
Elevate the tympanomeatal flap anteroinferiorly to open up Prussaks's space

1.06



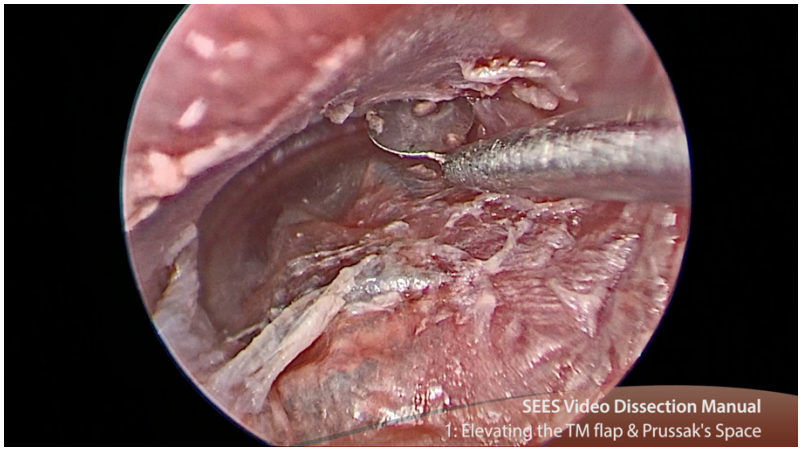
Pull the flap further anteroinferiorly to reveal the anterior malleolar ligament and a communication between Prussak's space and the anterior epitympanum

1.07



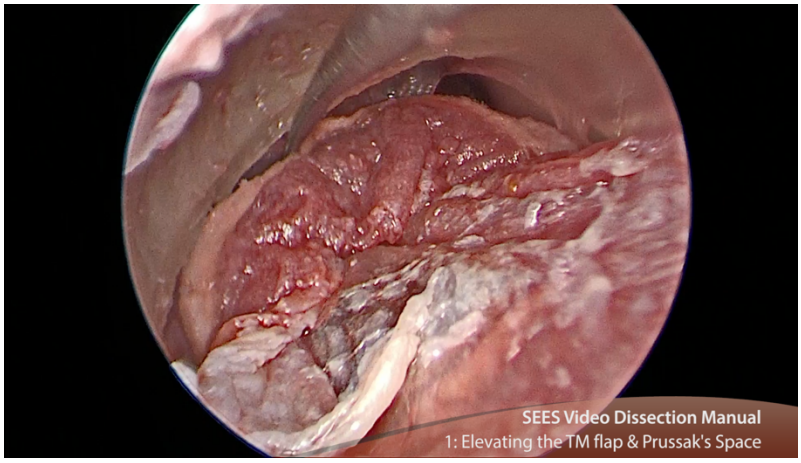
Lift the cartilaginous cap of the lateral process of the malleus and continue down the long axis of the handle, peeling the periosteum off the bone of the malleus to the umbo

1.08



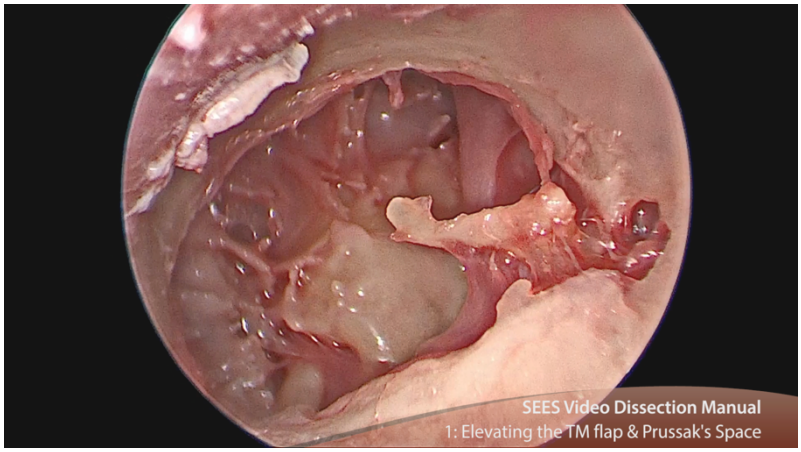
Once the skin is completely off the malleus, the flap is replaced and the anterior canal incision is made to begin to complete skin cuff removal

1.09



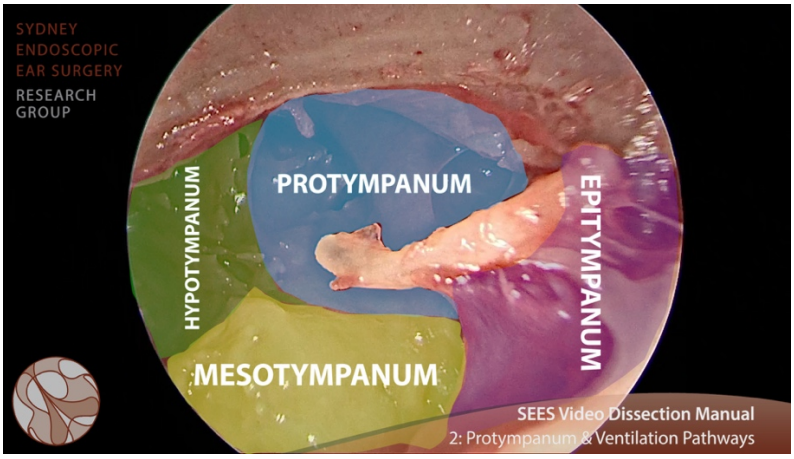
The mucosa of the middle ear has to be divided to completely remove the skin cuff

1.10



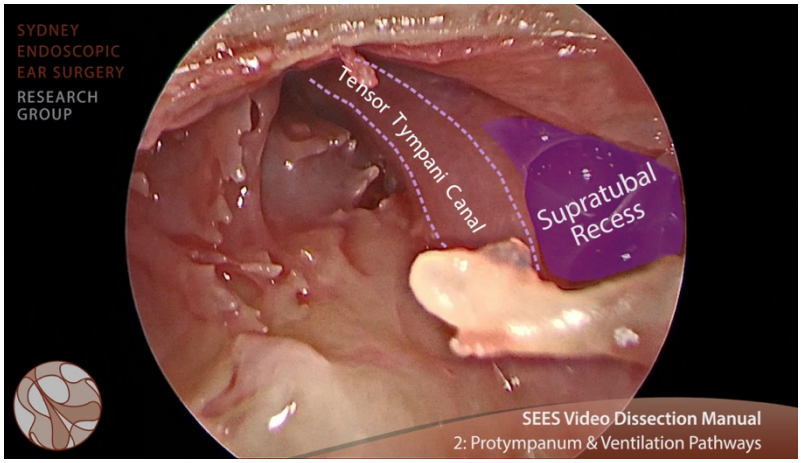
This is the final view of the middle ear after removal of the skin cuff

2.01



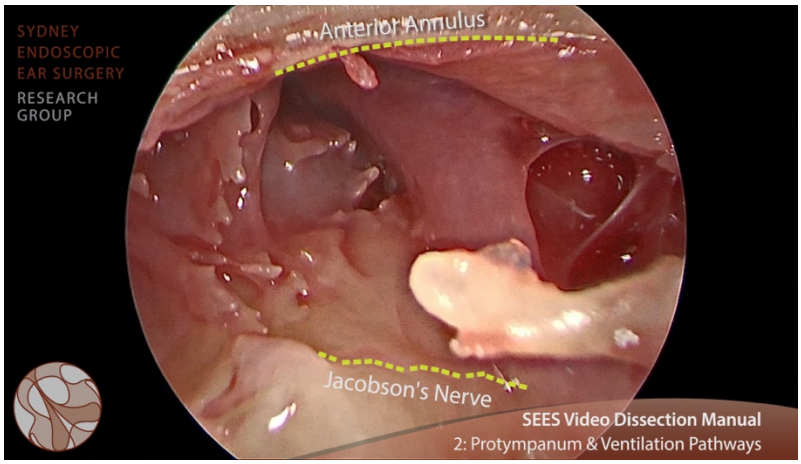
Identify the protympanum and its relation to the epitympanum, mesotympanum and hypotympanum, which it is confluent with

2.02



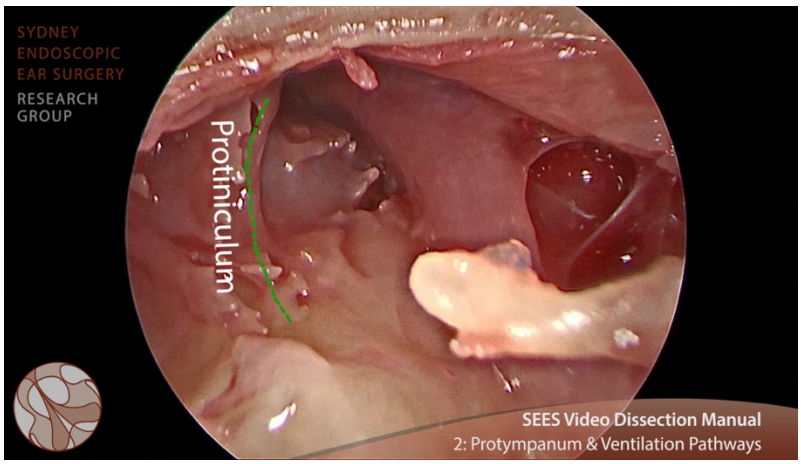
Observe the superior boundaries of the protympanum, the tensor tympani canal, merging posterior with the supratubal recess

2.03



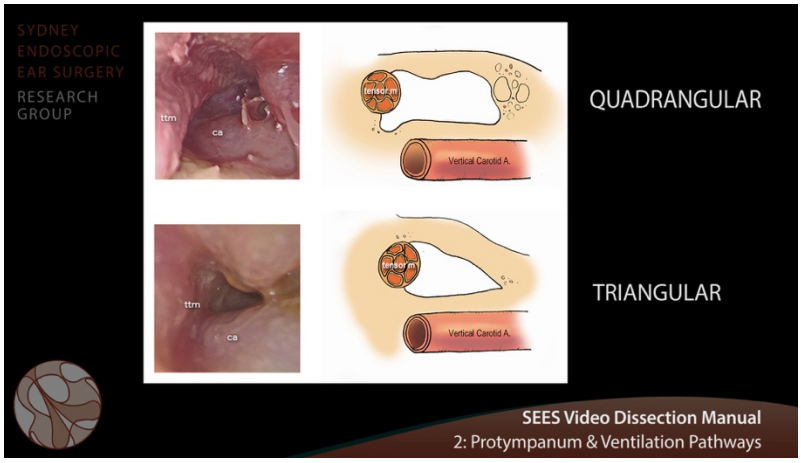
Observe the posterior boundaries of the protympanum, marked by the Jacobson's nerve medially and the anterior annulus laterally

2.04



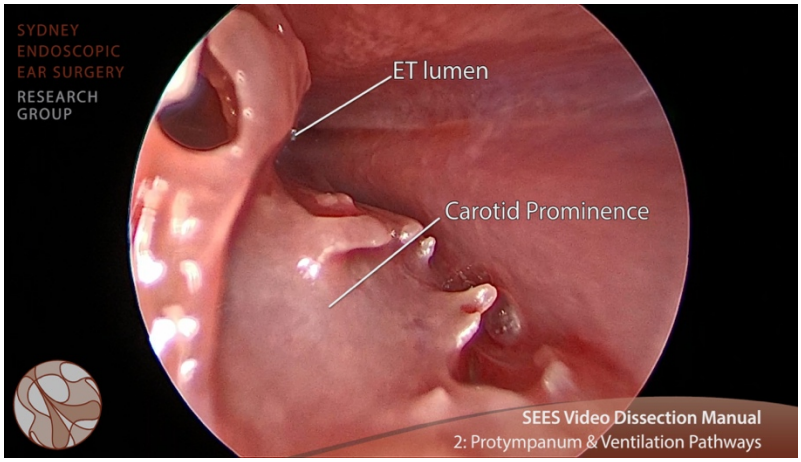
Observe the inferior boundary of the protympanum, marked by the protiniculum

2.05



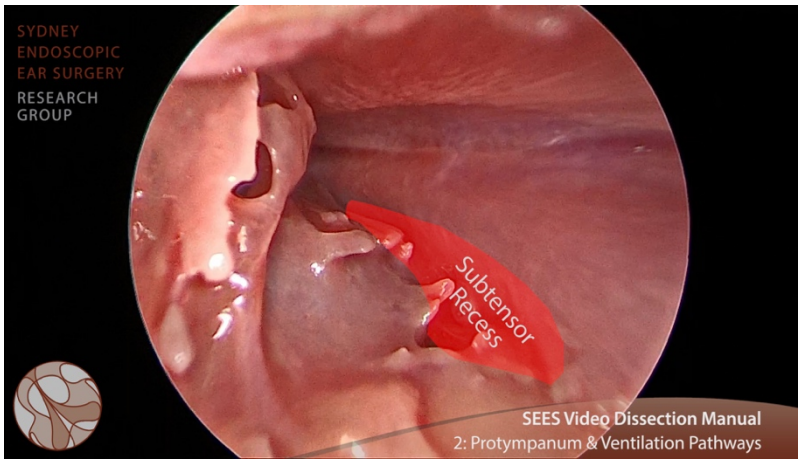
Identify whether your specimen has a conformation that is Type A (Quadrangular) or Type B (Triangular), in a place perpendicular to the long axis of the ET through the vertical carotid artery.

