

Tympanoplasty

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Outline

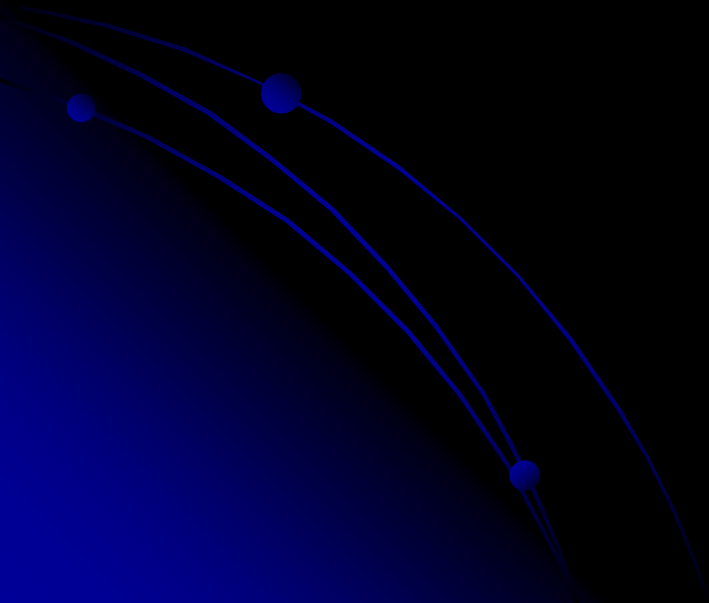
- Define terms
- History
- Anatomy and Embryology
- Physiology of sound transmission
- Etiology
- Preoperative evaluation
- Techniques
- Tympanoplasty in children
- Complications
- Results

Introduction

- **Myringoplasty** - reconstruction of a perforation of the tympanic membrane (TM)
 - Assumes – normal middle ear (ME) mucosa and ossicles
 - TM is not elevated from its sulcus
- **Tympanoplasty** – reconstruction of the TM
 - Also includes addressing middle ear pathology
 - Cholesteatoma, adhesions
 - Ossicular chain problems
 - Usually involves elevating the TM from its sulcus

Introduction

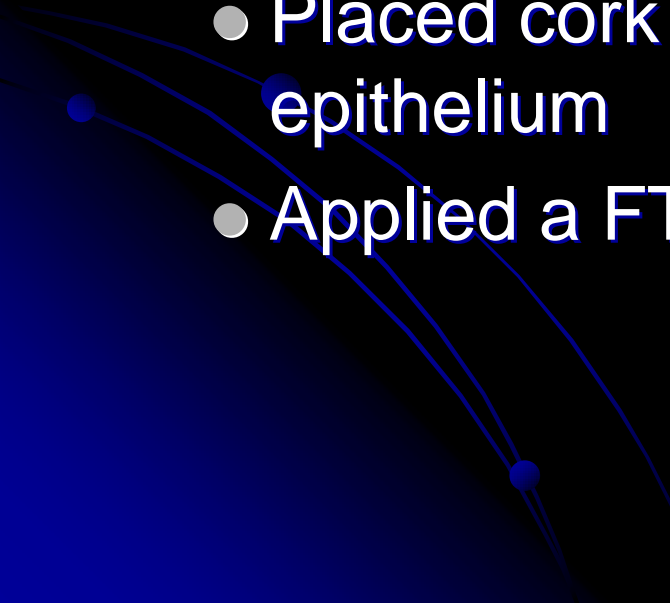
- Tympanoplasty is sub-classified based on
 - Medial or lateral grafting
 - Associated type of ossicular chain reconstruction (OCR)



History

- 1640 – Banzer
 - First attempt at repair of a TM perforation
 - Used pigs bladder as a lateral graft
- 1853 – Toynbee
 - Placed a rubber disk attached to a silver wire over the TM
 - Reported significant hearing improvement
- 1863 – Yearsley
 - placed a cotton ball over a perforation
- 1877 – Blake
 - Paper patch

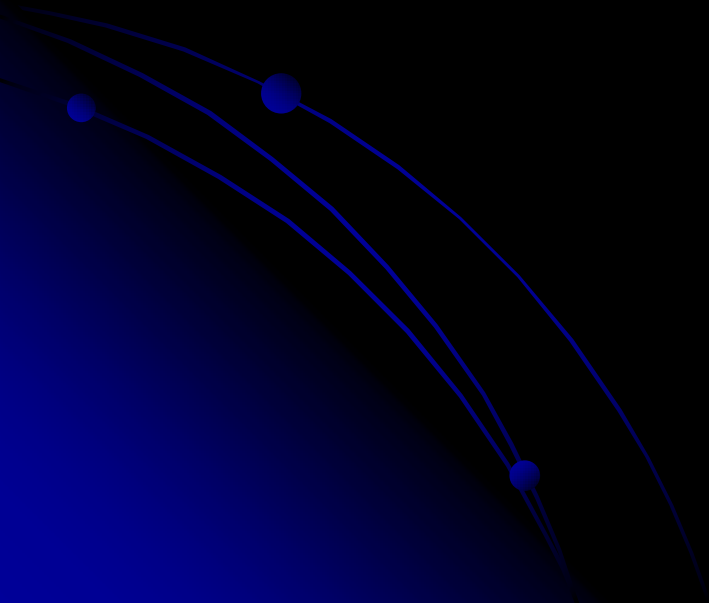
History

- 1876 – Roosa
 - Treated TM perf. with chemical cautery
 - 1878 – Berthold
 - Coined the term myringoplasty
 - Placed cork plaster against TM to remove epithelium
 - Applied a FTSG
- 

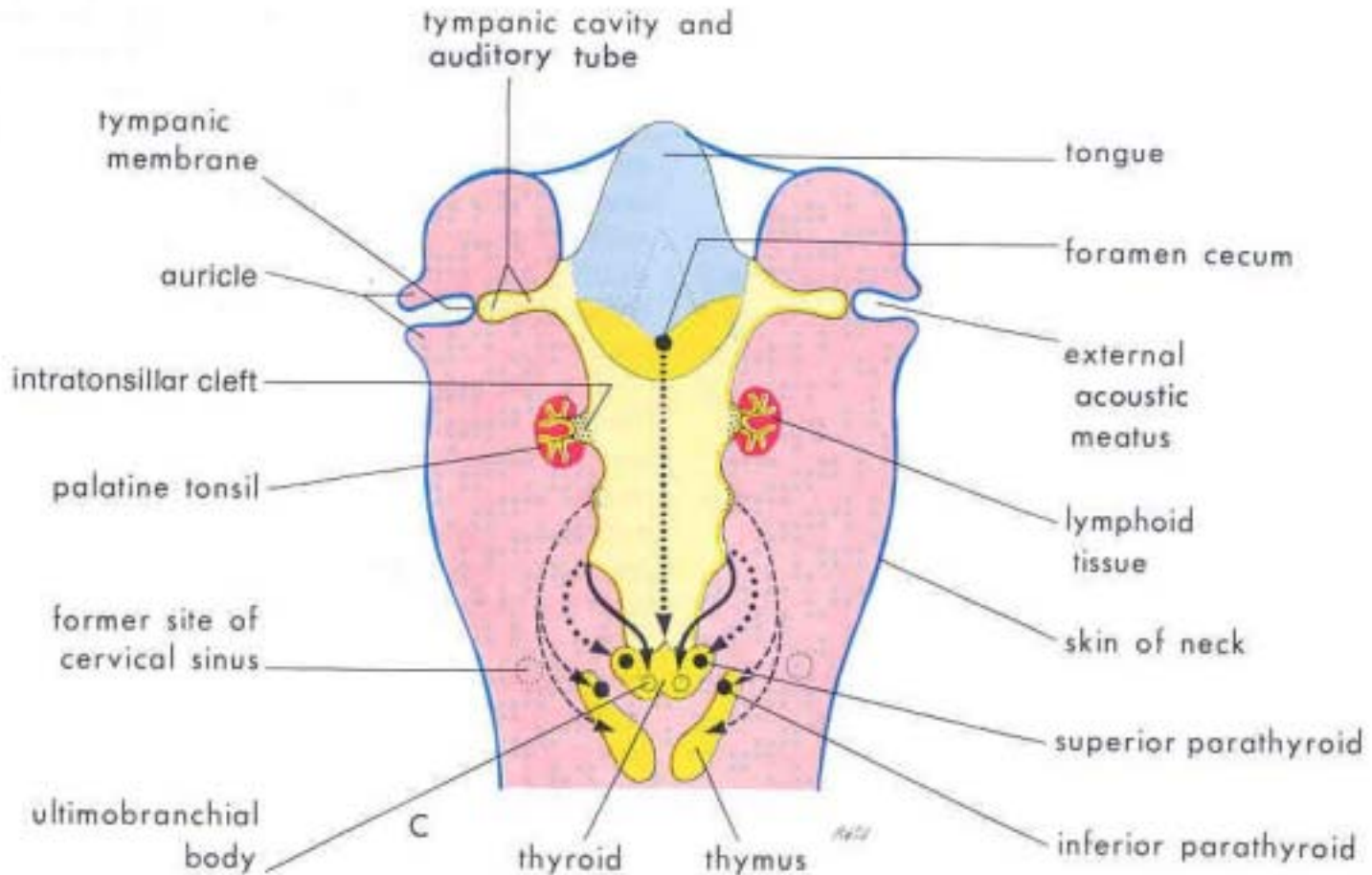
History

- 1950s – Wullstein and Zollner
 - STSG over de-epithelialized TM
- 1956 - Wullstein
 - Described five types of tympanoplasty
- 1957 – first medial graft performed by Shea with vein graft
- 1961 – Storrs
 - introduced the use of temporalis fascia grafting
 - Medial grafting
- 1961 and 1967 – House, Glasscock and Sheehy
 - Developed and refined techniques for lateral grafting


Anatomy and Embryology of the Tympanic Membrane



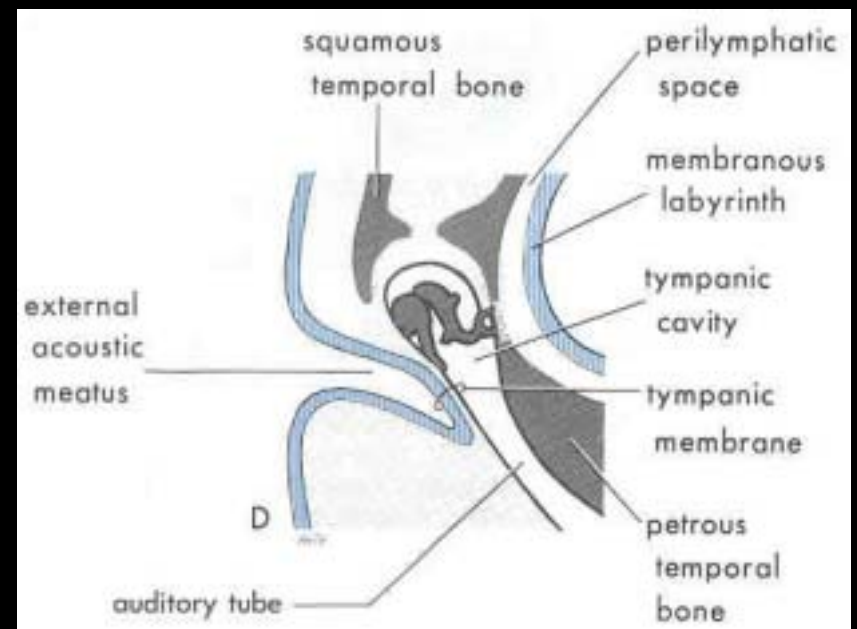
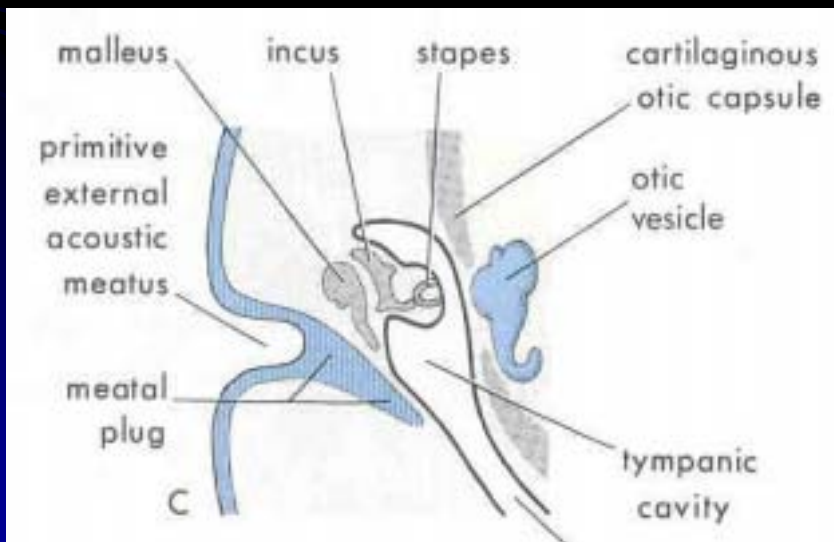
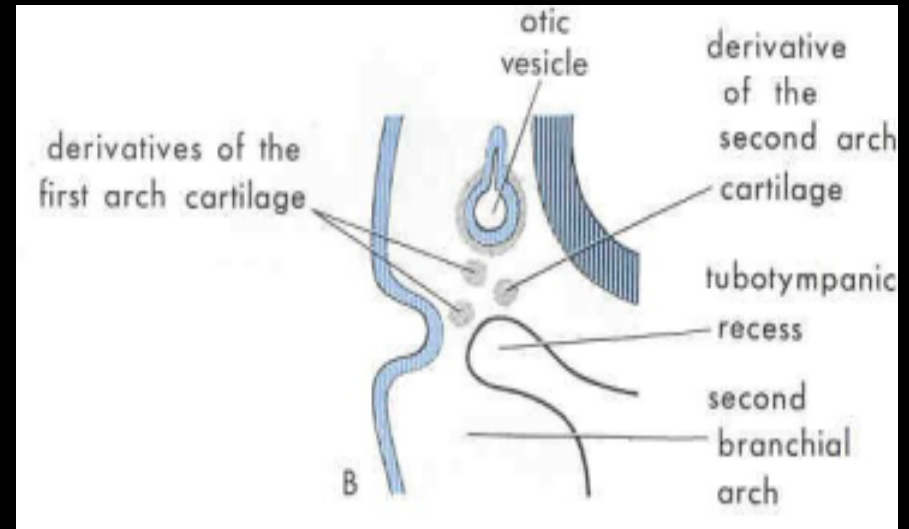
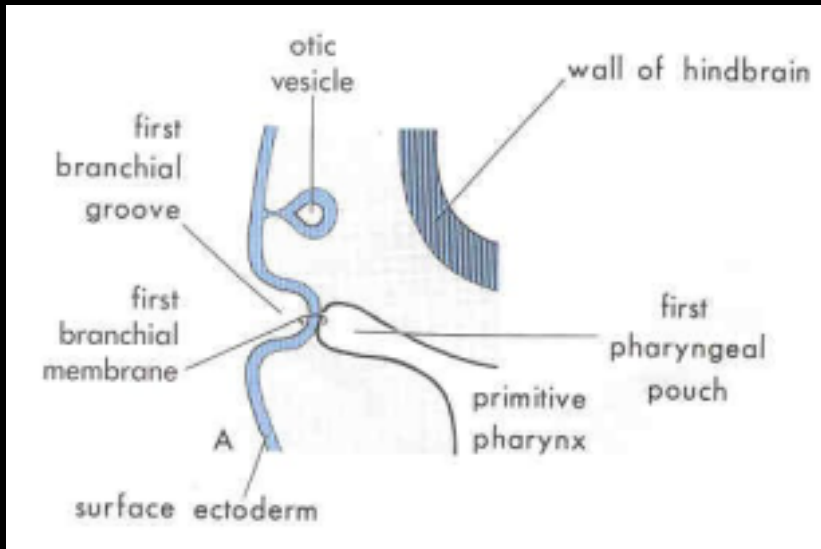
Embryology