2.06



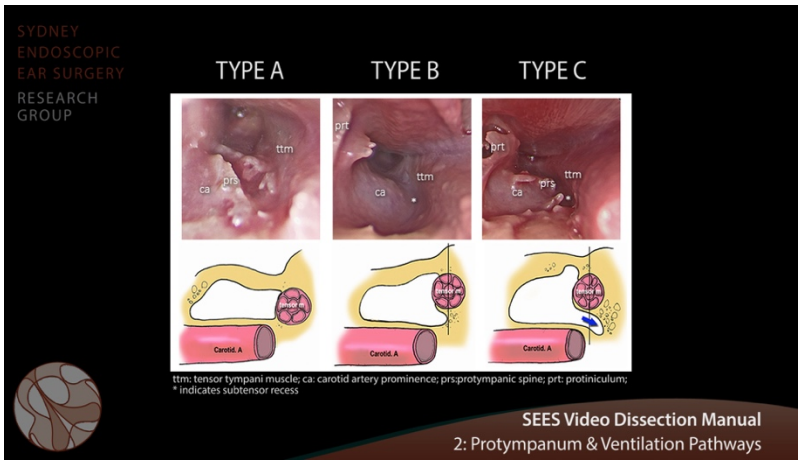
Identify the ET lumen anteriorly and observe the carotid prominence, which often has air cells or a bony spine over it

2.07



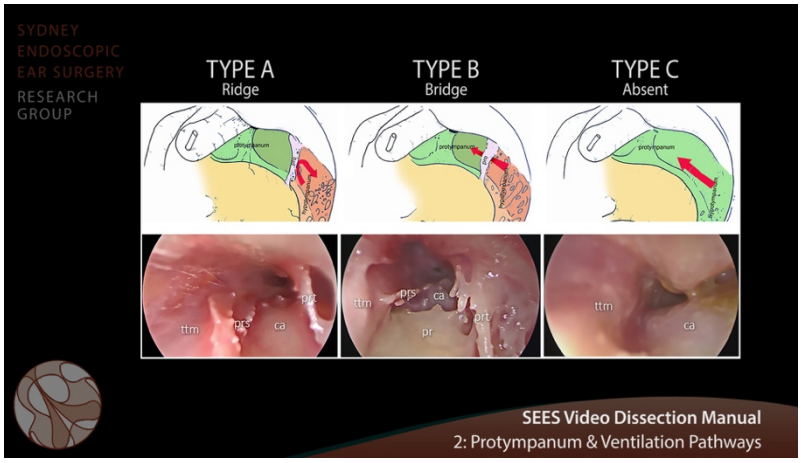
Observe the subtensor recess, an area of pneumatisation inferomedial to the tensor canal.

2.08



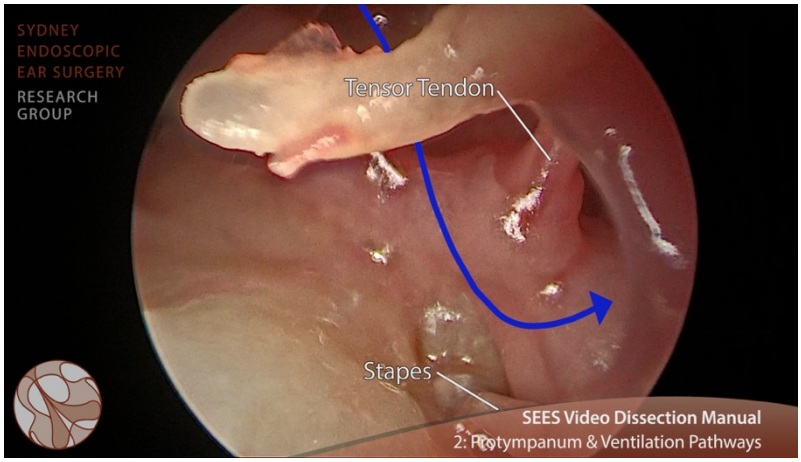
Identify whether your specimen has a Type A (flat), Type B (shallow) or Type C (deep) subtensor recess

2.09



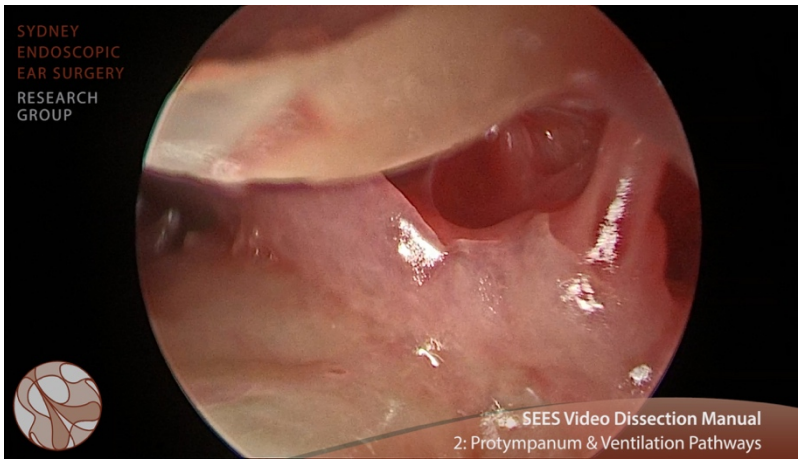
Identify whether your specimen has a Type A (ridge), Type B (bridge) or Type C (absent) protiniculum

2.10



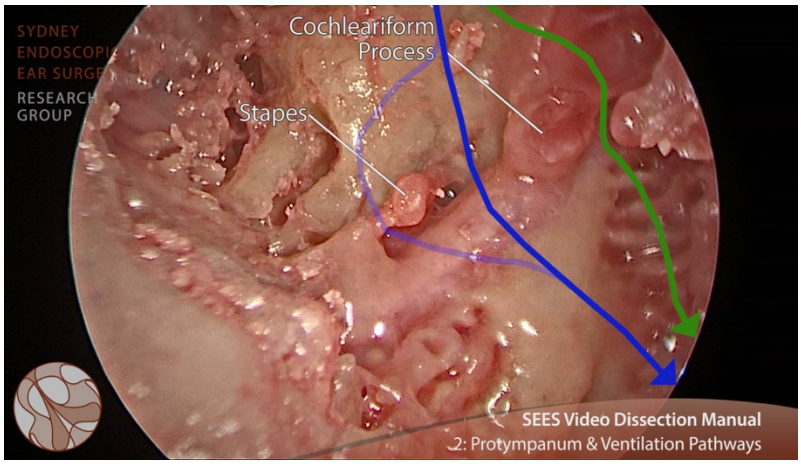
Inspect the main ventilation pathway of the ear, taking note of the pertinent structures that surround it

2.11



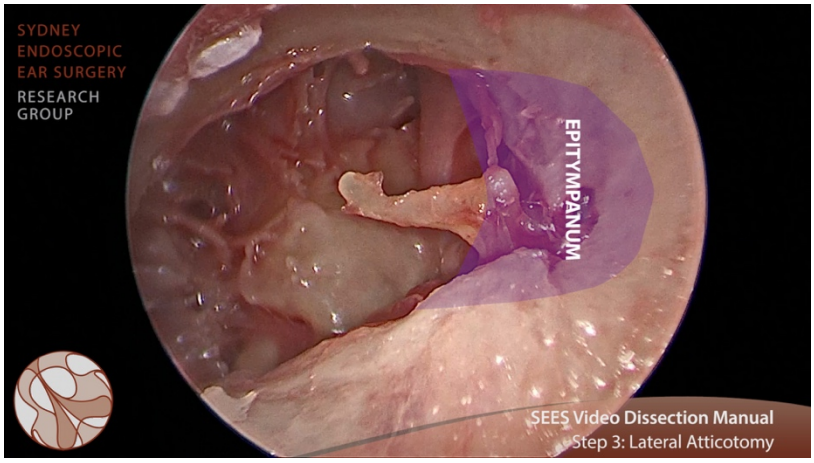
Observe the tensor fold, and whether it is intact or acts as an alternate ventilation pathway in your specimen – this can be more clearly seen by nipping the malleus at the neck

2.12



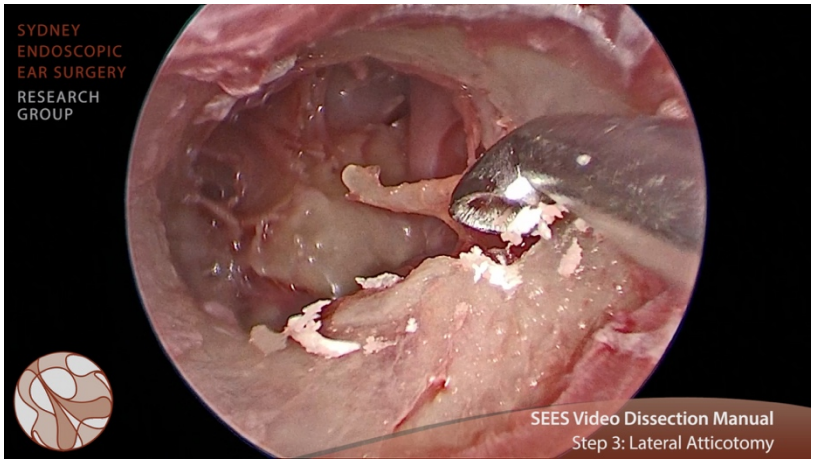
Identify main pathway (blue) through the anterior isthmus, accessory pathway (faded blue) through the posterior isthmus and the alternate ventilation pathway (green), tensor fold

3.01



The epitympanum lies superior to the mesotympanum behind the bony scutum. Prusak's space lies medial to pars flacida at the infero-lateral aspect of the epitympanum.

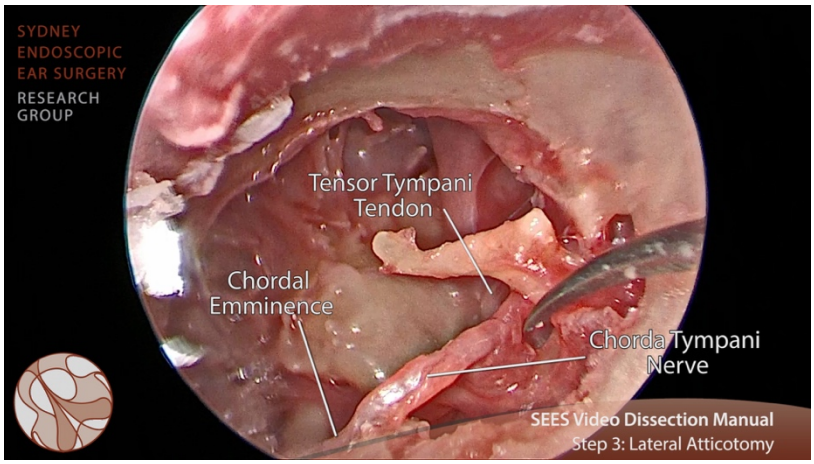
3.02



Begin by curetting the bony scutum.

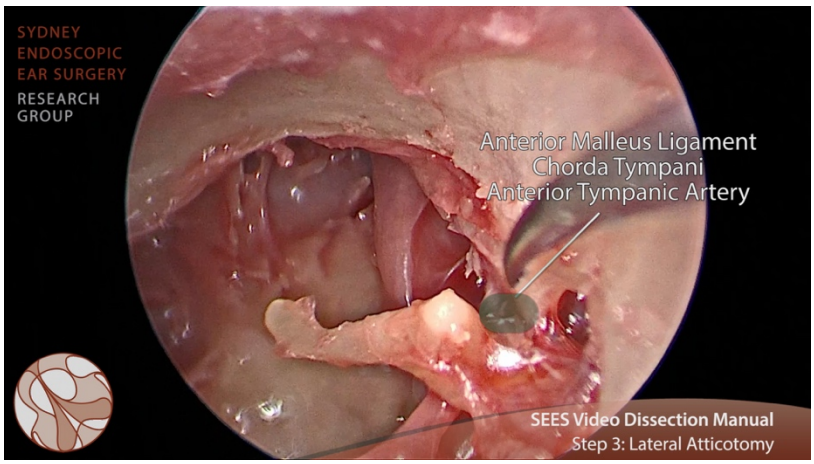
Be careful not to disturb the delicate ligaments and mucosal folds.

3.03



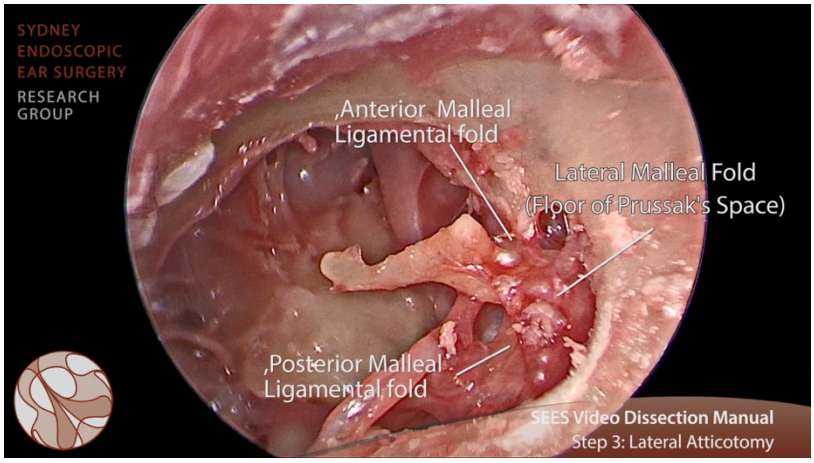
Identify and trace the course of the chorda tympani nerve from the chordal eminence, running anteriorly, medial to the malleus neck.

3.04



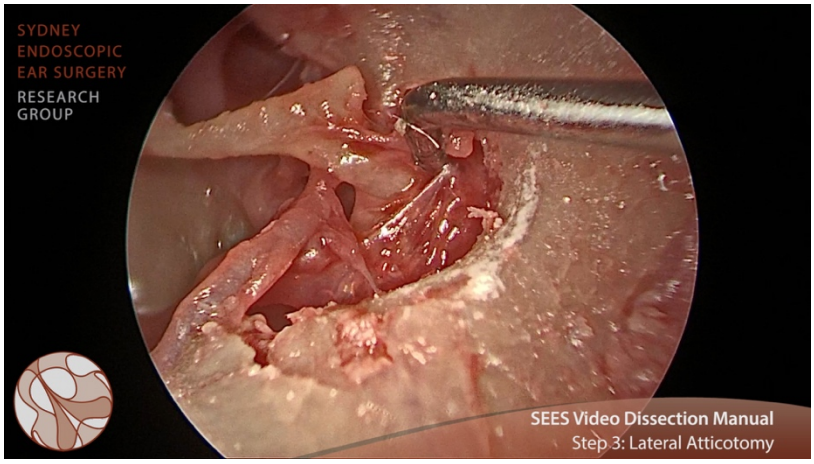
The nerve exits anteriorly at the anterior tympanic notch, through the petro-tympanic fissure which also carries the anterior tympanic artery and anterior malleus ligament.

3.05



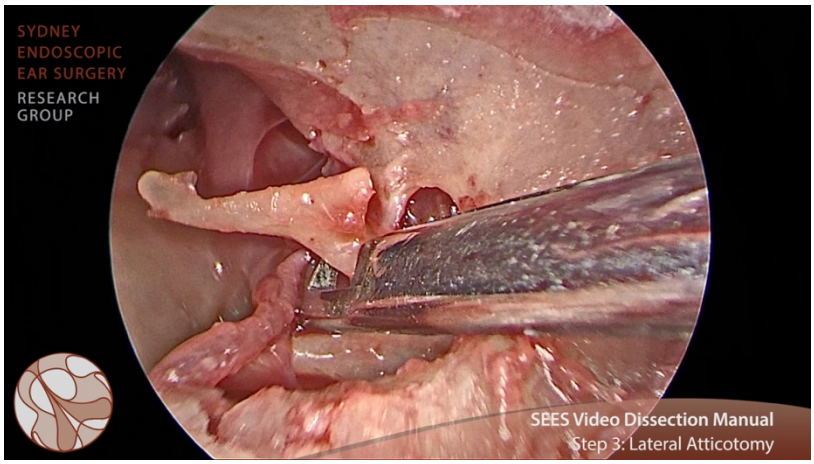
Continue to curette until Prussak's space is revealed. Lateral: Pars Flacida; Medial: Malleus neck; Superior: Lateral Malleal Fold Inferior: Ant & Post Pouch of von Tröltsch.

3.06



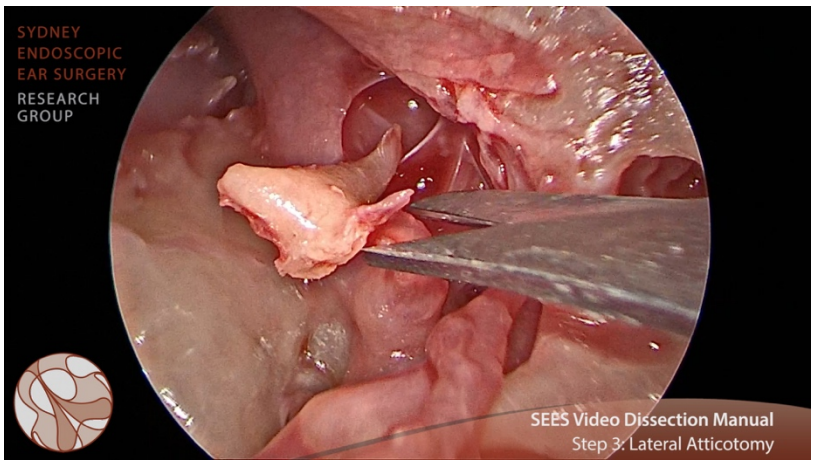
Use a Thomassin dissector to remove the lateral malleal fold, thus breaking through from Prussak's space into the true epitympanum.

3.07



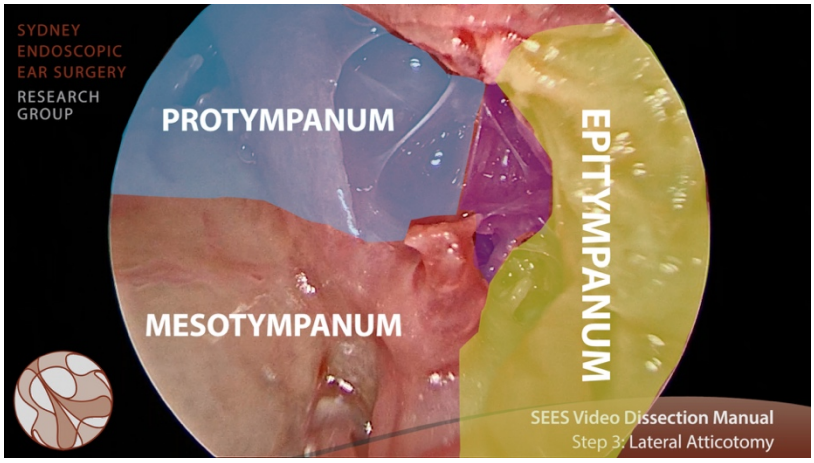
Use malleus nippers at the neck and remove the malleus handle, in order to better appreciate the ventilation routes and better understand the important tensor fold

3.08



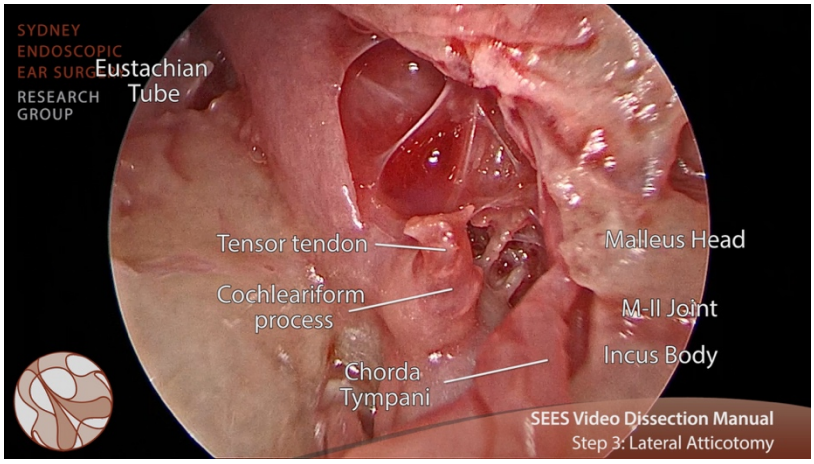
The tensor fold extends anteriorly from tensor tendon, separating (if intact) smooth protympanum from the rough anterior epitympanum. Cut the tensor tendon to enable malleus removal

3.09



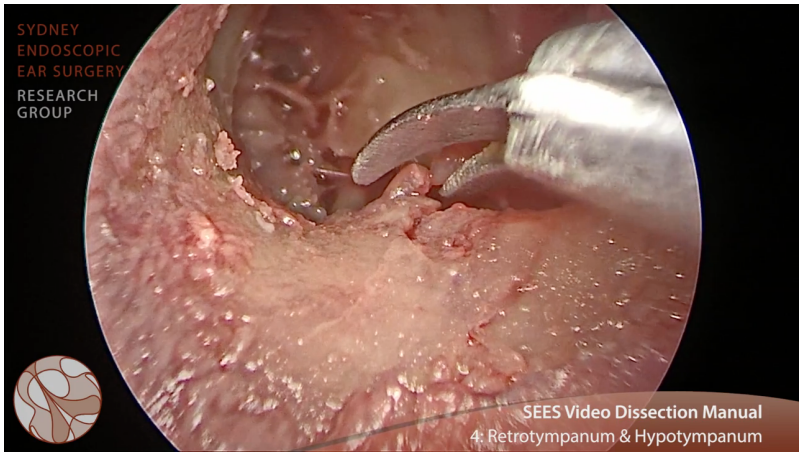
Surgical opening of the tensor fold is straightforward endoscopically and opens up an important alternative ventilation pathway.

3.10



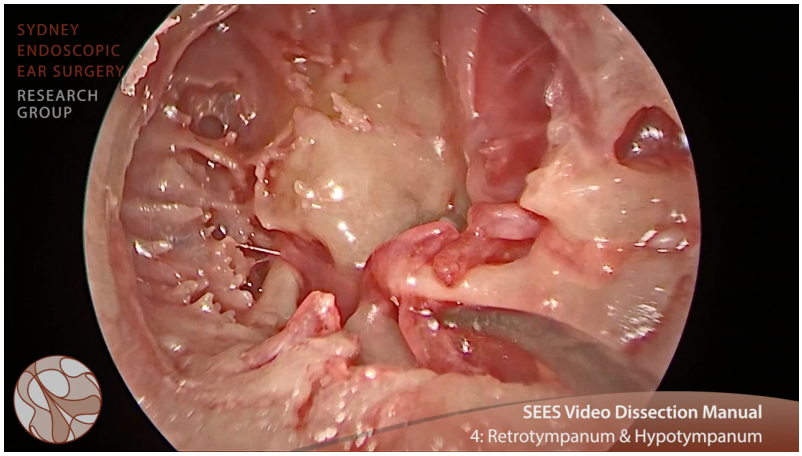
Take a final look at the anatomy on view before proceeding to Step 4.

4.01



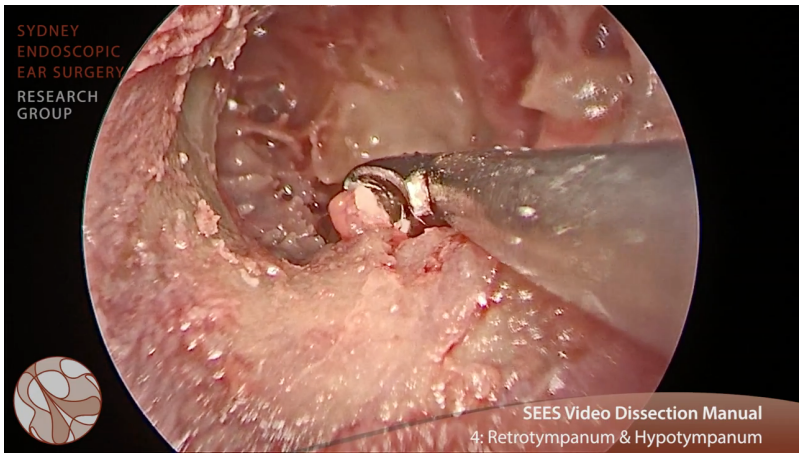
Divide the chorda tympani at the chordal eminence and fold forward

4.02



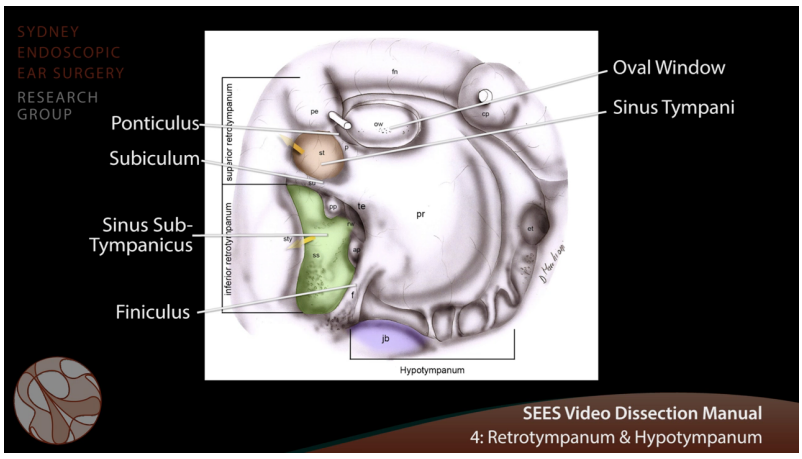
Clear adhesions in the retroympanum. Here we are clearing the facial recess.

4.03



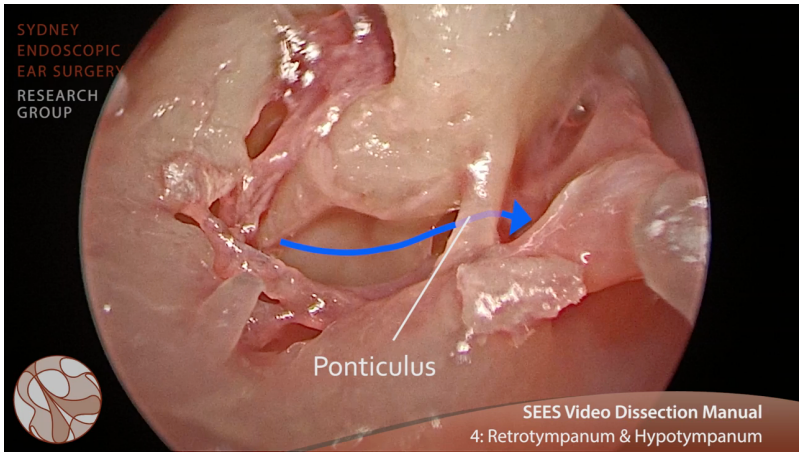
Curette the chordal eminence to allow a better view into the retrotympanum

4.04



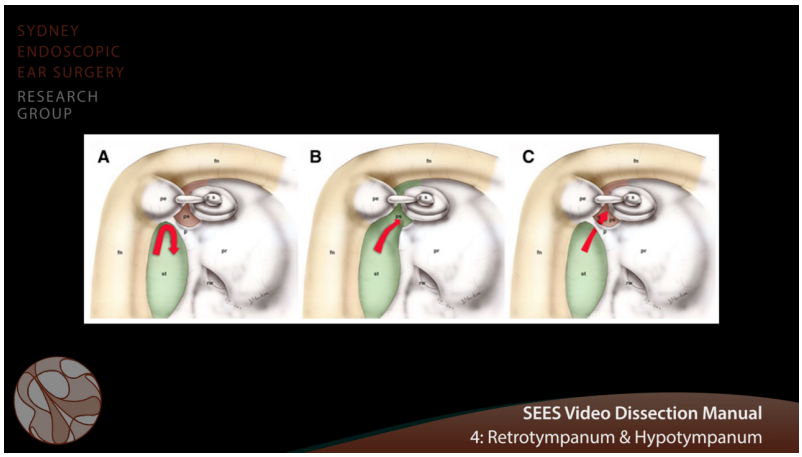
Revise the overall layout of the retrotympanum. In particular:
The recesses – oval window niche (posterior sinus), sinus tympani, sinus subtympanicus.
The dividers – ponticulus, subiculum, and finiculus.

4.05



Ponticulus. The ponticulus joins the promontory to the pyramidal process and divides the sinus tympani from the posterior (tympanic) sinus or oval window niche.

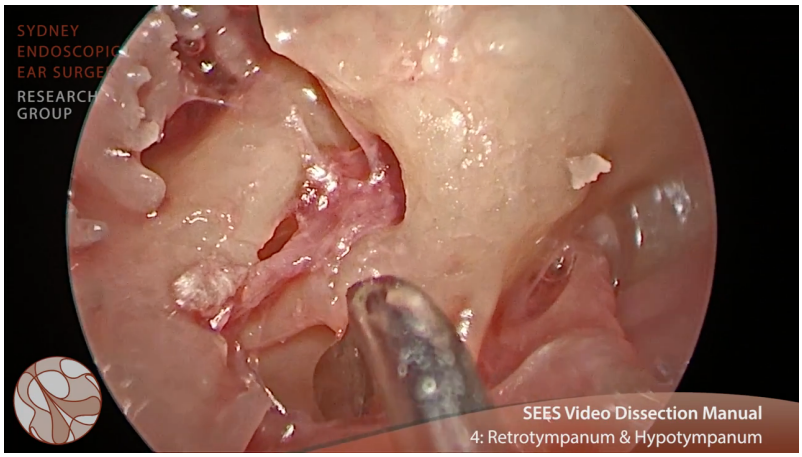
4.06



Variations of ponticulus.