Embryology

- 4th week of gestation
 - TM develops from three sources
 - Ectoderm – 1st branchial groove
 - Endoderm – 1st branchial pouch
 - Mesoderm – 1st and 2nd branchial arches
- 

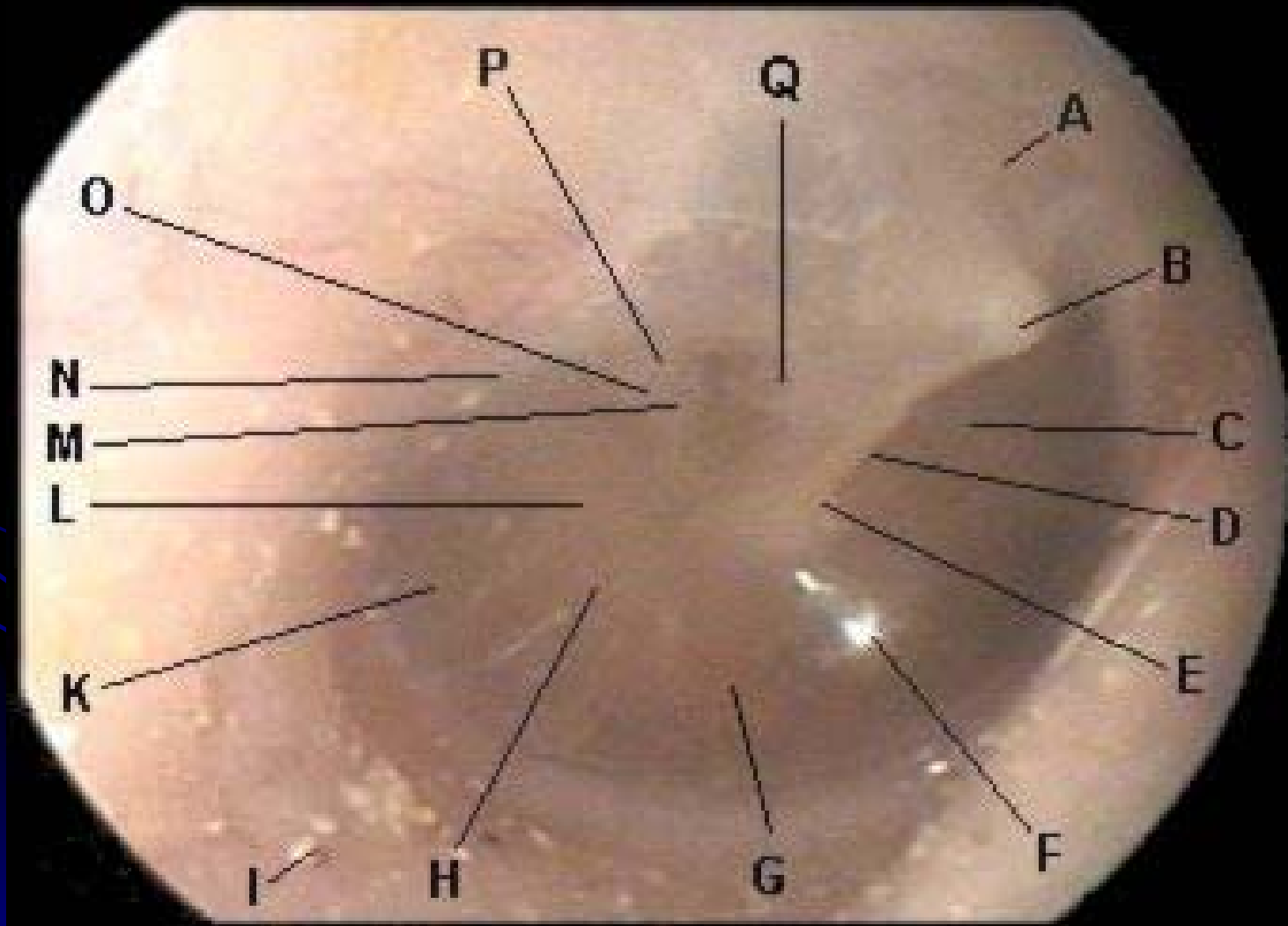
Embryology



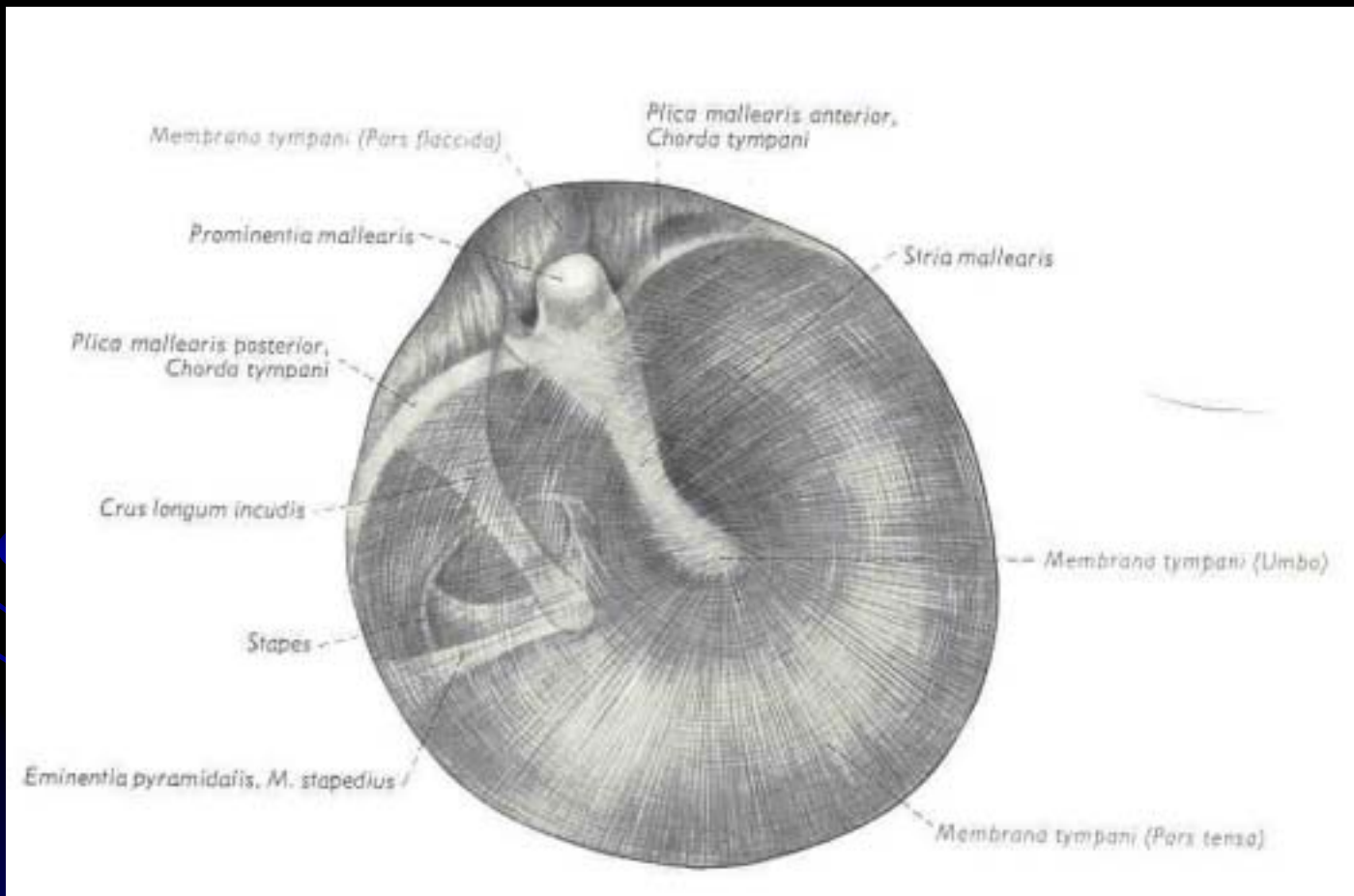
Anatomy

- TM is oval in shape
 - 8 mm X 10 mm
 - 55 degrees to the floor of the meatus
 - Near circumferential fibro-cartilaginous thickening
 - Annular ligament or annulus
 - 3 layers – 130 microns thick
 - Outer epithelial – keratinizing squamous
 - Middle fibrous – superficial radial, deep circular
 - Inner – mucosa
 - Epithelial migratory pattern
 - Centrifugal growth for the umbo outward

Anatomy

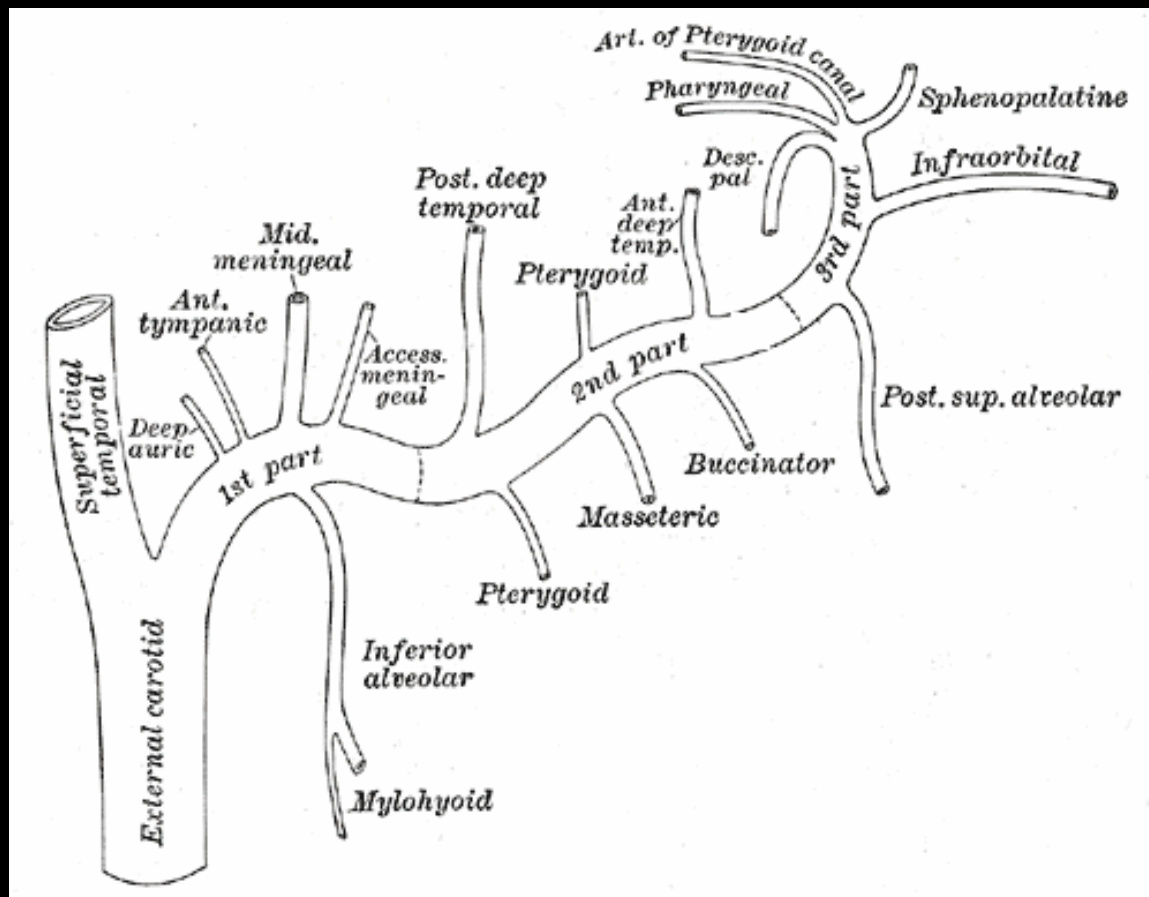


Anatomy



Anatomy

- Blood supply
 - Inner surface
 - Ant. Tymp a.
 - Outer surface
 - Deep auricular a.



Blood Supply

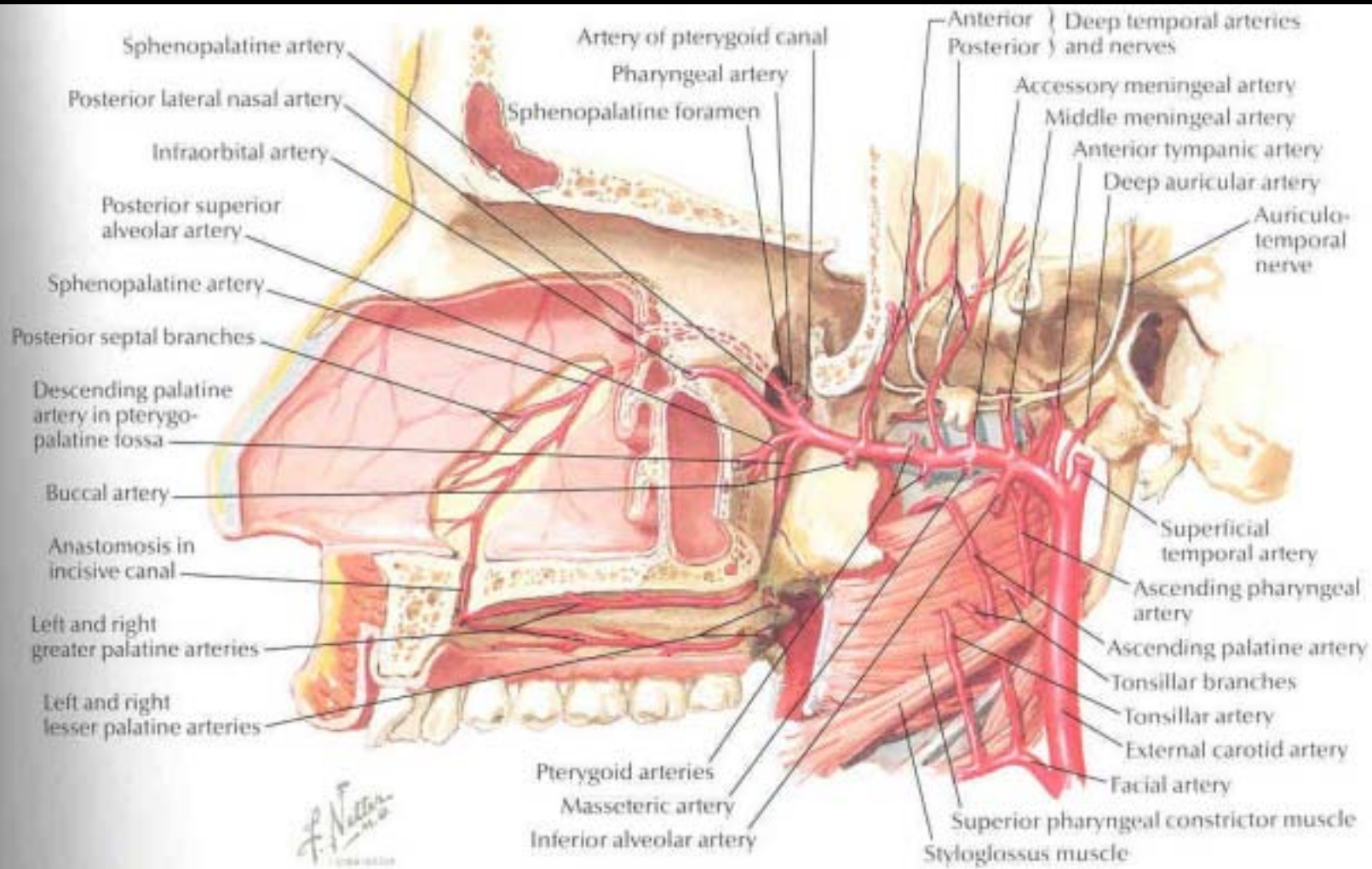
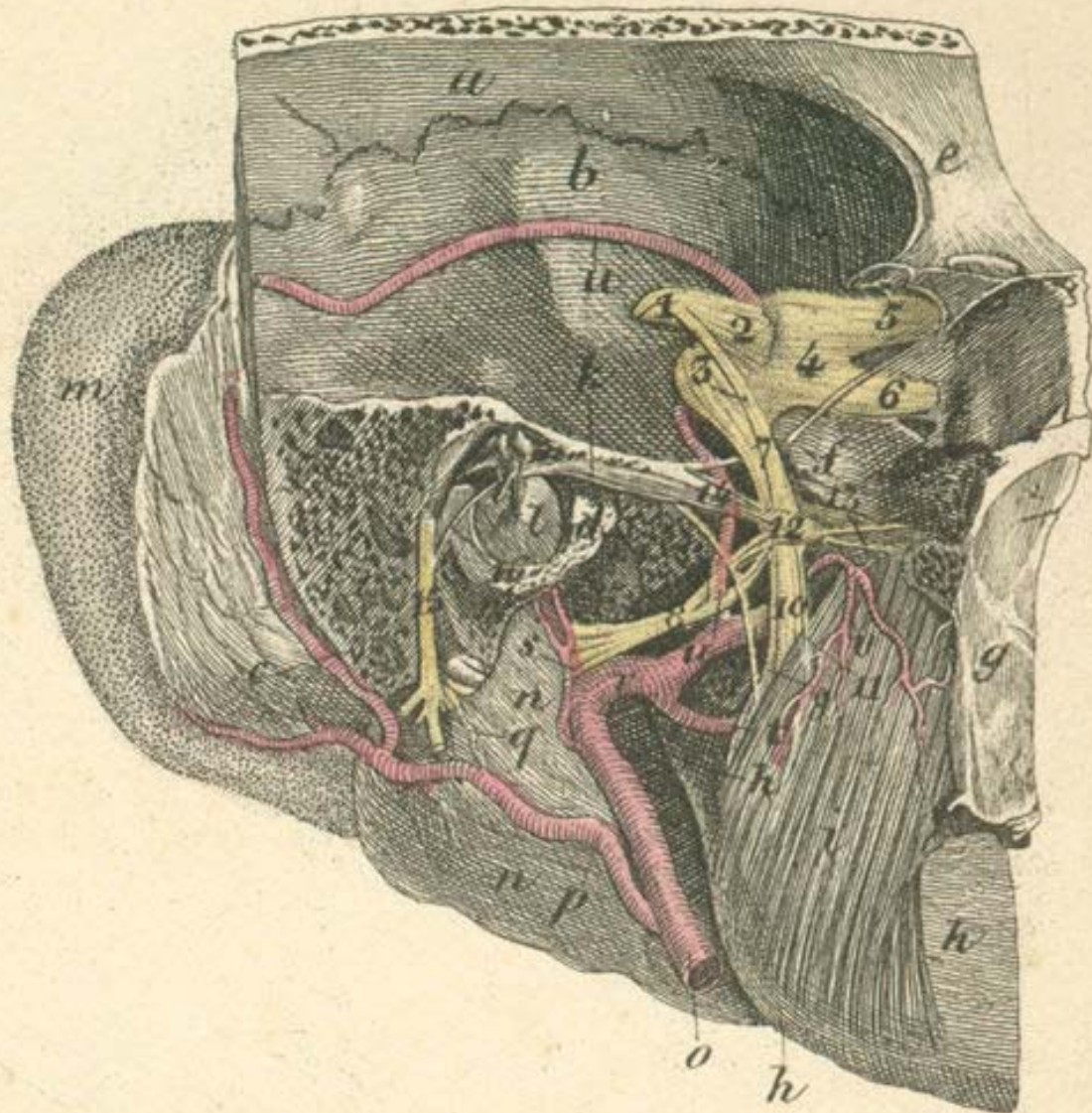
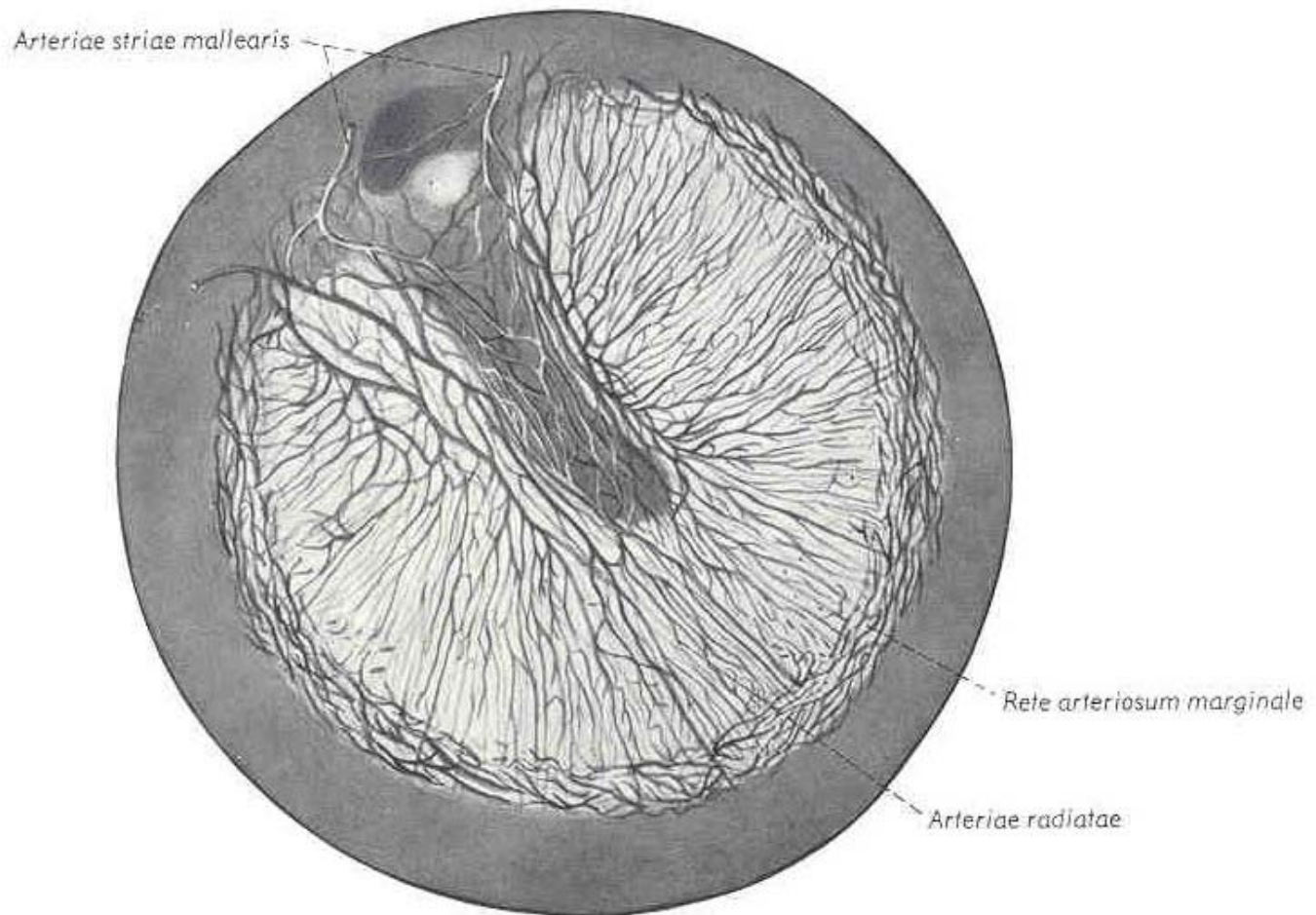


Fig. 2.



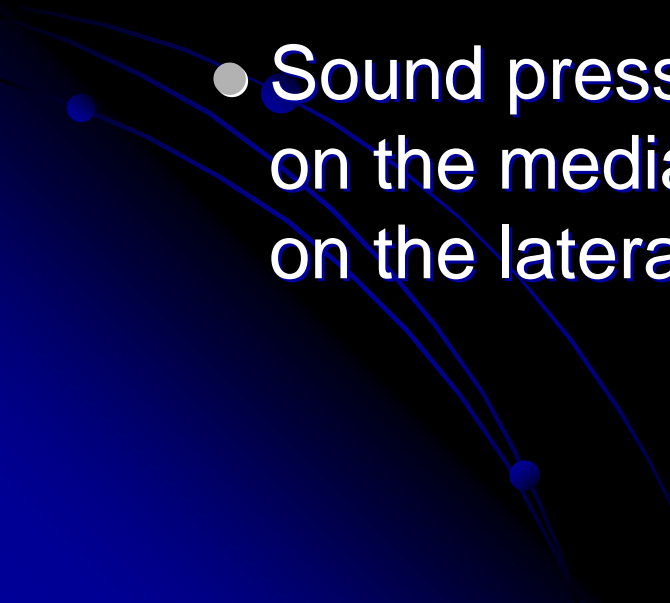
Anatomy



Physiology of the TM

- Middle ear
 - Transforms air waves to fluid waves
 - Two mechanisms
 - Area affect of TM
 - TM area:foot plate area – 17:1
 - Lever action of the ossicles
 - 1.3:1 malleus to incus ratio
 - 22:1 combined transformer ratio of middle ear
 - Translates to 25 dB

Physiology of hearing with TM perforations

- Effects on hearing
 - Decreased transformer ratio
 - Round window stimulation causes inner ear fluid waves that cancel out those at the oval window
 - Sound pressure entering the perforation acts on the medial surface of the TM against that on the lateral surface
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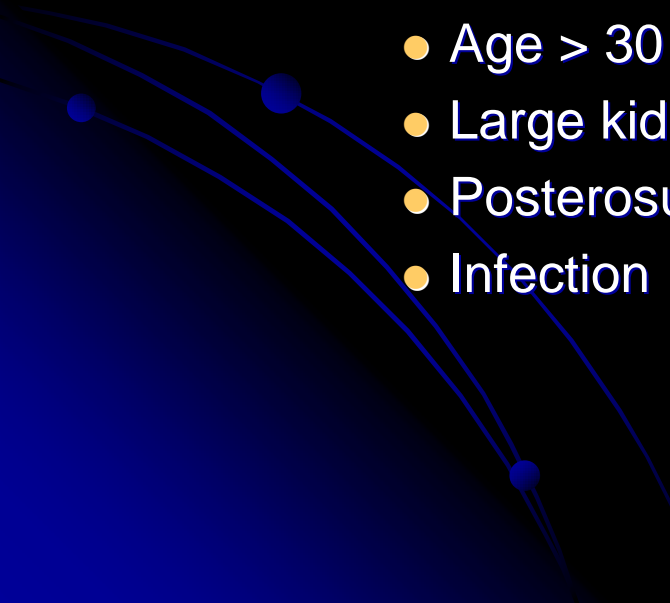
Etiology of TM perforations

- Infection – most common cause
 - Bacteria
 - Mycobacterium
 - Viruses
- Trauma
 - Penetrating trauma
 - Self induced with cue tip most common penetrating cause
 - Blunt
 - Temporal bone fractures
 - Longitudinal fractures more common than transverse fractures
 - Slap injury

Etiology of TM perforations

- Trauma
 - Thermal
 - Welders and steelworkers
 - Lightning
 - Barotrauma
 - Cadaver studies – 14-33 lbs/in²
 - Keller (1958) – 195-199 dB sound pressure
 - Iatrogenic
 - Retained ventilation tube
 - Nicoles et al. – 40% incidence of perforation with retained tubes > 36 months vs. 19% < 36 months