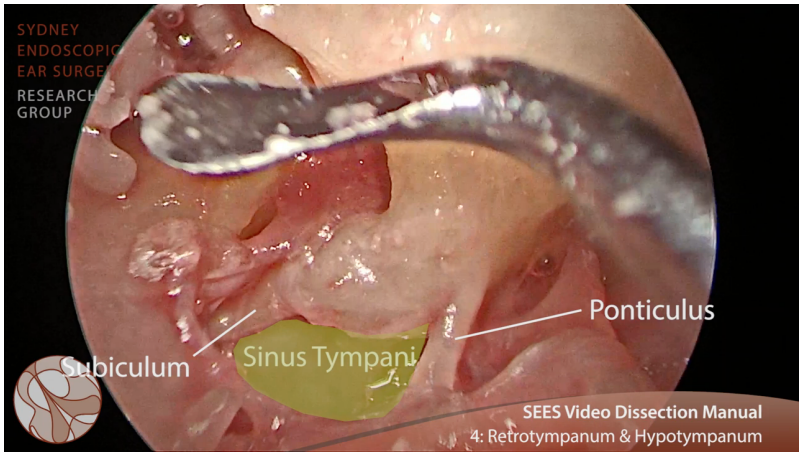
Type A – barrier between sinus tympani (ST) and posterior sinus (PS).
Type B – allows direct communication between ST and PS
Type C – a true bridge.

4.07



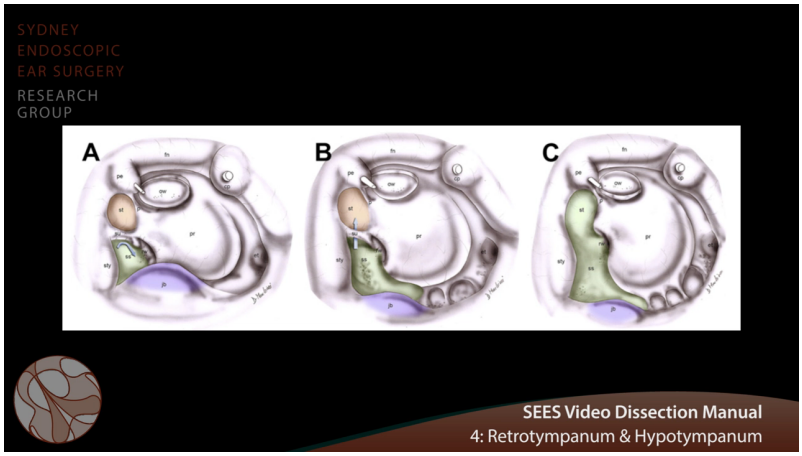
Sinus tympani. Take a dissector and gauge the depth of the sinus. Appreciate the boundaries: the ponticulus above, subiculum below. It lies medial to the facial nerve.

4.08



Subiculum – separates the sinus tympani (ST) from the sinus subtympanicus (SST).

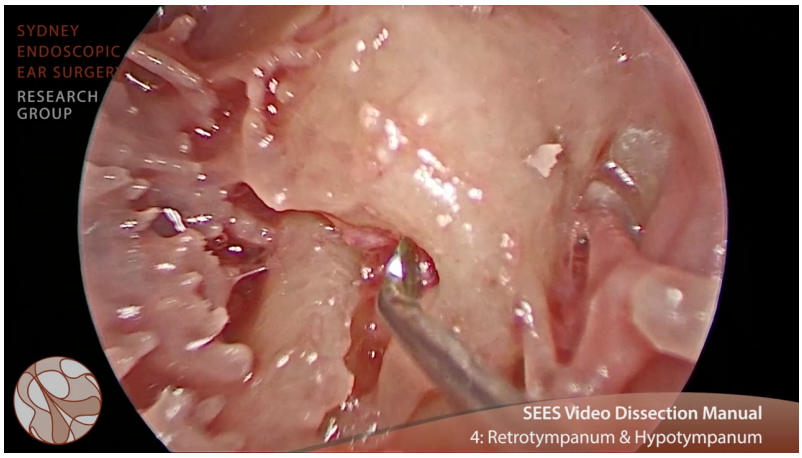
4.09



Subiculum variations.

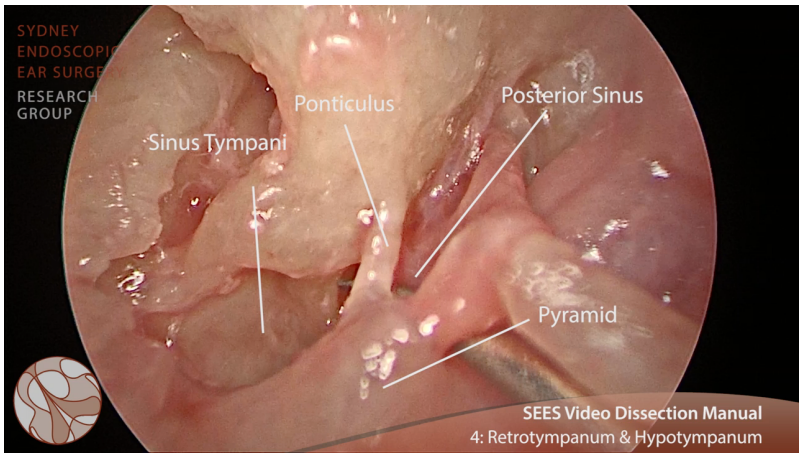
Types:
A: barrier between ST and SST.
B: bridge with tunnel connecting ST and SST
C: low ridge between ST and SST

4.10



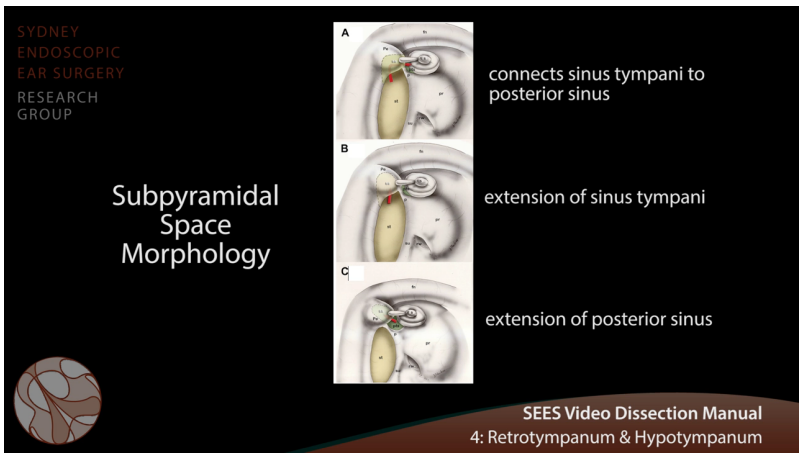
Round window – identify the round window, and clear any false membrane/adhesions.

4.11



Pyramid & subpyramidal space. Identify the pyramid. Pass an instrument under the pyramid into the subpyraidal space. See if it is confluent with the sinus tympani (ST)band/or posterior sinus (PS)(oval window).

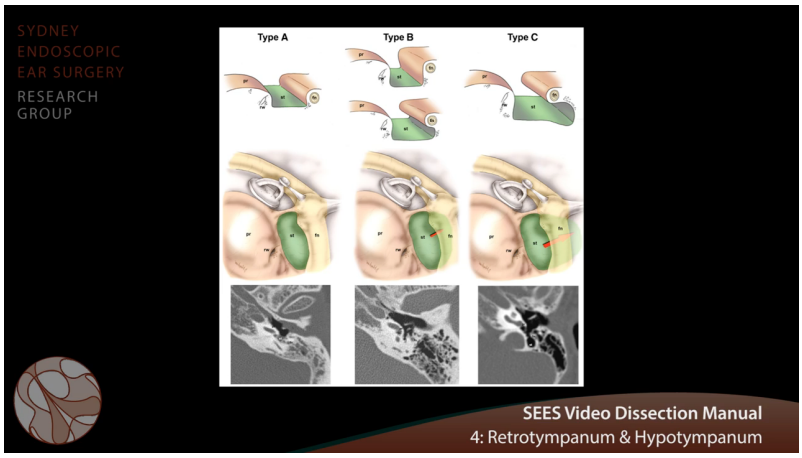
4.12



Subpyramidal space types

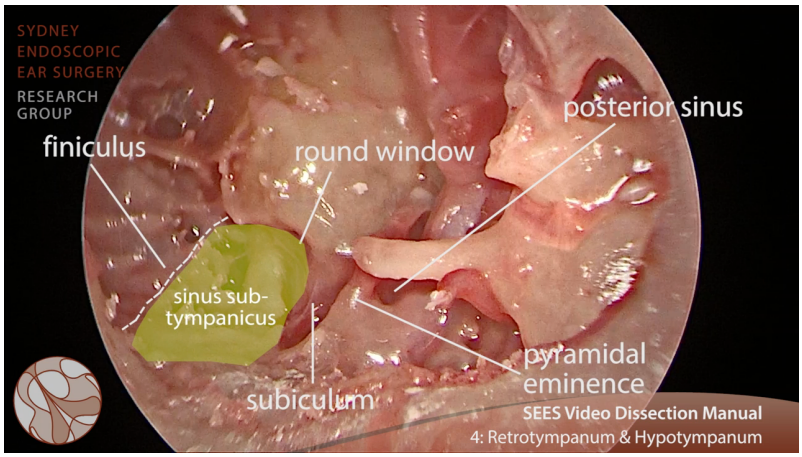
Types:
A - connects ST & PS
B - connects ST only
C - connects PS only

4.13



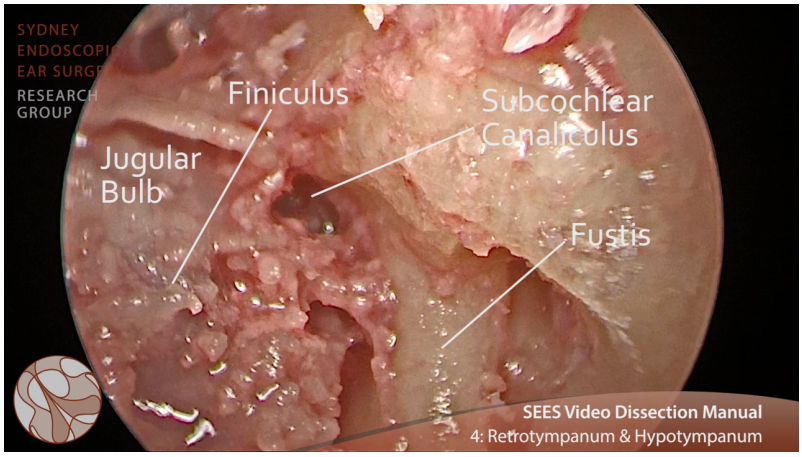
Sinus Tympani – Depth & Morphology
Examine the ST in more detail.
Type A – shallow
Type B – deep or starts to develop medial to ('under') facial nerve
Type C – extends significantly posteromedial to facial nerve.

4.14



Sinus subtympanicus (SST) – curette tegmen of the round window to visualise the membrane.
Confirm the boundaries – subiculum, finiculus, round window.

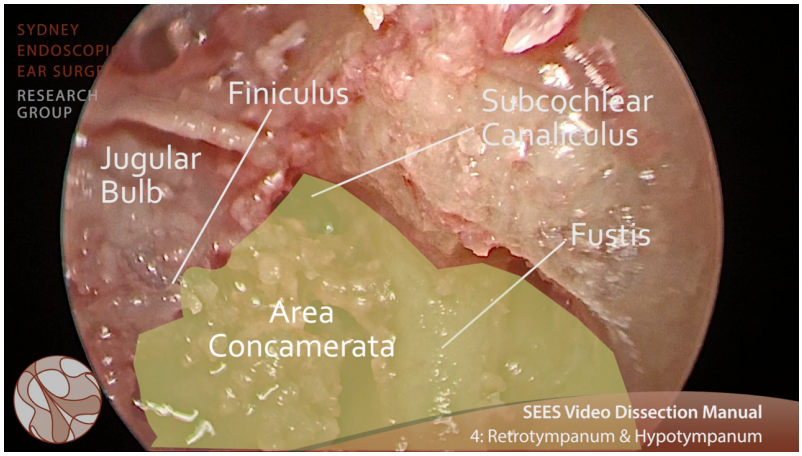
4.15



Look for the infracochlear tunnel/subcochlear canaliculus with an instrument.

Types:
A – communicates with petrous apex
B – does not communicate with petrous apex
C – absent

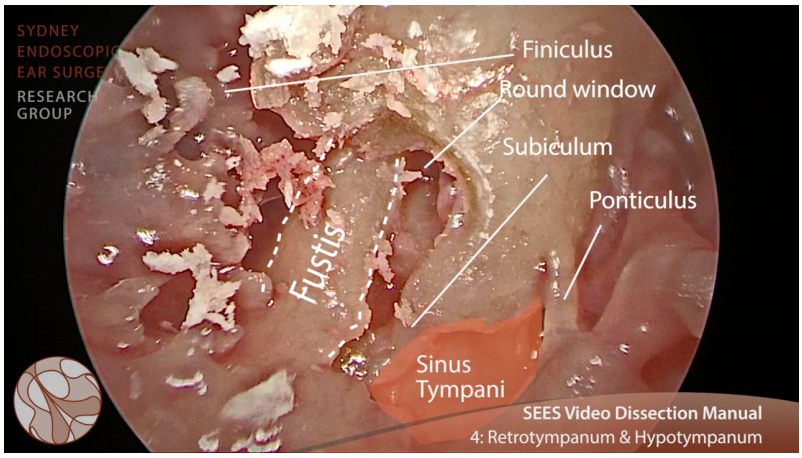
4.16



Finiculus – this is the boundary between the sinus subtympanicus and the hypotympanum.