Etiology of TM perforations

- Traumatic TM perforations
 - 1992 – Kristensen
 - 80% heal spontaneously
 - Thermal injuries 40% heal spontaneously
 - Other negative factors
 - Age > 30 years
 - Large kidney bean shaped central perforations
 - Posterosuperior perforations
 - Infection
- 

Preoperative Evaluation

- History
 - Hearing loss
 - Tinnitus
 - Vertigo
 - Otalgia
 - Otorrhea
 - Facial paralysis
 - Prior otologic procedures
 - Medical history – DM, heart, lung, kidney, liver


Preoperative Evaluation

- Physical exam – complete H/N exam
 - Facial nerve
 - External ear
 - Tullio's Phenomenon
 - Otomicroscopy
 - Ear canal
 - TM
 - Perforation – location, size
 - Retraction pockets, granulation tissue
 - Status of middle ear through perforation
 - Audiometry – preferable with a dry ear
 - Air and bone lines, acoustic reflexes
 - Tympanometry
 - +/- CT temporal bone

Indications for Surgery

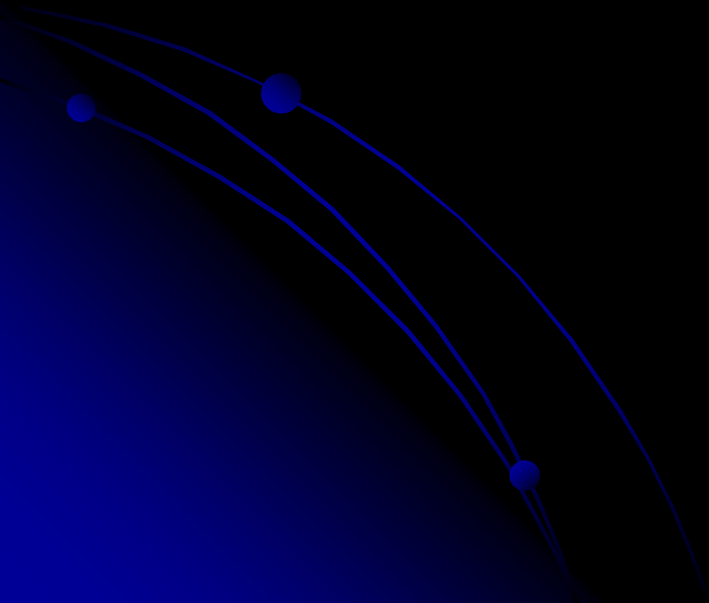
- Conductive hearing loss due to TM perforation or ossicular dysfunction
- Chronic or recurrent otitis media secondary to contamination
- Progressive hearing loss due to chronic middle ear pathology
- Perforation or hearing loss persistent > 3 months due to trauma, infection, or surgery
- Inability to bathe or participate in water sports safely

Goals of Surgery

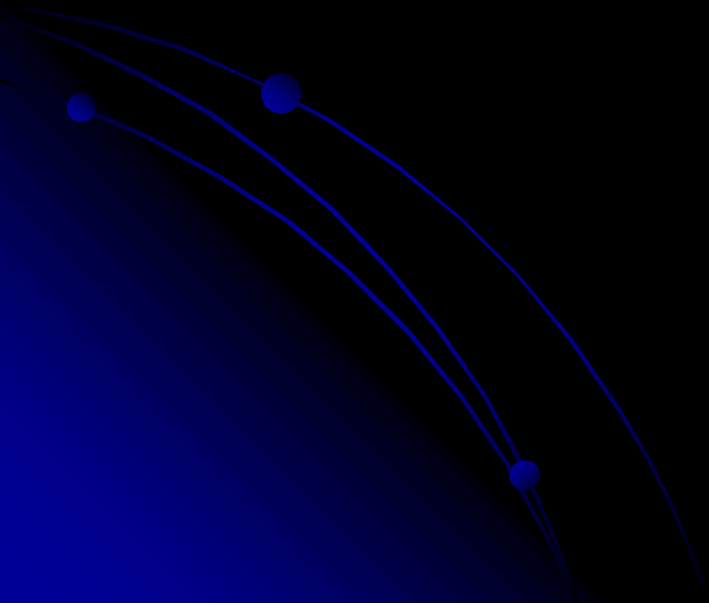
- Establish an intact TM
 - Eradicate middle ear disease and create an air-containing middle ear space
 - Restore hearing by building a secure connection between the ear drum and the cochlea
- 

Techniques

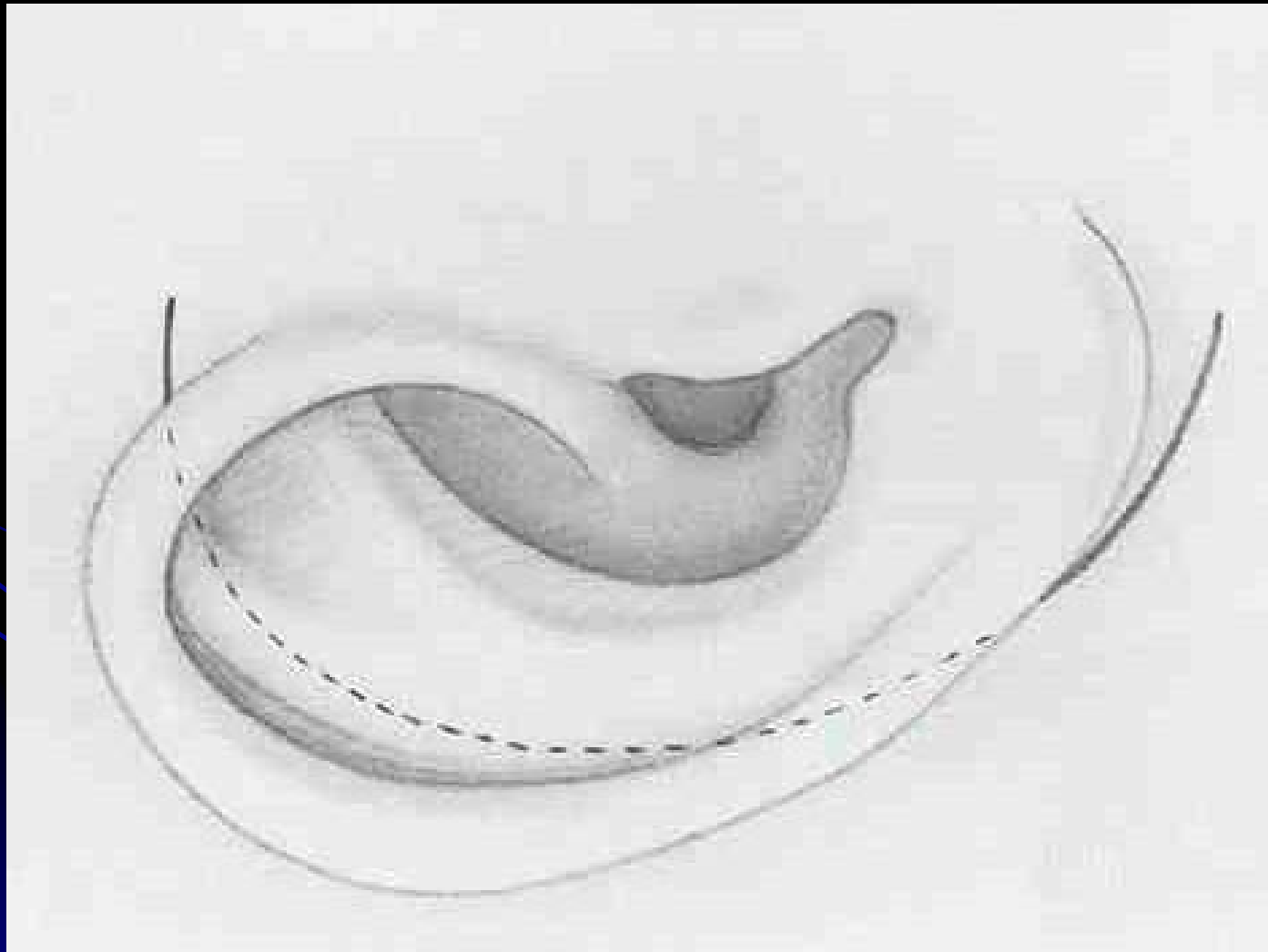
- Overlay technique (lateral grafting)
- Underlay technique (medial grafting)



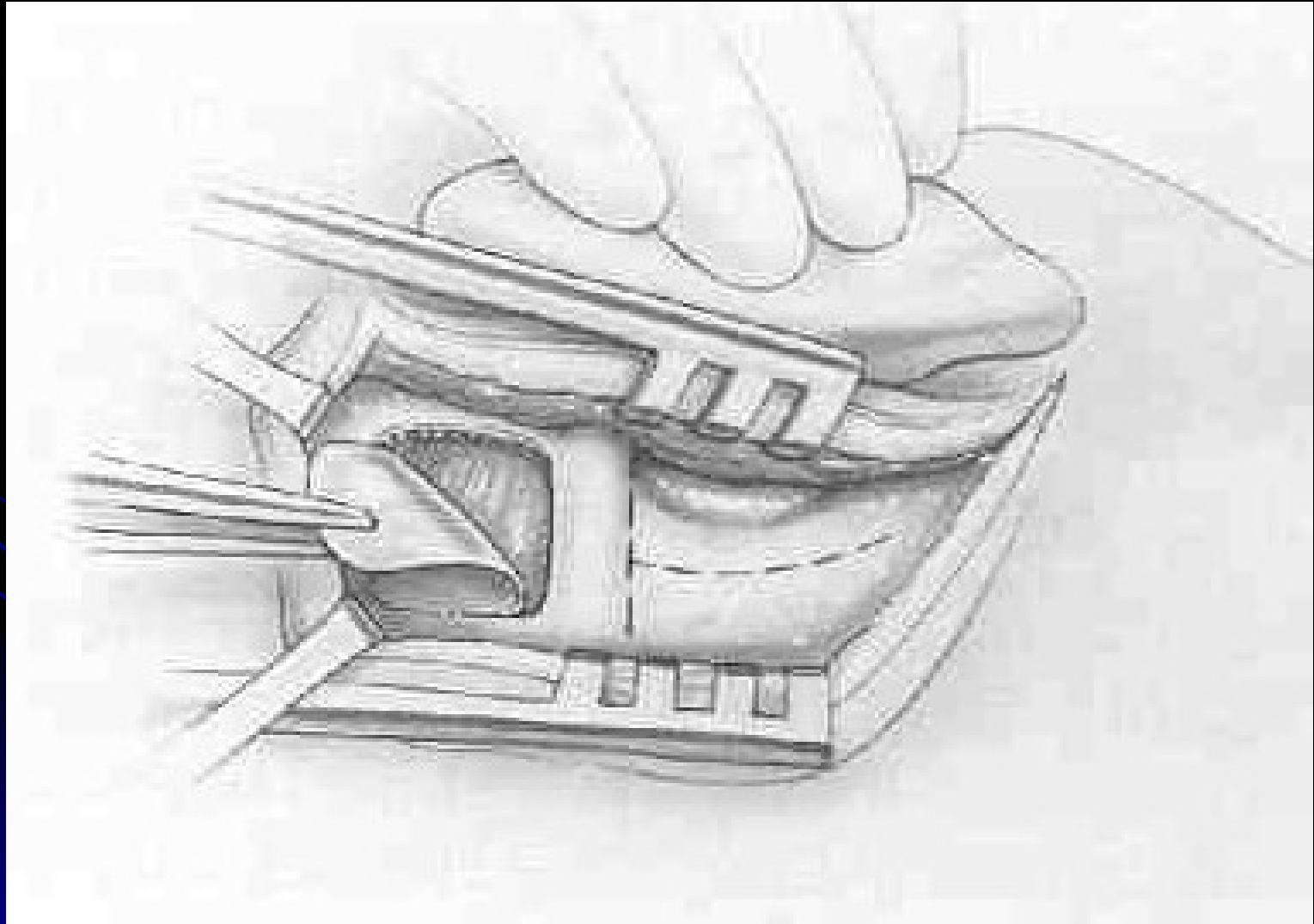
Lateral Grafting



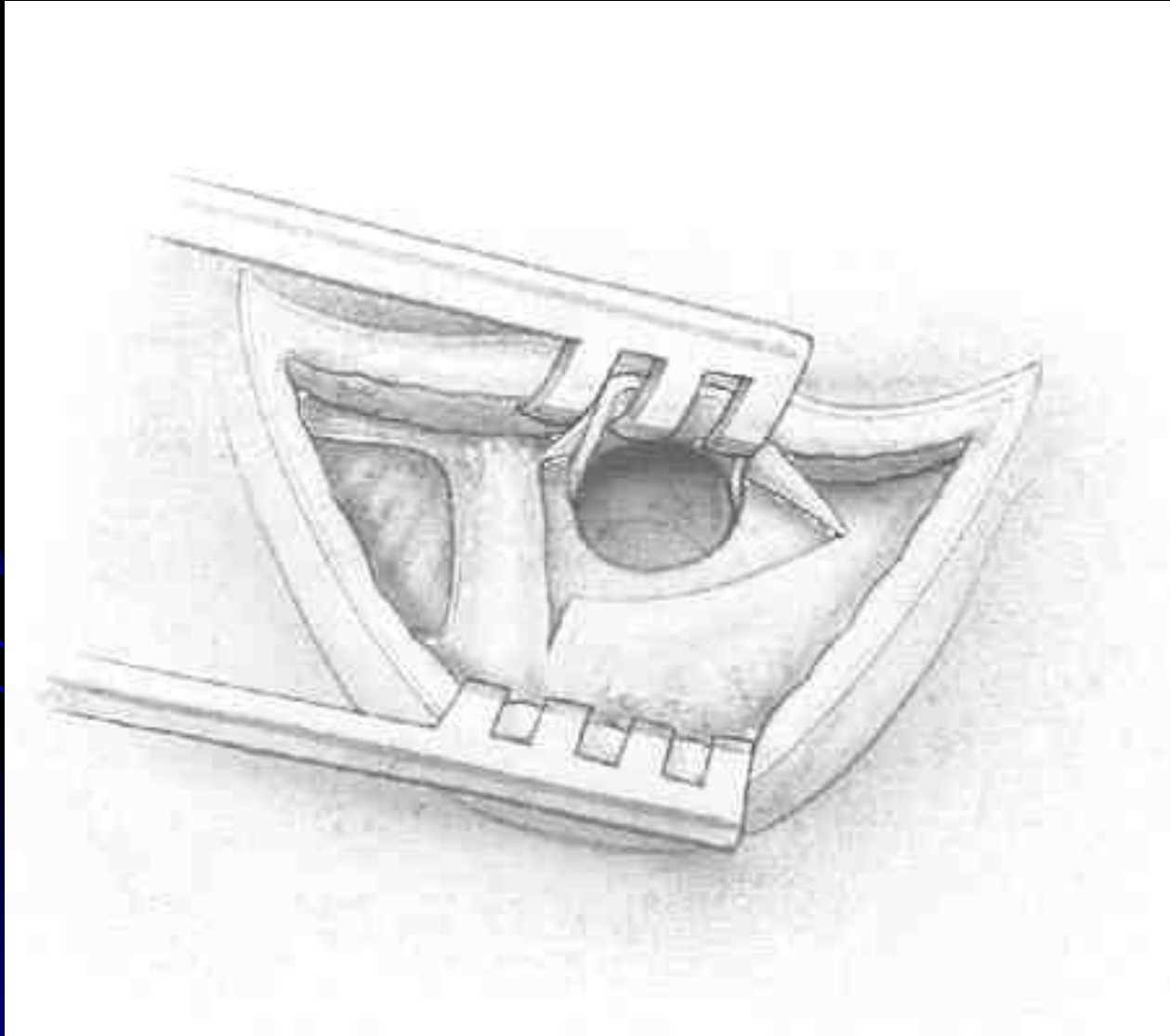
Postauricular incision



Harvest of temporalis Fascia Graft



Elevation of the vascular strip



Lateral Grafting

FIGURE 9-2

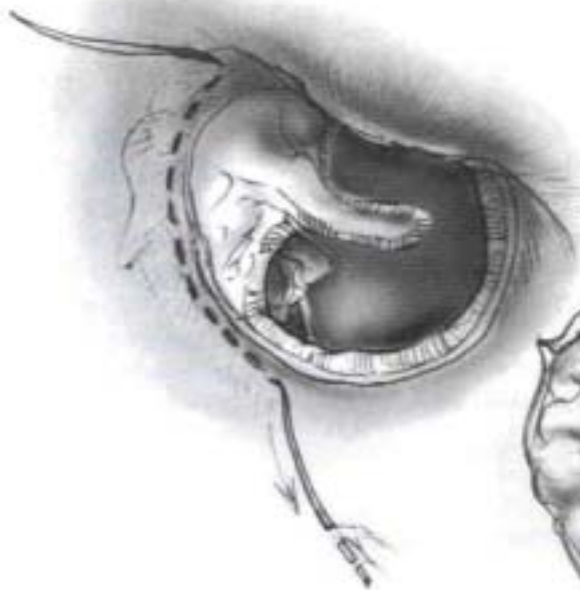
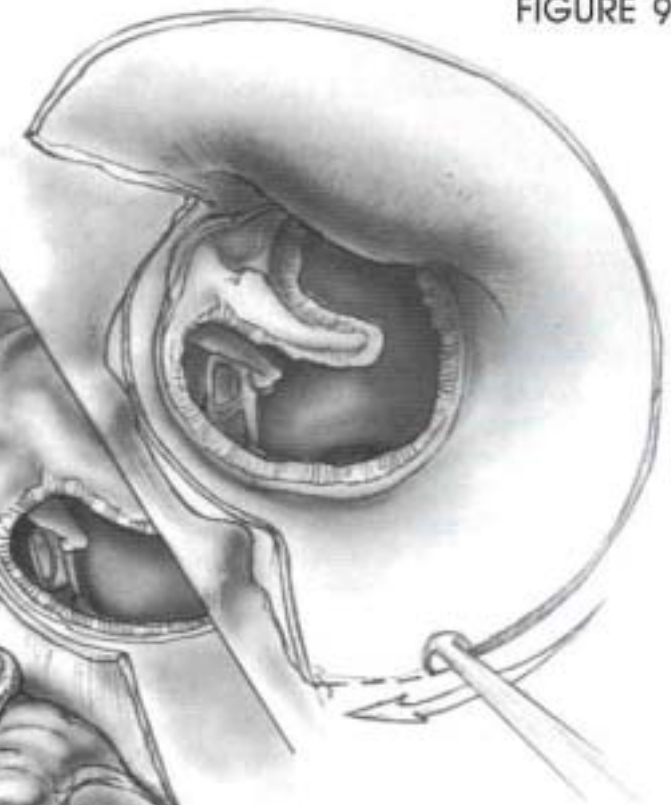


FIGURE 9-3



FIGURE 9-4



Removal of canal and TM skin

Drilling the anterior canal bulge

FIGURE 9-5

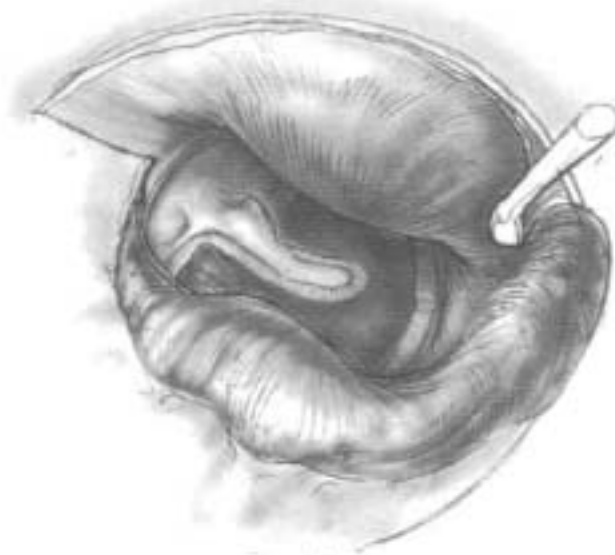


FIGURE 9-6

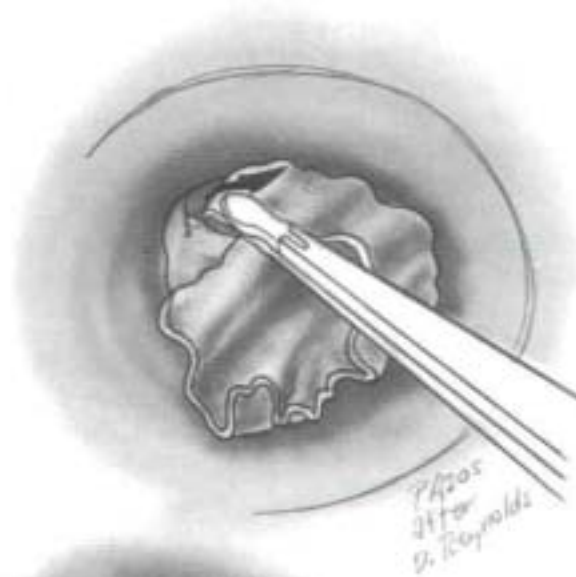


FIGURE 9-7

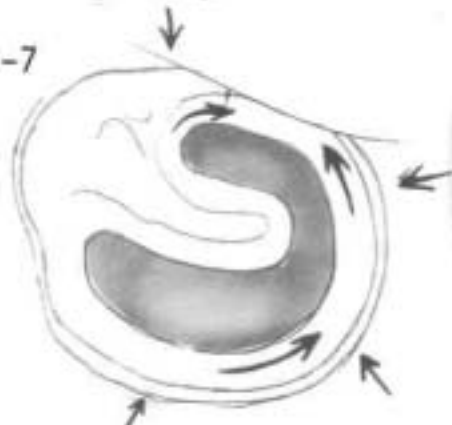
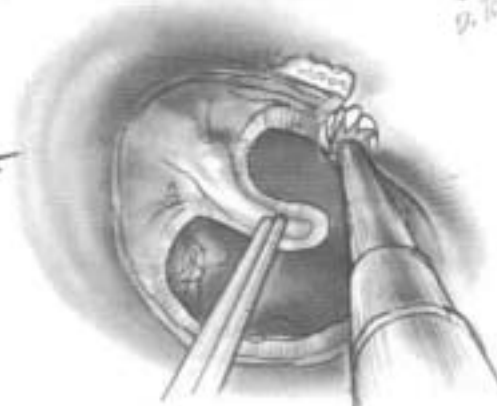
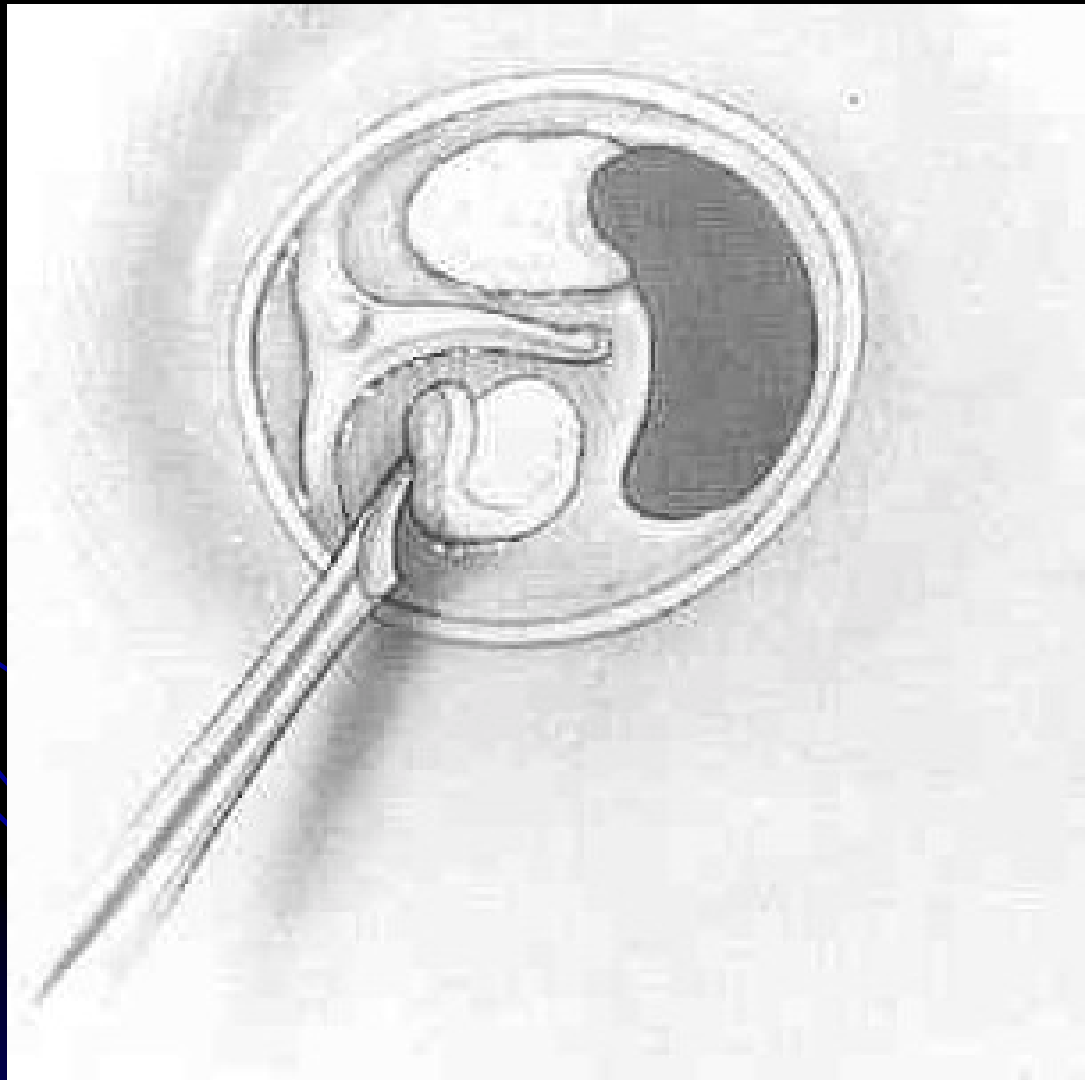