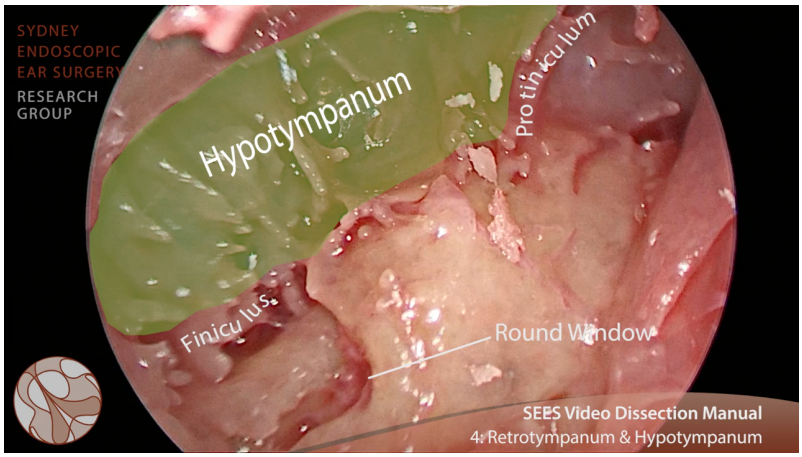
(The finiculus is not well developed in this specimen)

4.17



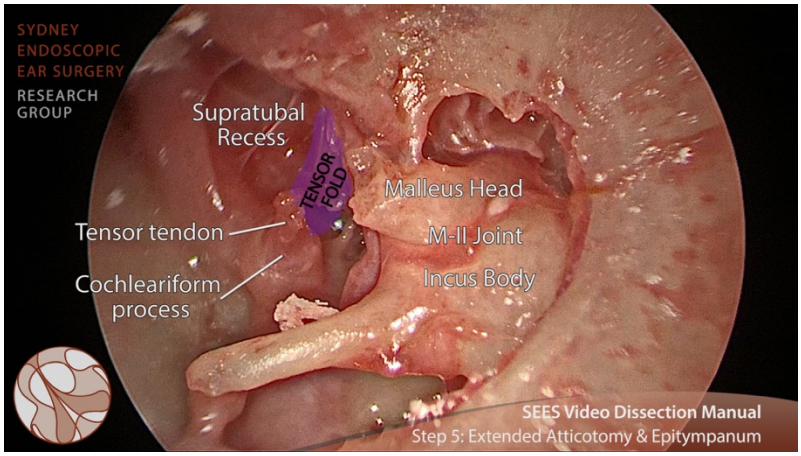
Fustis – appreciate the relationship to the round window, a useful guide.

4.18



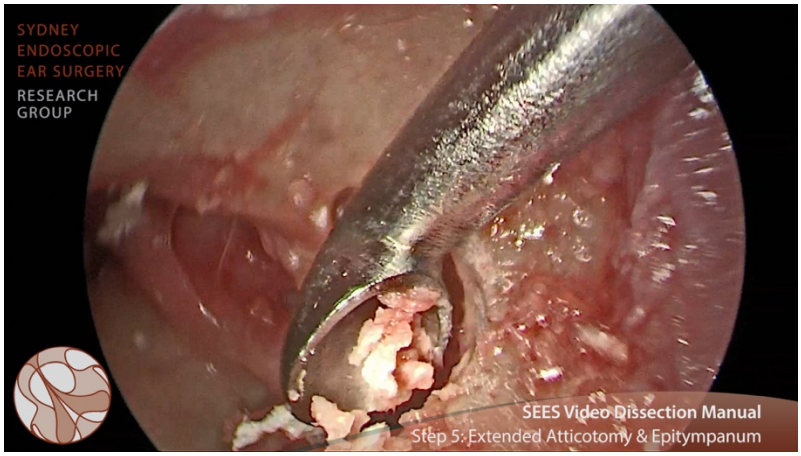
Hypotympanum. Appreciate the boundaries – finiculus, promontory, protiniculum, and the inferior annulus.

5.01



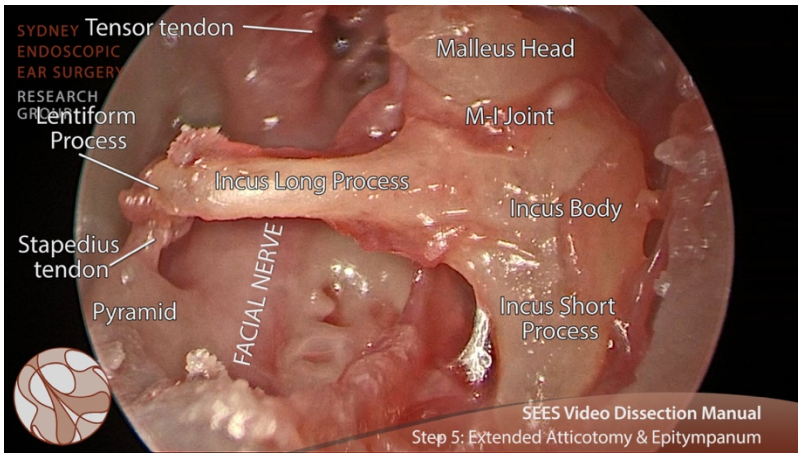
Identify the anatomy displayed through the previous steps

5.02



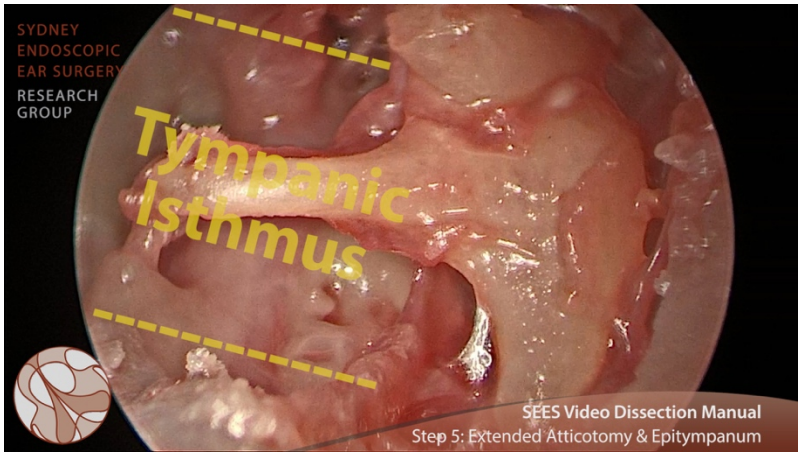
Then proceed to curette the remaining scutum, until the entire ossicular chain is visible and the tegmen superiorly can be clearly identified

5.03



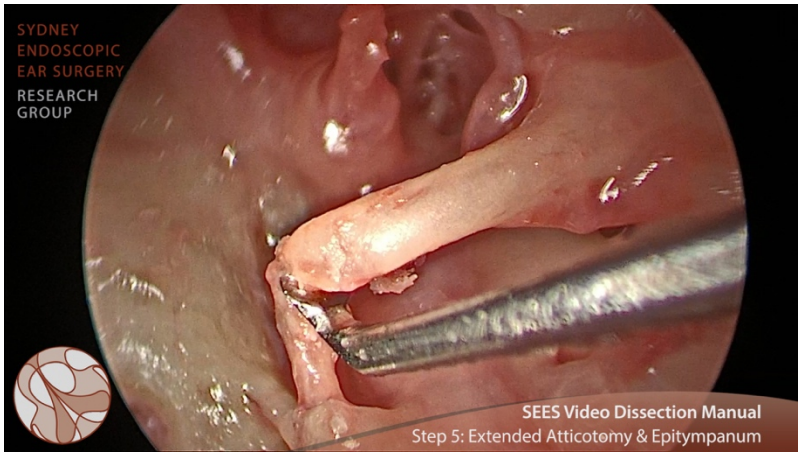
Identify all of the incus landmarks and the ligamental attachments to the bony surrounds. Note the posterior incudal ligament and the superior malleal ligament

5.04



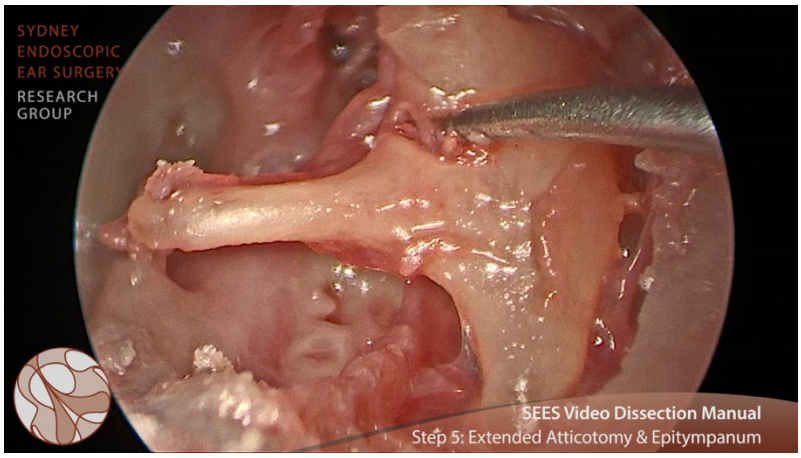
Pay particular attention to the tympanic isthmus. This is of critical importance in the ventilation of the attic and mastoid.

5.05



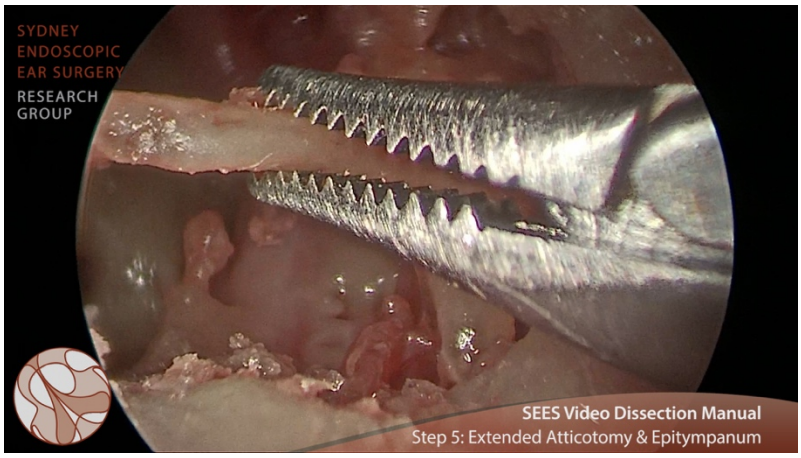
Divide the Incudo-stapedial joint. Use the joint knife and cut in a posterior to anterior direction, to enable stabilization of the stapes superstructure by the stapedius tendon.

5.06



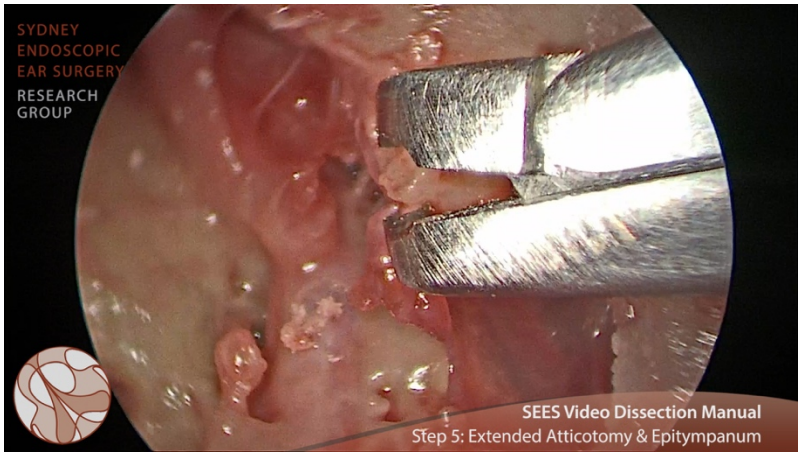
Divide the Incudo-Malleal Joint using a Rosen needle/pick.

5.07



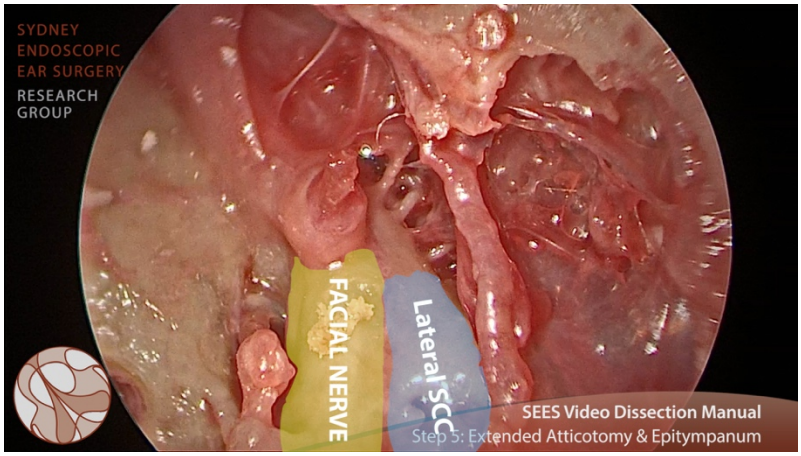
Use an alligator forceps to remove the incus by gripping the long process.

5.08



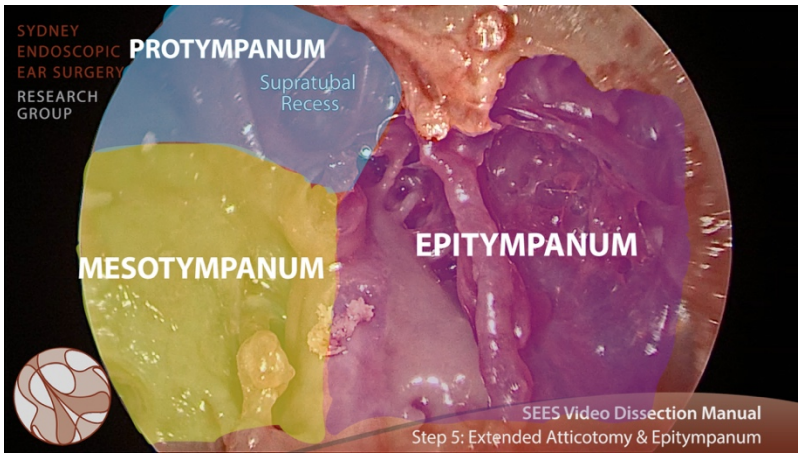
Use a right or left facing cupped forceps (depending on the ear) to grasp the remnant of the malleus head and remove it.