FIGURE 9-8



Ensure complete removal of TM epithelium



Shaping the fascia graft

FIGURE 9-9

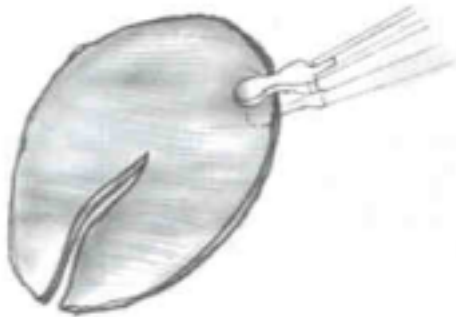


FIGURE 9-10

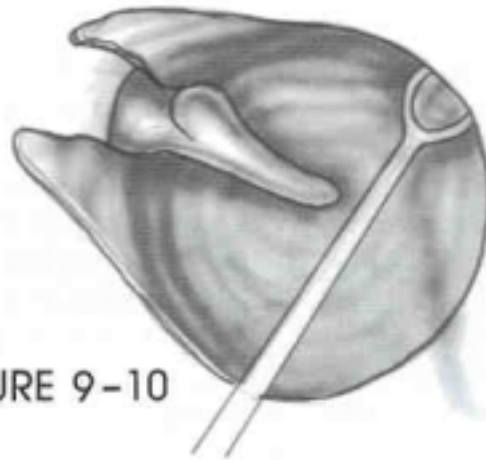


FIGURE 9-11

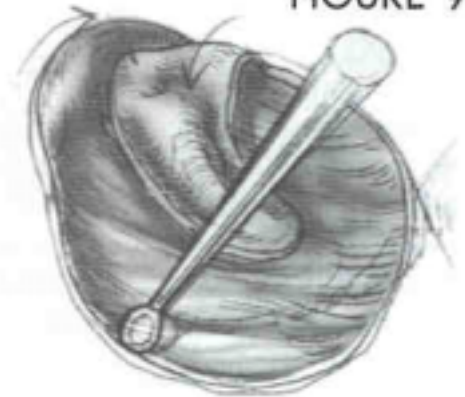


FIGURE 9-13

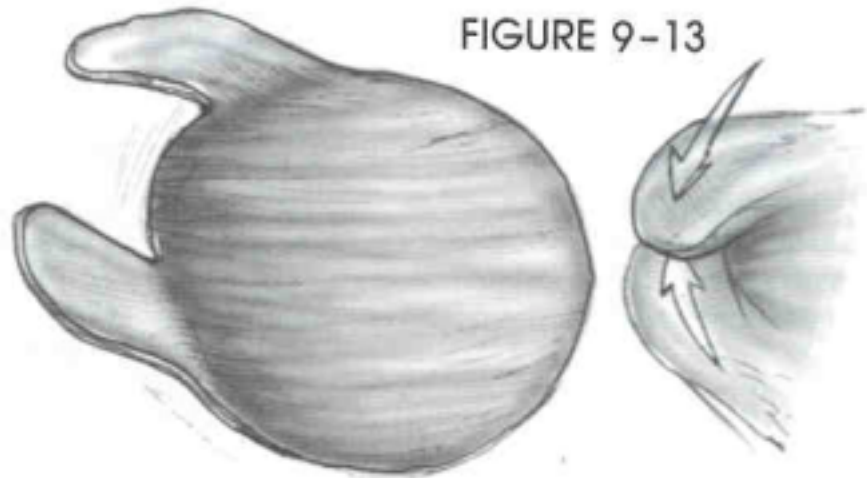
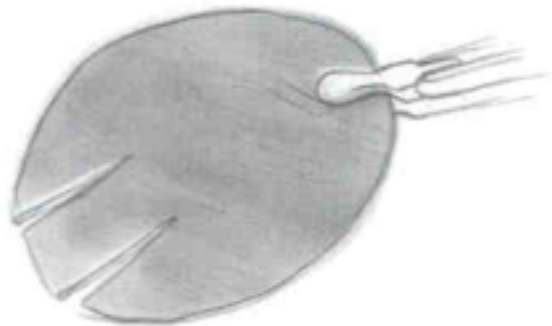
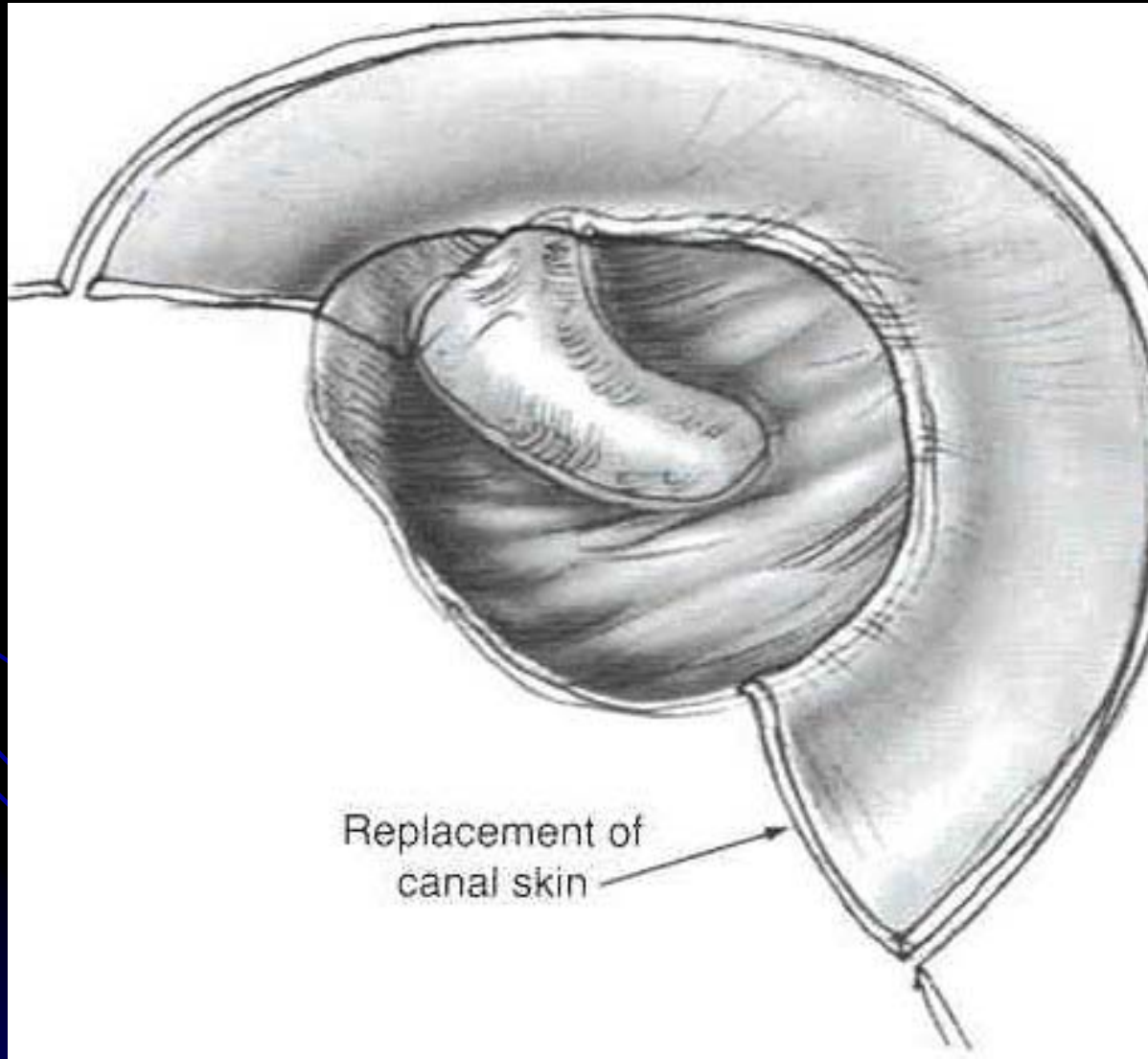


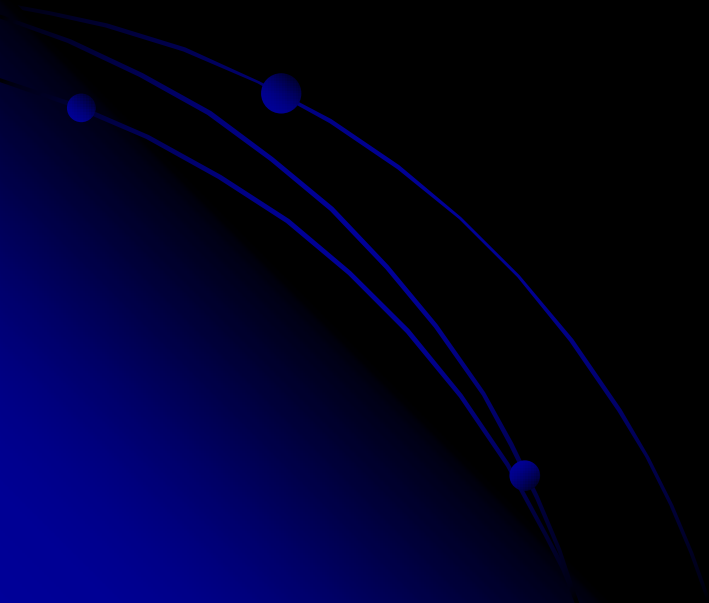
FIGURE 9-12



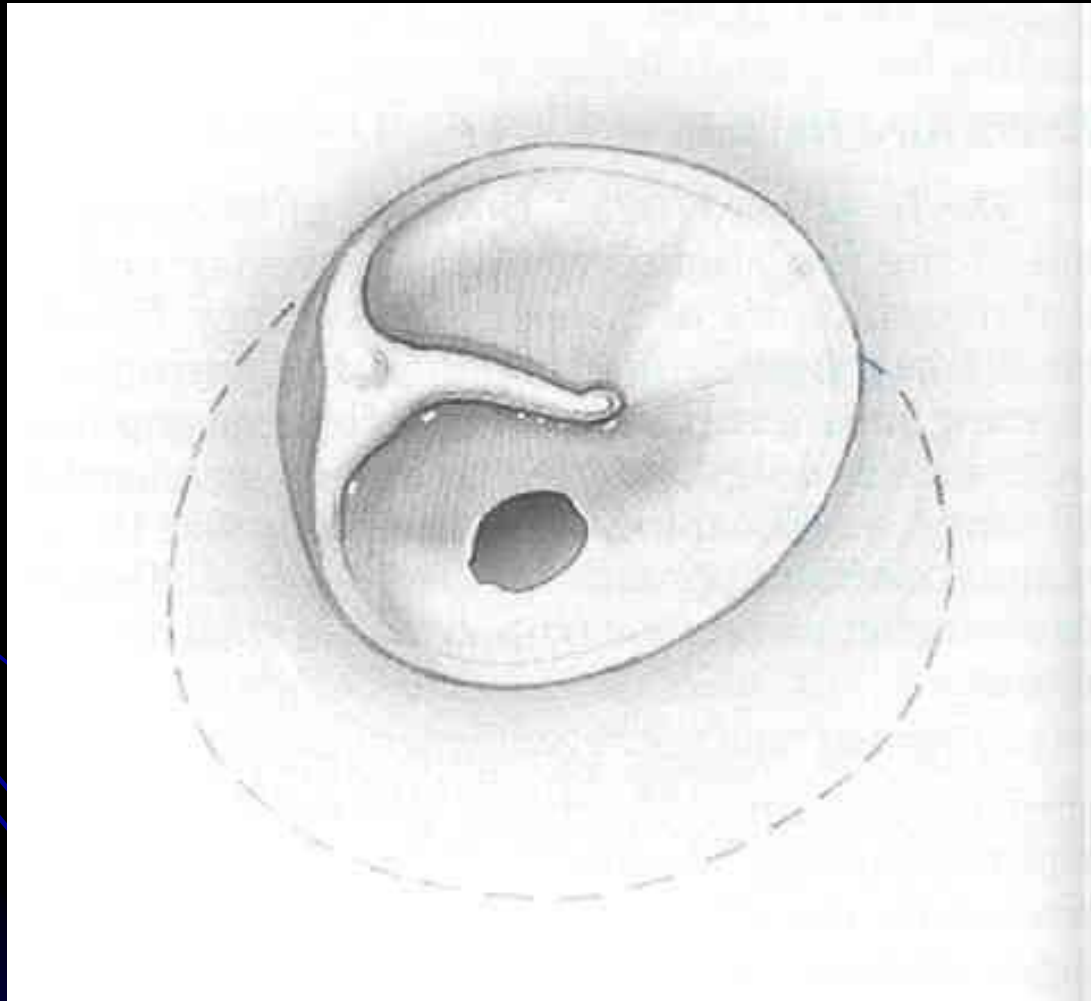
Replacing the canal skin



Medial Grafting

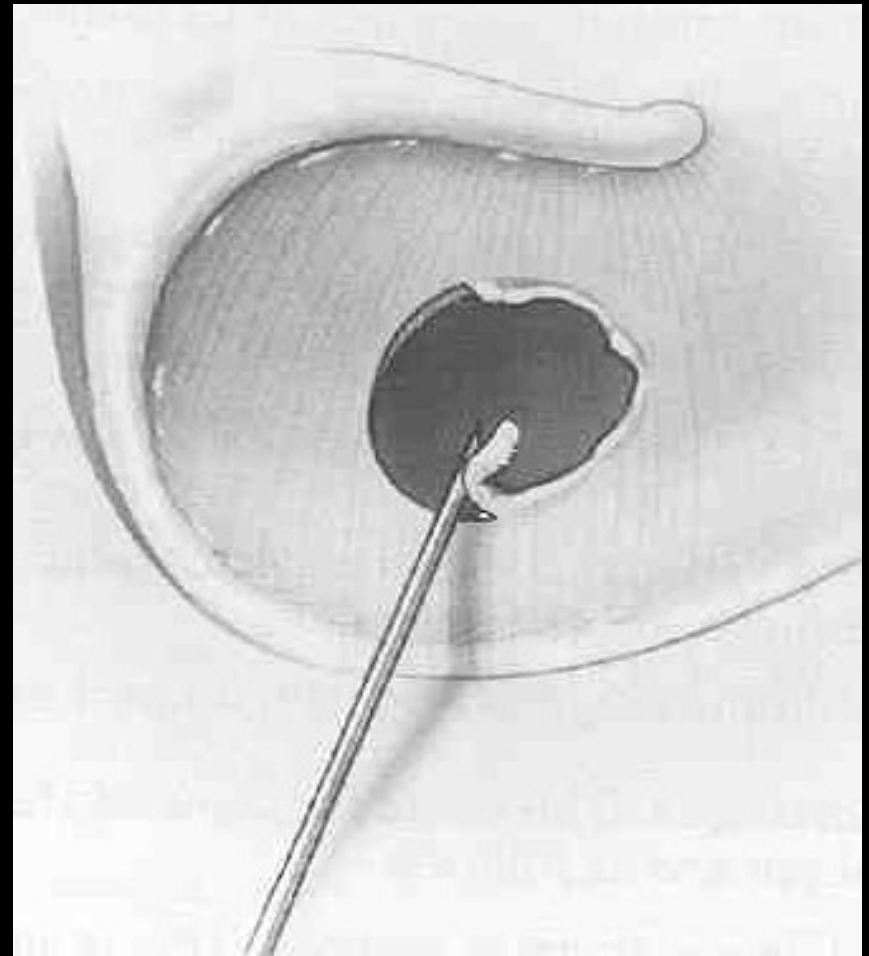


Medial Graft Position



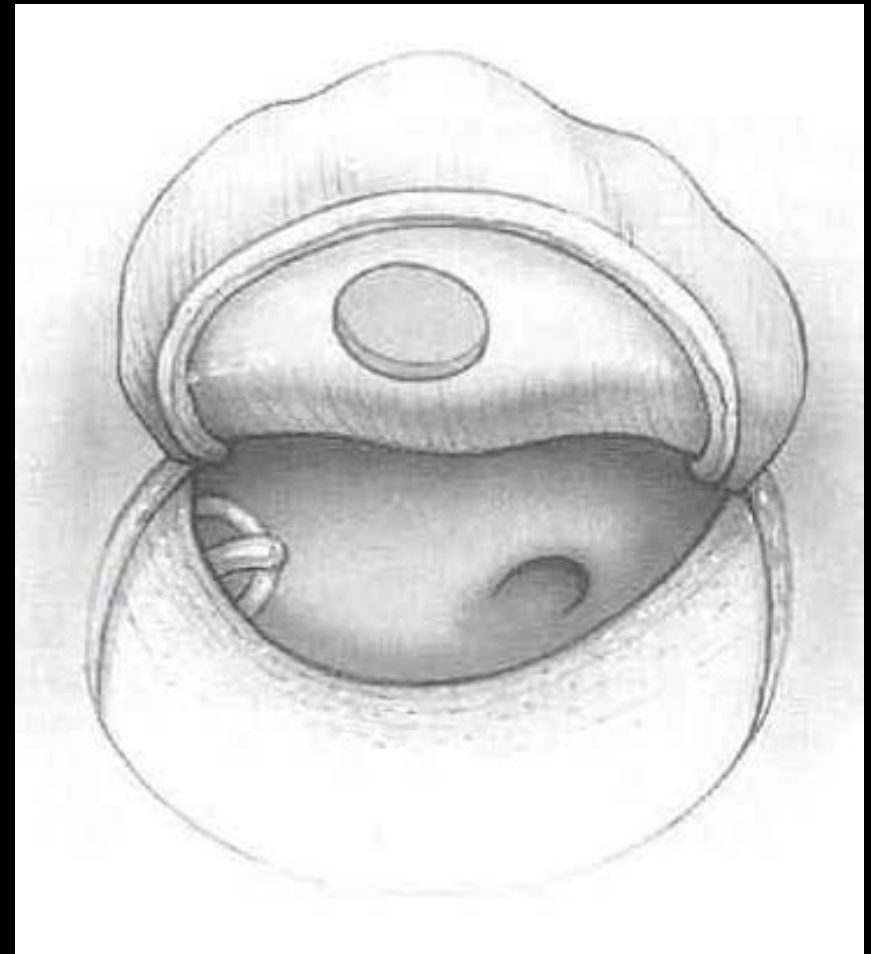
Debride the edges of the perforations

- Purpose
 - Separates the continuity of the inner mucosa with the outer epithelium
 - Disrupts the fistulous tract

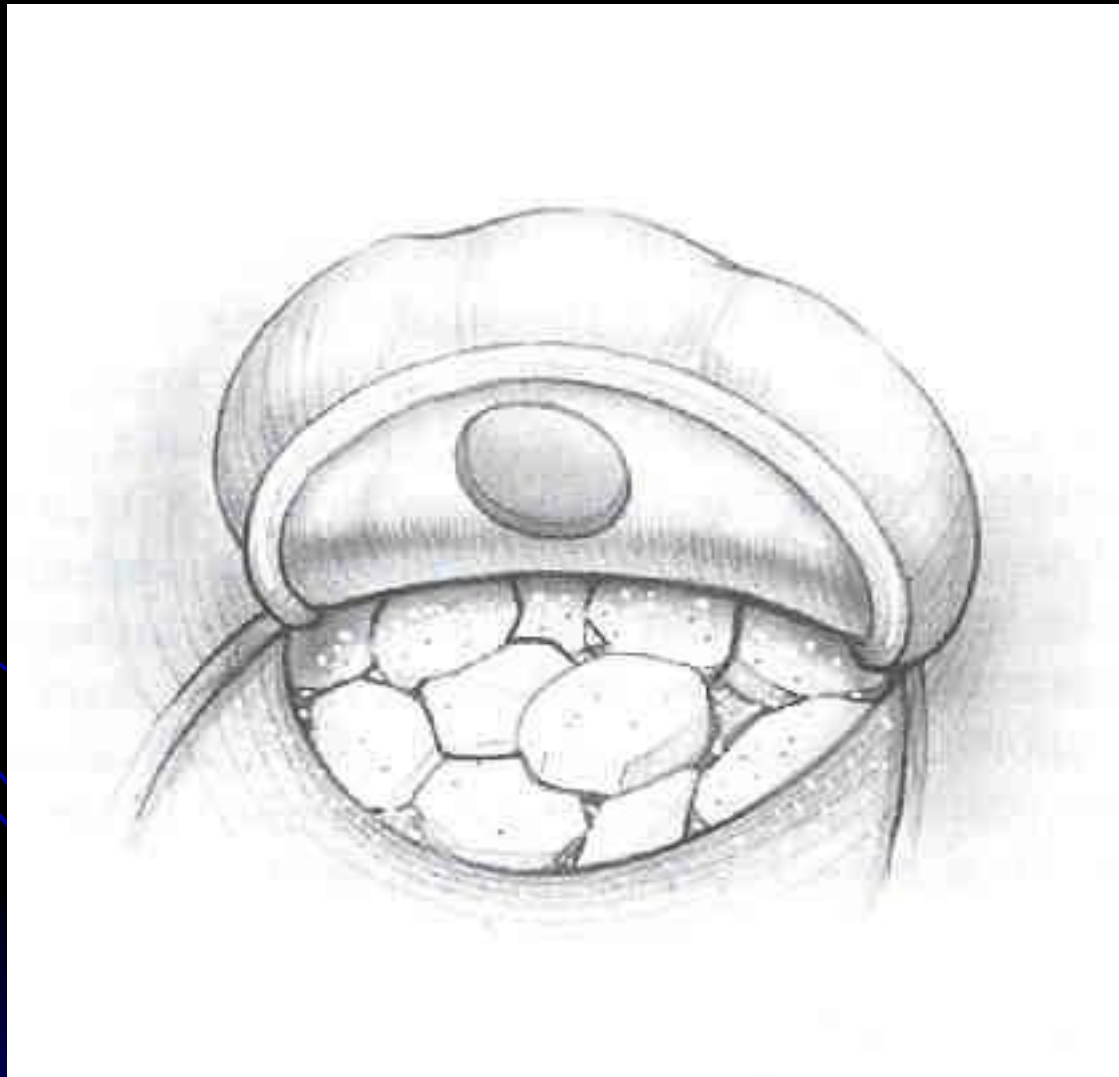


Elevation of the tympanomeatal flap

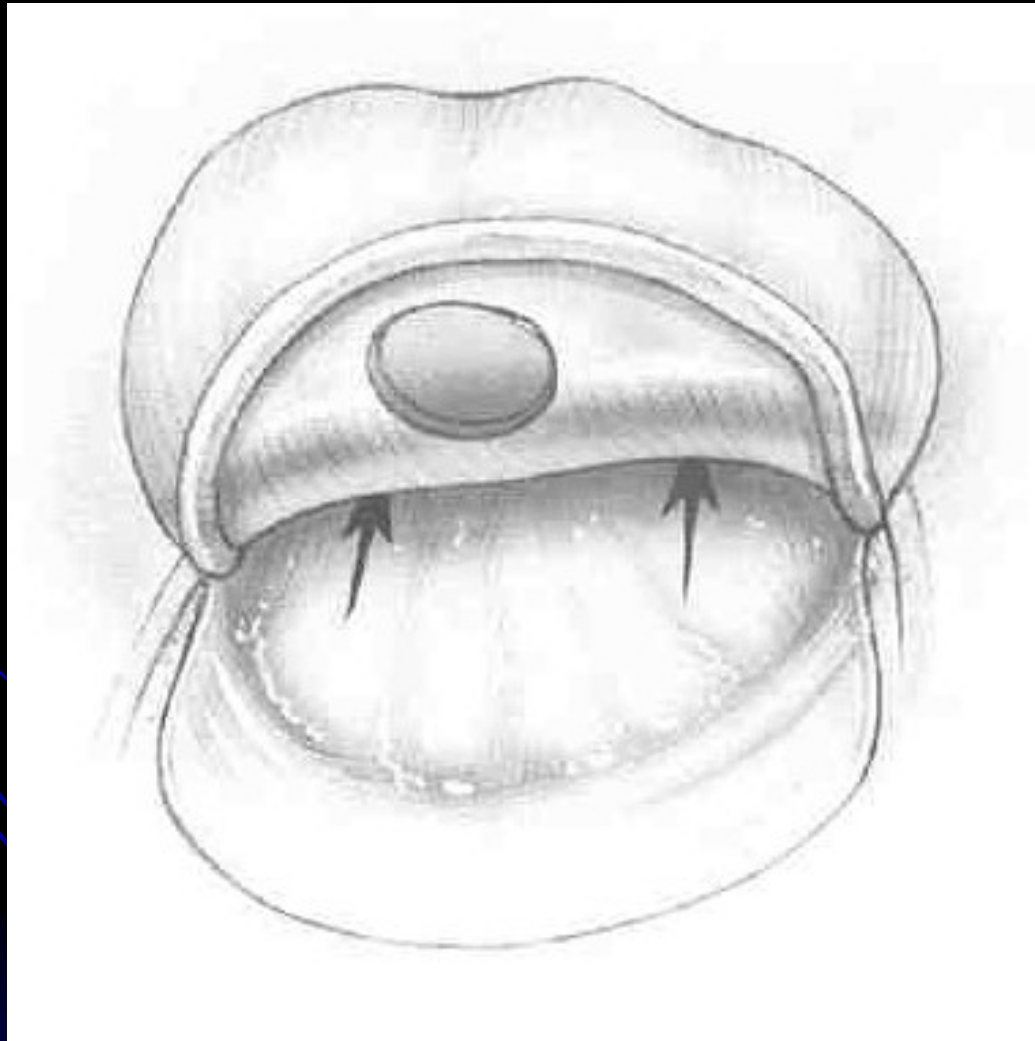
- Inspect the undersurface of the TM for squam
- Inspect the middle ear
 - Ossicles
 - Erosion
 - mobility
 - Round window reflex
 - Eustachian tube