5.09



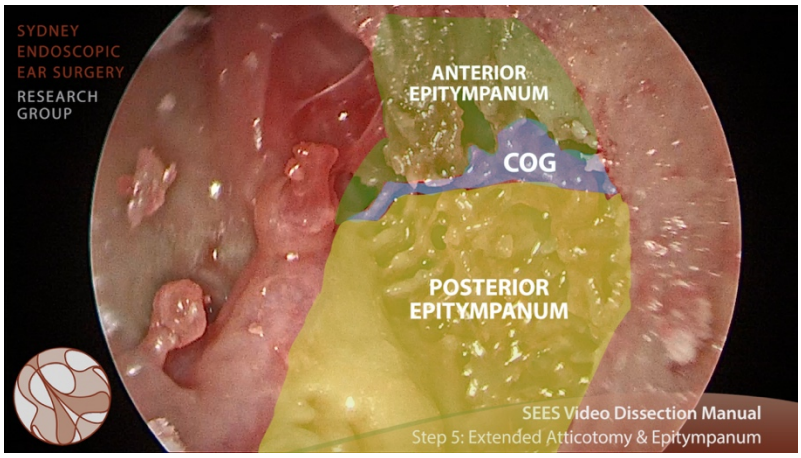
With the first two ossicles removed you can now appreciate the course of the facial nerve. The lateral semicircular canal lies postero-superiorly

5.10



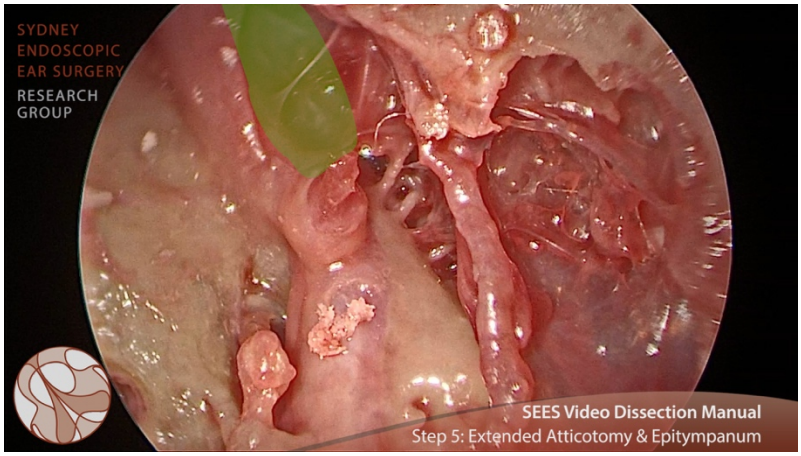
Make note of the boundaries of the three tympanic spaces.

5.11



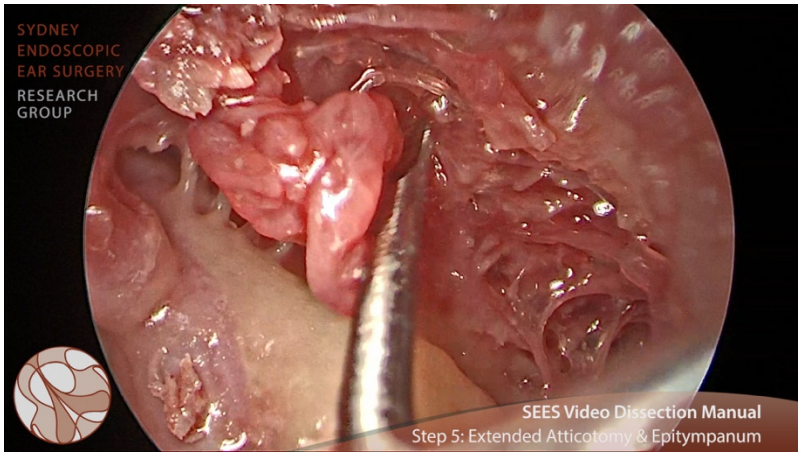
The "Cog" is a bony transverse plate descending from the tegmen to the cochleariform process, dividing the epitympanum into anterior and posterior divisions.

5.12



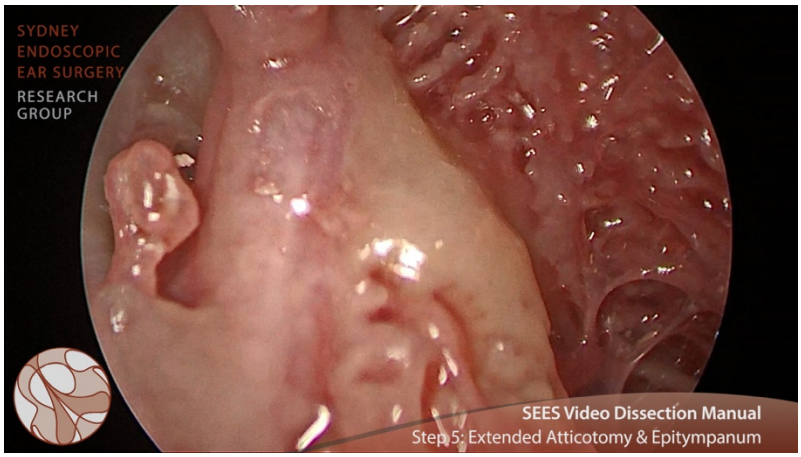
In your specimen, determine whether the tensor fold has a horizontal or vertical orientation.

5.13



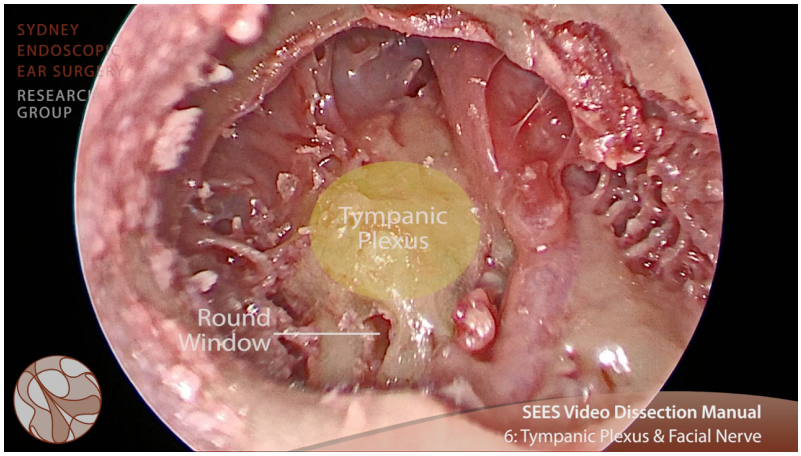
Using a double angled Thomassin dissector remove any remaining mucosal tissue or debris in the attic.

5.14



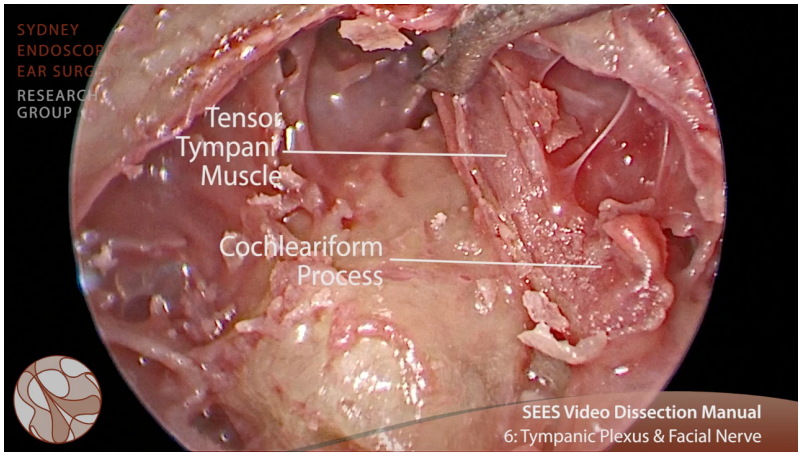
Use a 45° telescope to assess the mastoid antrum. It is possible to visualise a large proportion of the cavity in most specimens.. Use various dissection tools to explore how far you can reach,

6.01



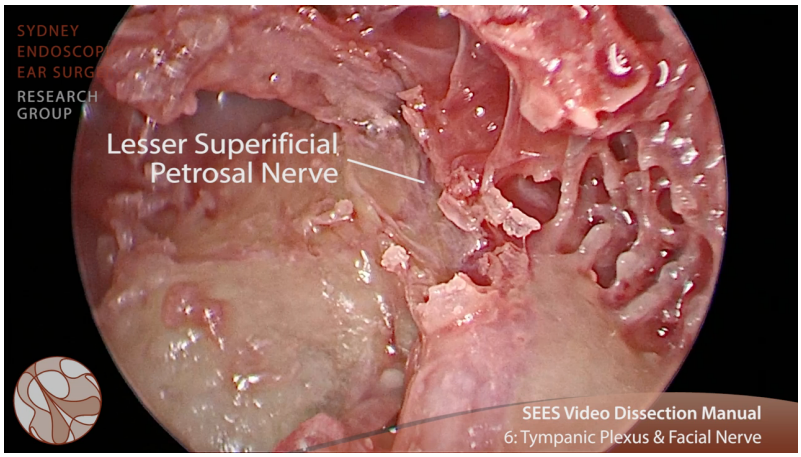
Jacobson's nerve – identify the nerve and the tympanic plexus & branches on the promontory

6.02



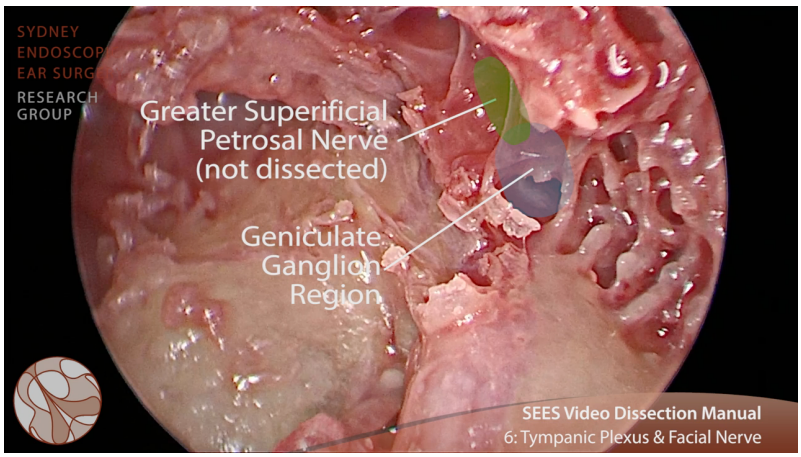
Tensor tympani muscle – curette the cochleariform process and uncover the muscle belly. Appreciate the course of the muscle superior to the Eustachian tube opening

6.03



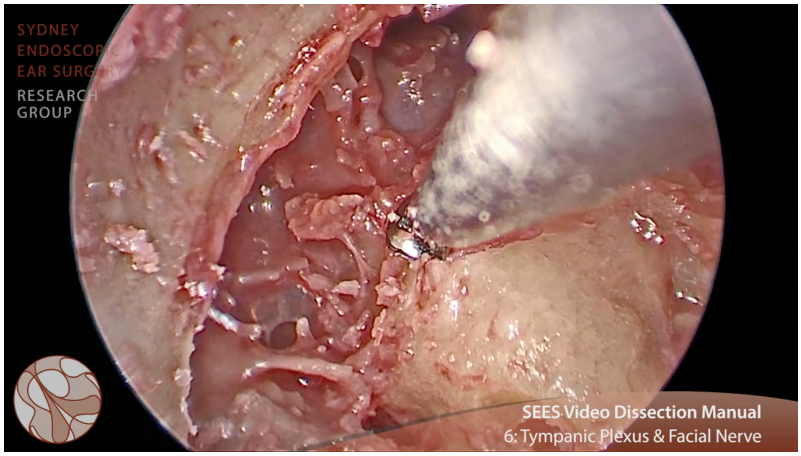
Lesser superificial petrosal nerve (LSPN) – use the curette to elevate the tensor tympani muscle out of it's groove, and identify the LSPN exiting the plexus deep to it.

6.04



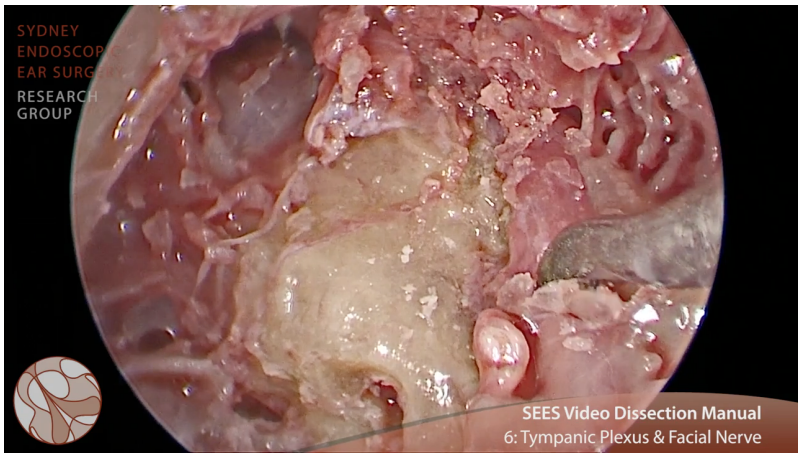
GSPN & Geniculate Ganglion – Use a curette to identify the geniculate ganglion (we'll return to this again below), and the start of the GSPN Then divide and remove the reflected Tensor muscle belly.

6.05



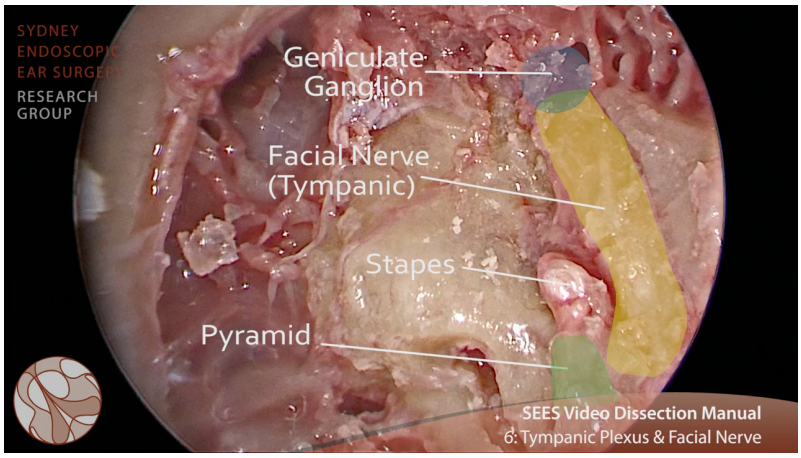
Finiculus – curette the finiculus (sustenaculum) to determine if the inferior tympanic artery runs through it. The artery often parallels Jacobsons' nerve.

6.06



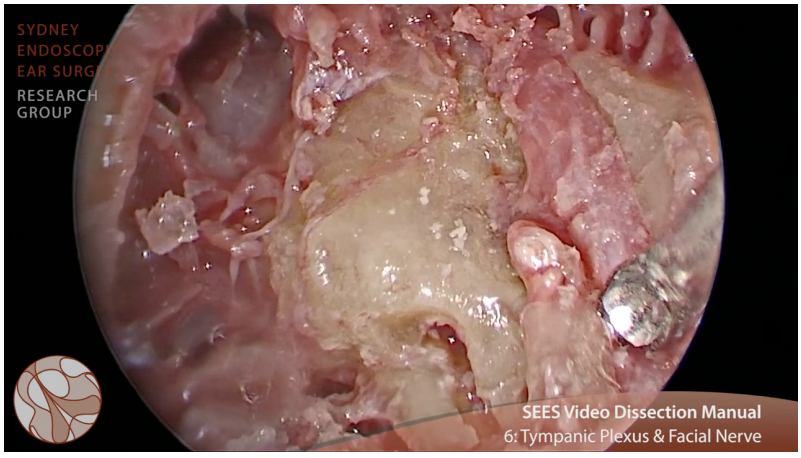
Facial nerve – decompress the facial nerve in the tympanic portion up to the pyramid.

6.07



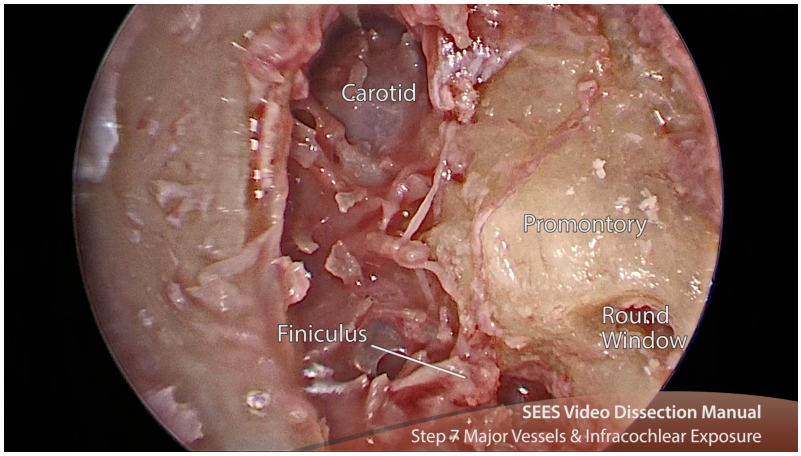
Fully trace the facial nerve and all surrounding structures

6.08



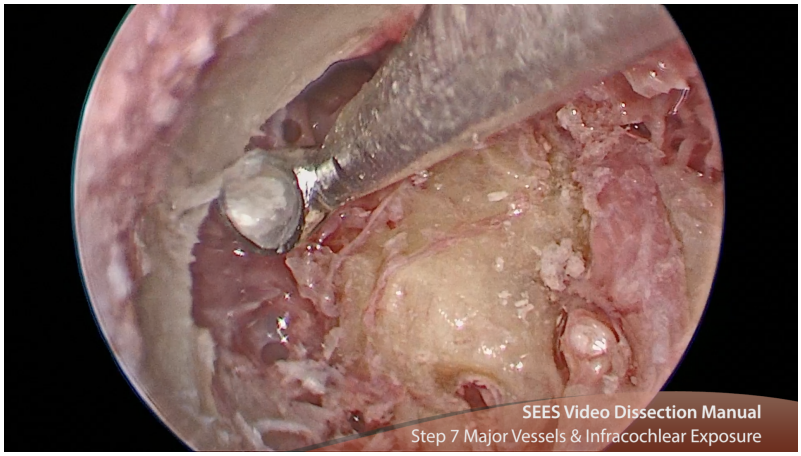
Curette the pyramid to show the stapedius muscle belly

7.01



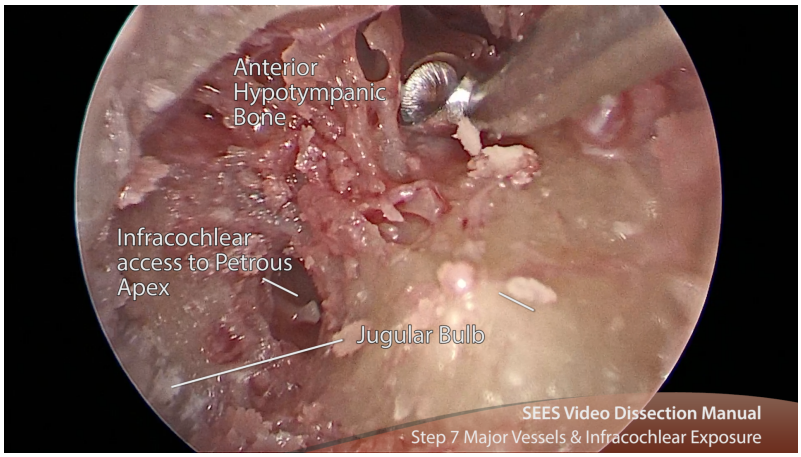
This is the first endoscopic view with a 30 degree scope, showing the infracochlear region.

7.02



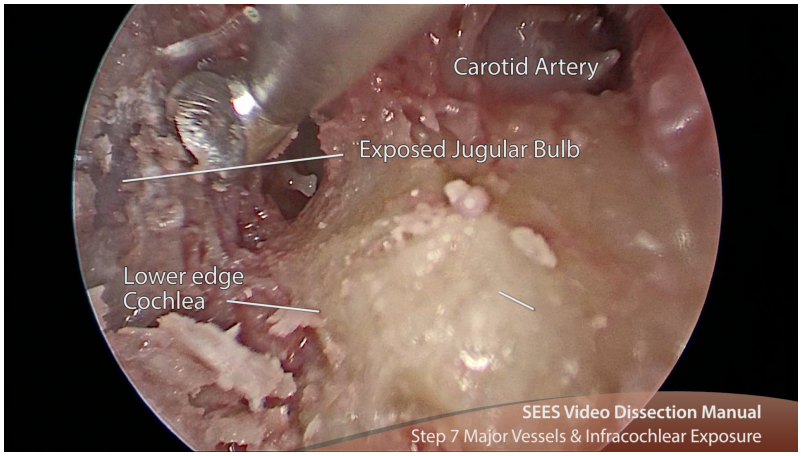
The curette is used for this demonstration of anteroinferior bone removal.

7.03



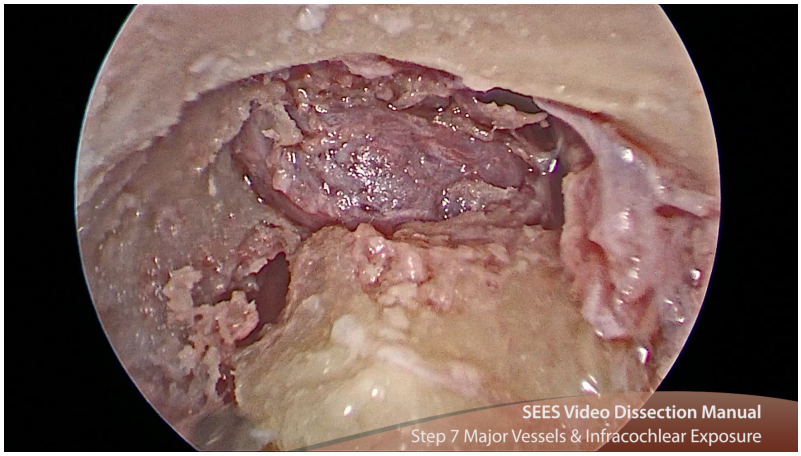
The bone removal is further extended to the anterior hypotympanic cells , lateral to the carotid artery.

7.04



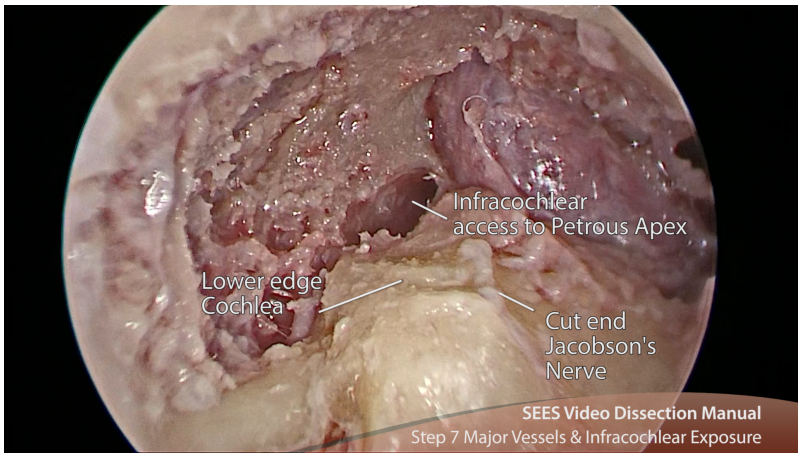
Here the bone is being removed with a curette off the jugular bulb.

7.05



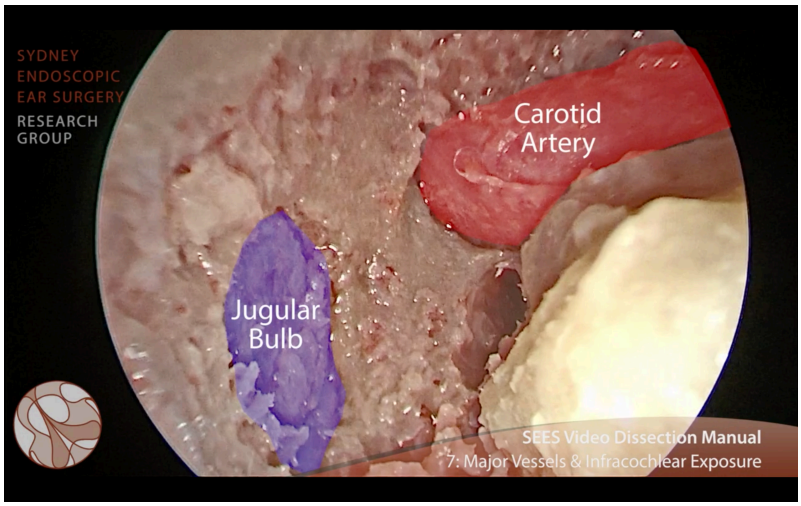
Now bone removal off the carotid artery. The posterior genu of the carotid forms the inferior floor of the protympanum.

7.06



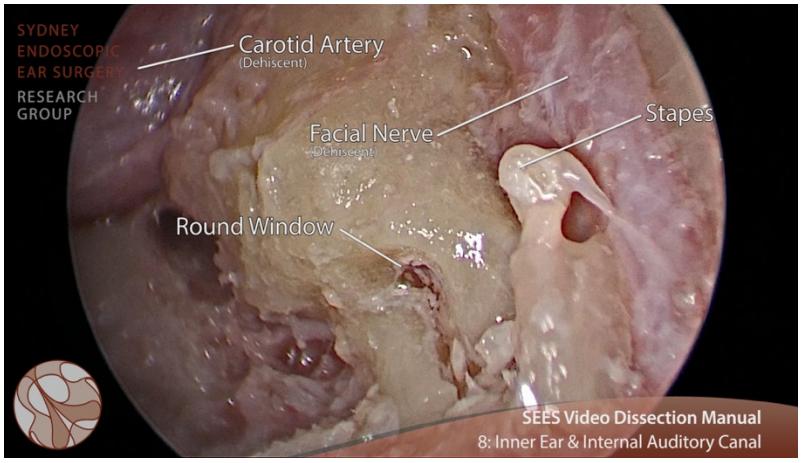
A 30 degree view of the infracochlear approach from superior to inferior. Note the cut edge of Jacobson's nerve at the inferior margin of the cochlea.

7.07



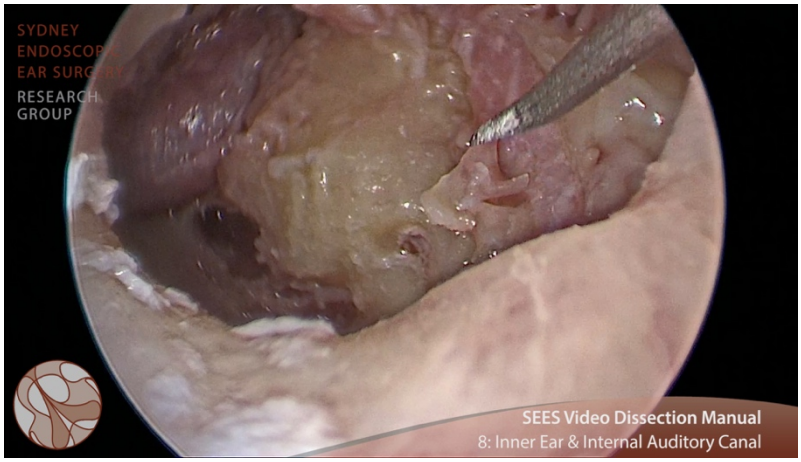
A 45 degree endoscopic view of the final infracochlear dissection.

8.01



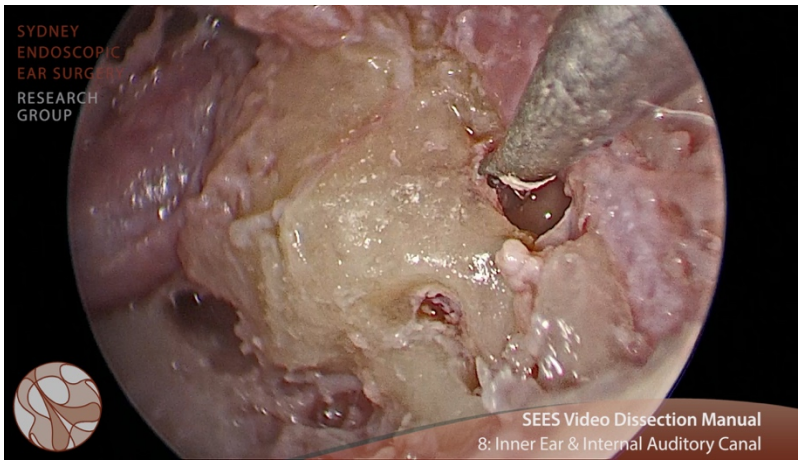
Orient yourself with the pertinent anatomy of the middle ear

8.02



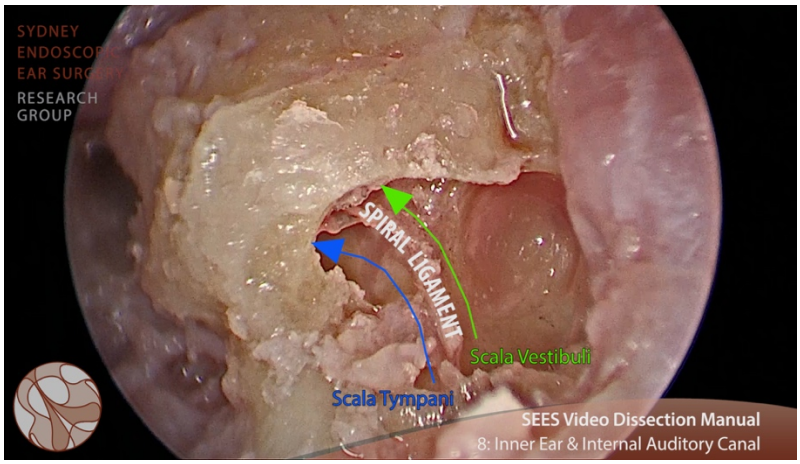
Begin by dividing the stapedius tendon, then use a small pick to avulse the entire stapes. Curettage of the pyramidal process may be necessary.

8.03



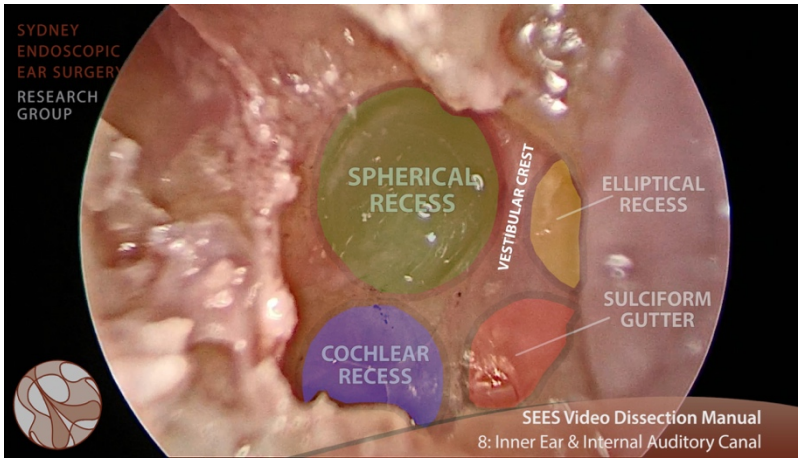
Curette posteroinferiorly from the oval window towards the round window to open and unroof the vestibule

8.04



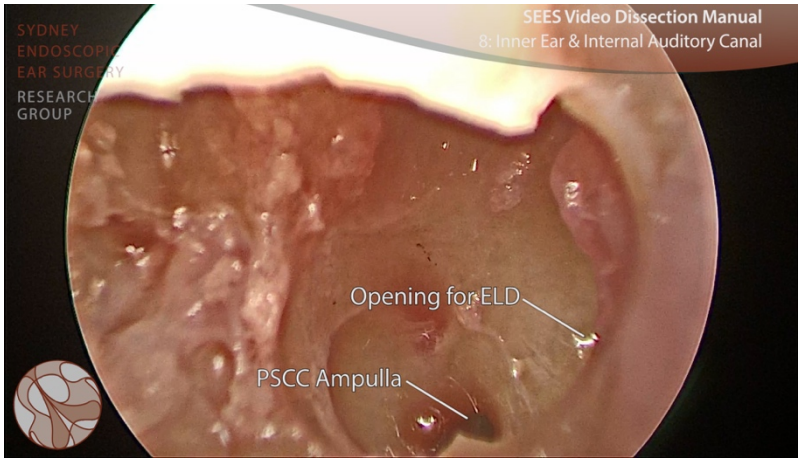
Continue curettage to follow the cochlear duct, identifying the scala tympani and vestibuli and the spiral ligament

8.05



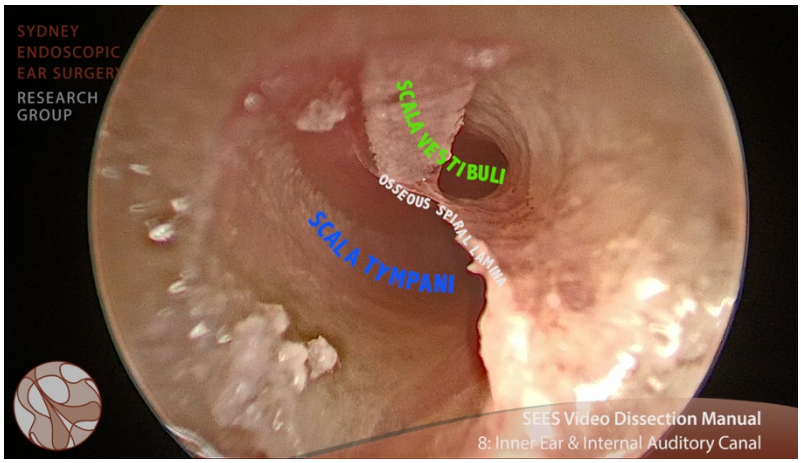
Observe the bony recesses within the vestibule: the spherical, elliptical, cochlear recesses and the sulciform gutter

8.06



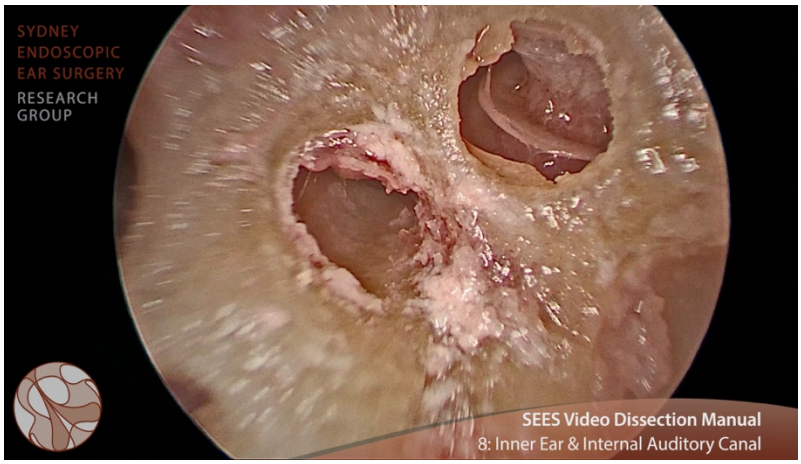
Attempt to observe the ampulla of the posterior SCC, as well as the opening of the endolymphatic duct with an angled endoscope

8.07



Use an angled endoscope to look into the cochlear and appreciate the scalae and osseous spiral lamina in cross section

8.08

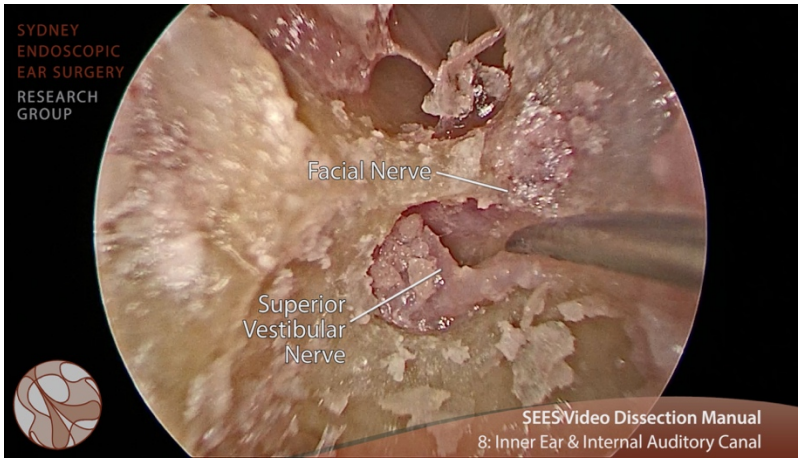


Curette just inferior to the cochleariform process to open the middle turn of the cochlea

8.09

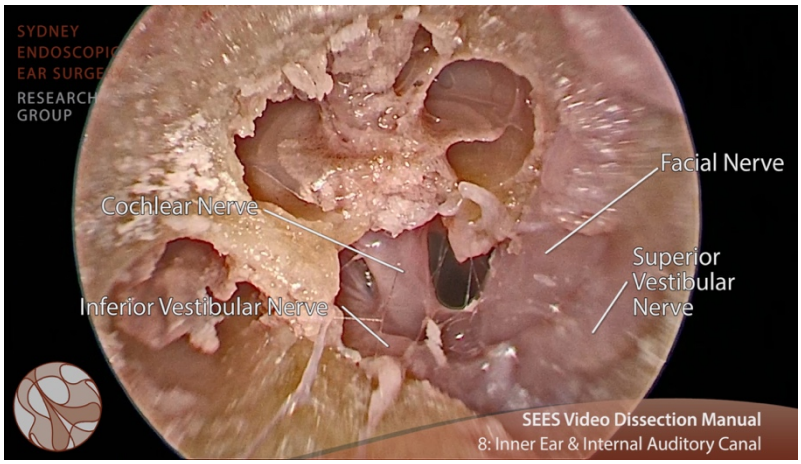
Identify the scala tympani and vestibuli through this new opening

8.10



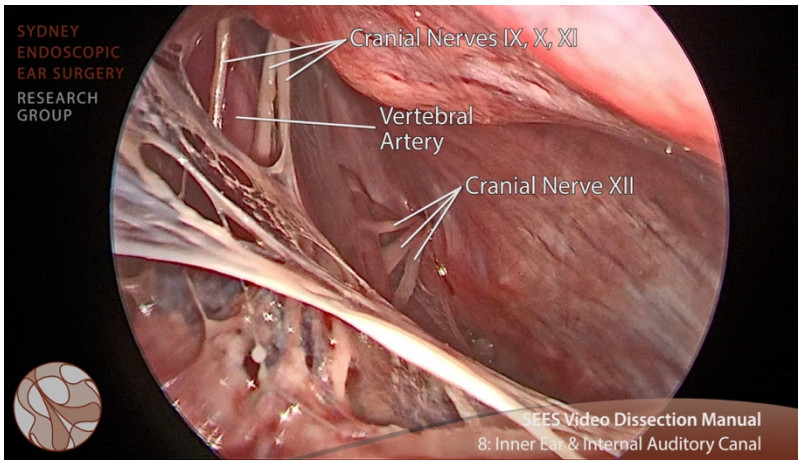
Continue curetting posterosuperior to the middle turn of the cochlear at the anterior aspect of the vestibule, to expose the internal auditory canal

8.11



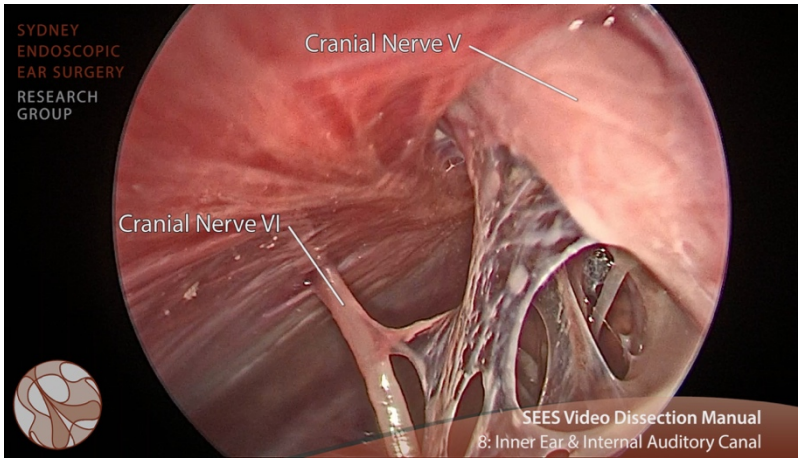
Identify the nerves of the internal auditory canal: the cochlear, facial, superior and inferior vestibular nerves

8.12



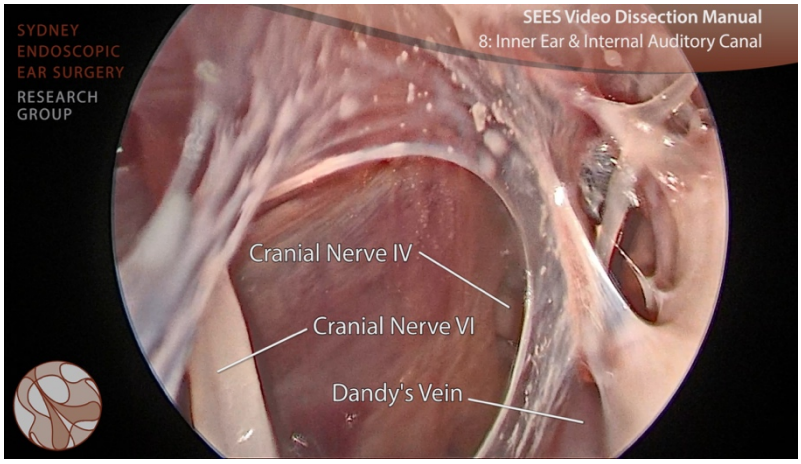
Pass an angled endoscope through the IAC into the cerebellopontine angle and inferiorly, observe CN IX-XI grouped togerther, as well as CNXII and vertebral artery

8.13



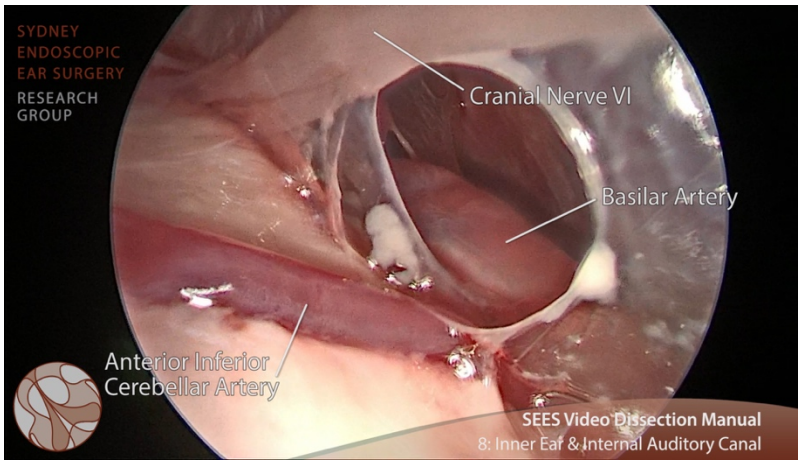
Angling superiorly within the CPA, observe the trigeminal nerve entering Meckel's cave, as well as the abducens nerve

8.14



Moving the endoscope more posterior, the trochlear nerve and Dandy's vein can now be seen

8.15



Angling further inferior, the basilar artery and the anterior inferior cerebellar artery branching off it can be seen