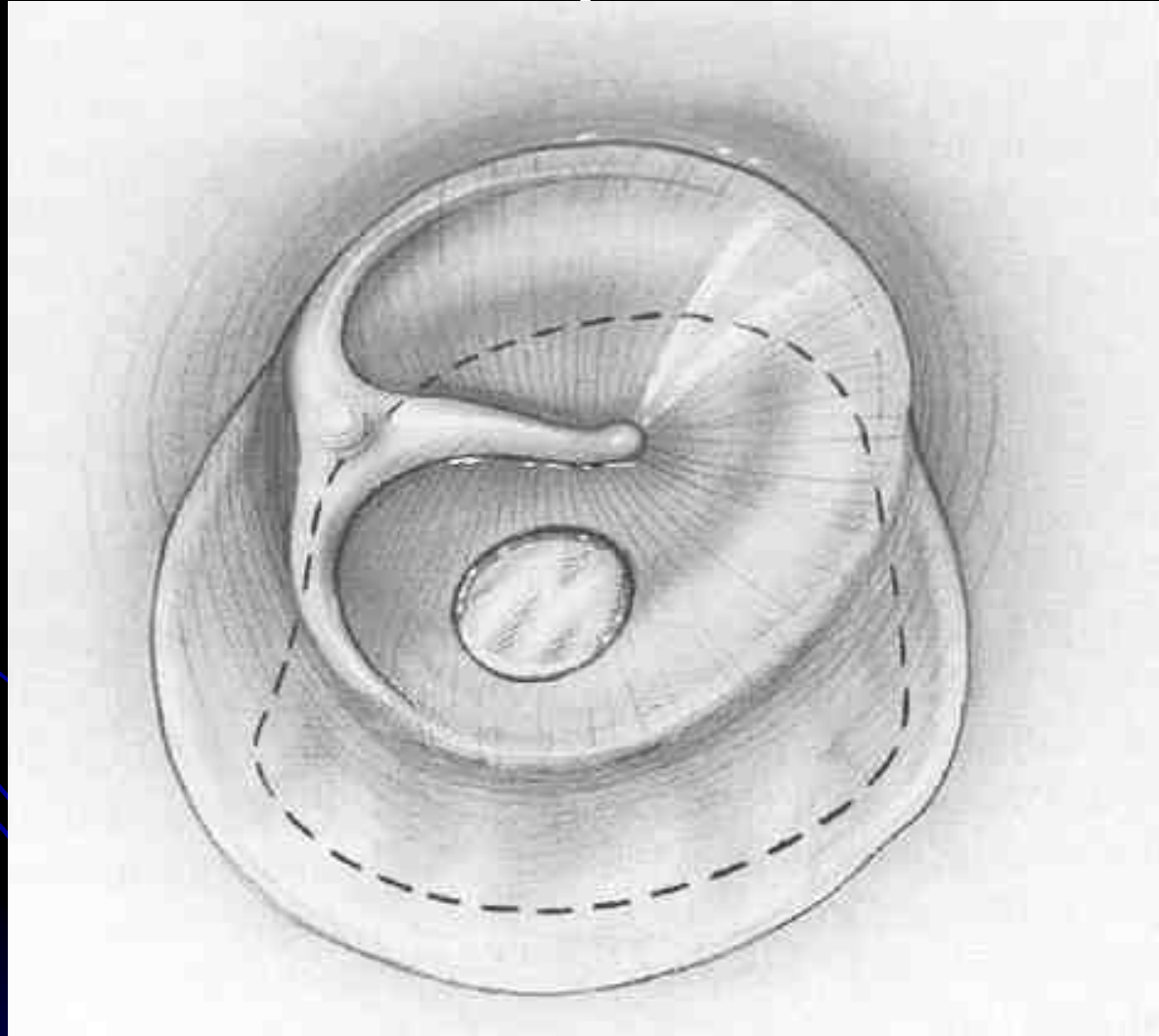
Pack middle ear with gelfoam



Placing medial fascia graft



Replacing the tympanomeatal flap



Medial vs. Lateral Graft Tympanoplasty

Advantages

Disadvantages

Overlay grafting

- Excellent exposure
- High graft take rate
- Applicable to all cases

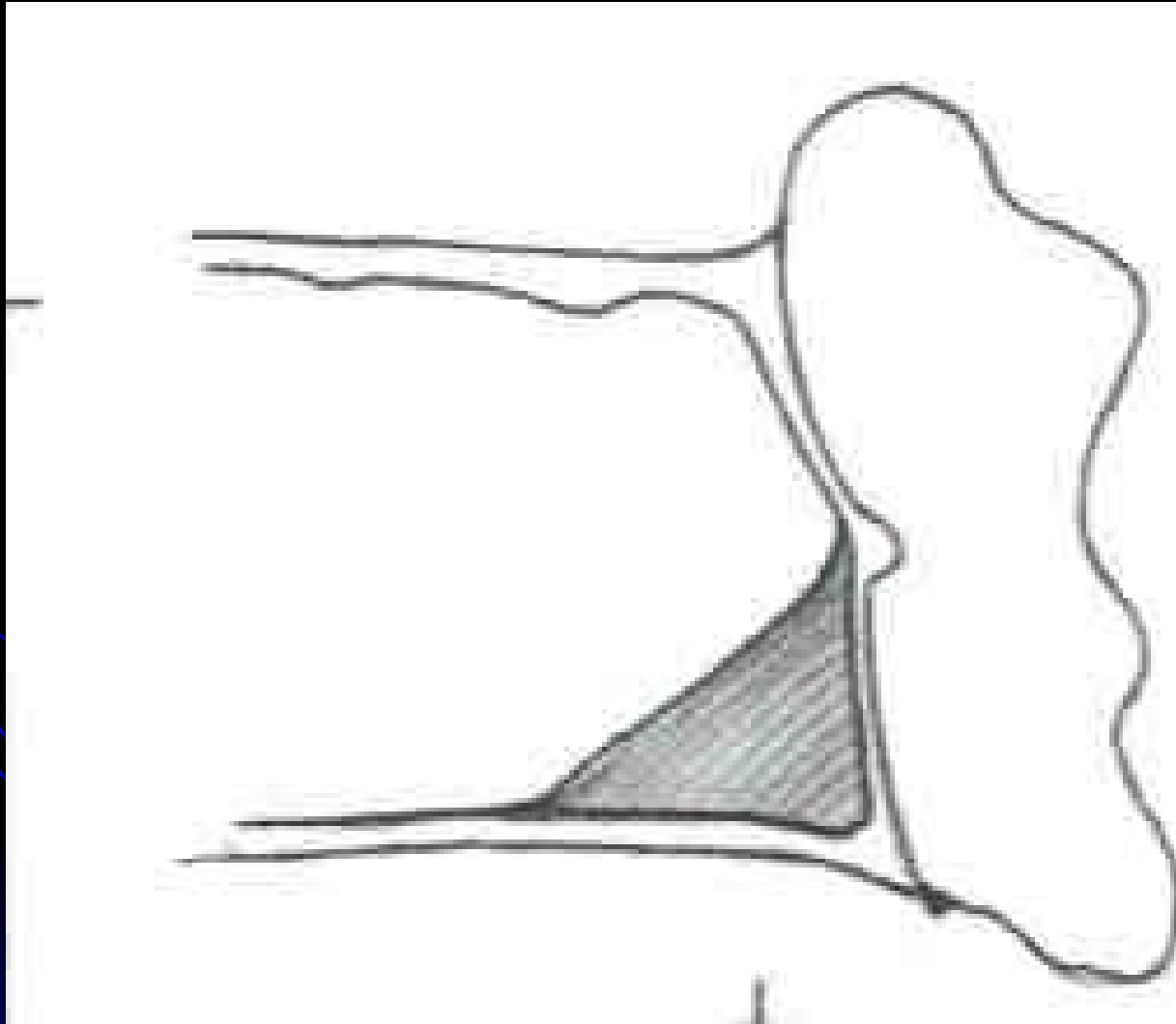
- Requires precision
- Longer healing time (months vs. weeks)
- Possibility of blunting, lateralization, or epithelial pearls

Underlay grafting

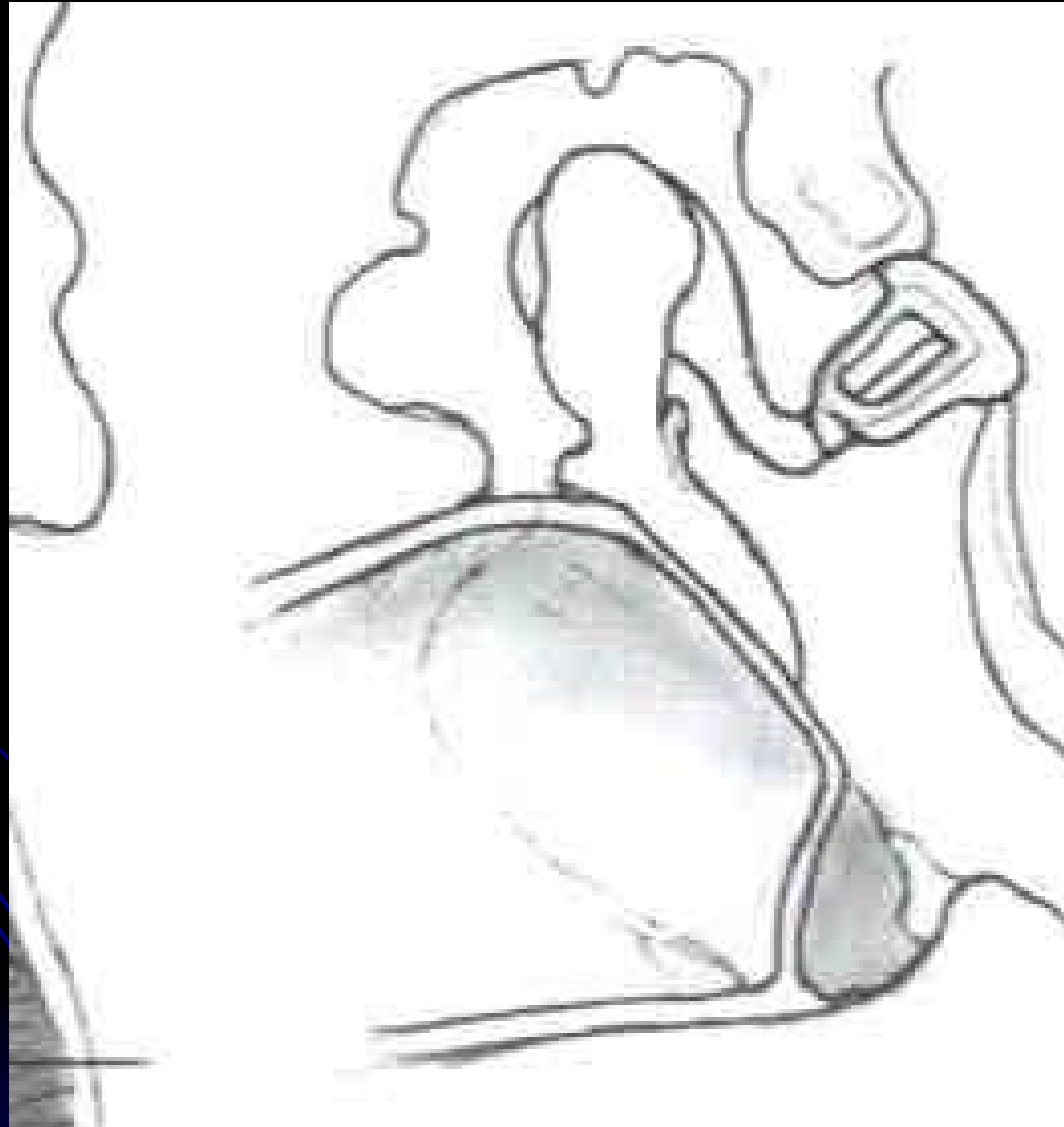
- Less blunting or lateralization
- High graft take rate
- Simpler technique

- Limited visualization
- Large, anterior perforation less suitable
- Difficult with small external auditory canal

Blunting of Annulus



Blunting at Annulus

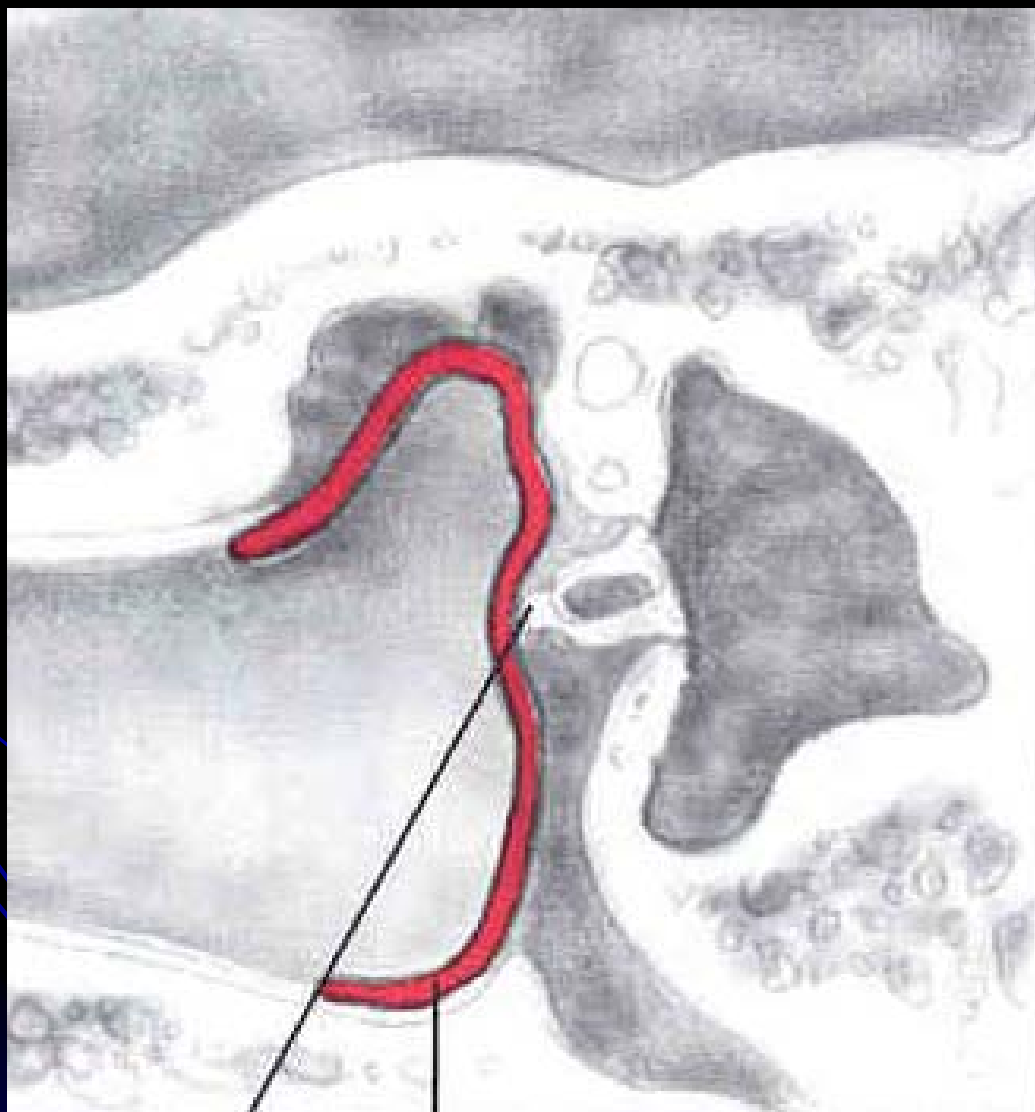


Classification of Tympanoplasty

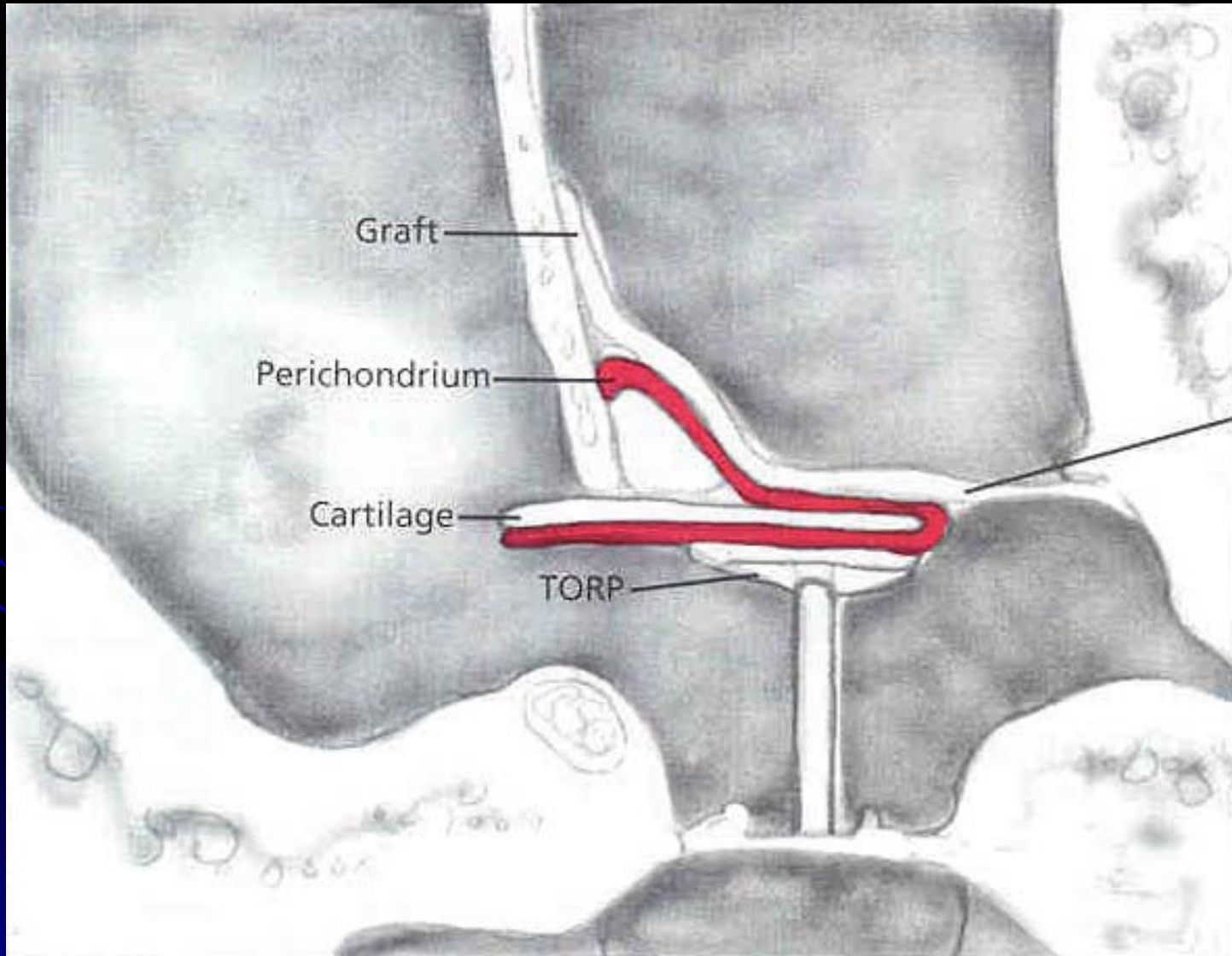
- Wullstein (1956)
 - Type I tympanoplasty
 - TM is grafted to an intact ossicular chain
 - Type II tympanoplasty
 - Malleus is partially eroded
 - TM +/- malleus remnant is grafted to the incus
 - Type III tympanoplasty
 - Malleus and incus are eroded
 - TM is grafted to the stapes suprastructure

- Wullstein classification continued...
 - Type IV tympanoplasty
 - Stapes suprastructure is eroded but foot plate is mobile
 - TM is grafted to a mobile foot plate
 - Type V Tympanoplasty
 - TM is grafted to a fenestration in the horizontal semicircular canal
 - Classification does not take into account middle ear pathology

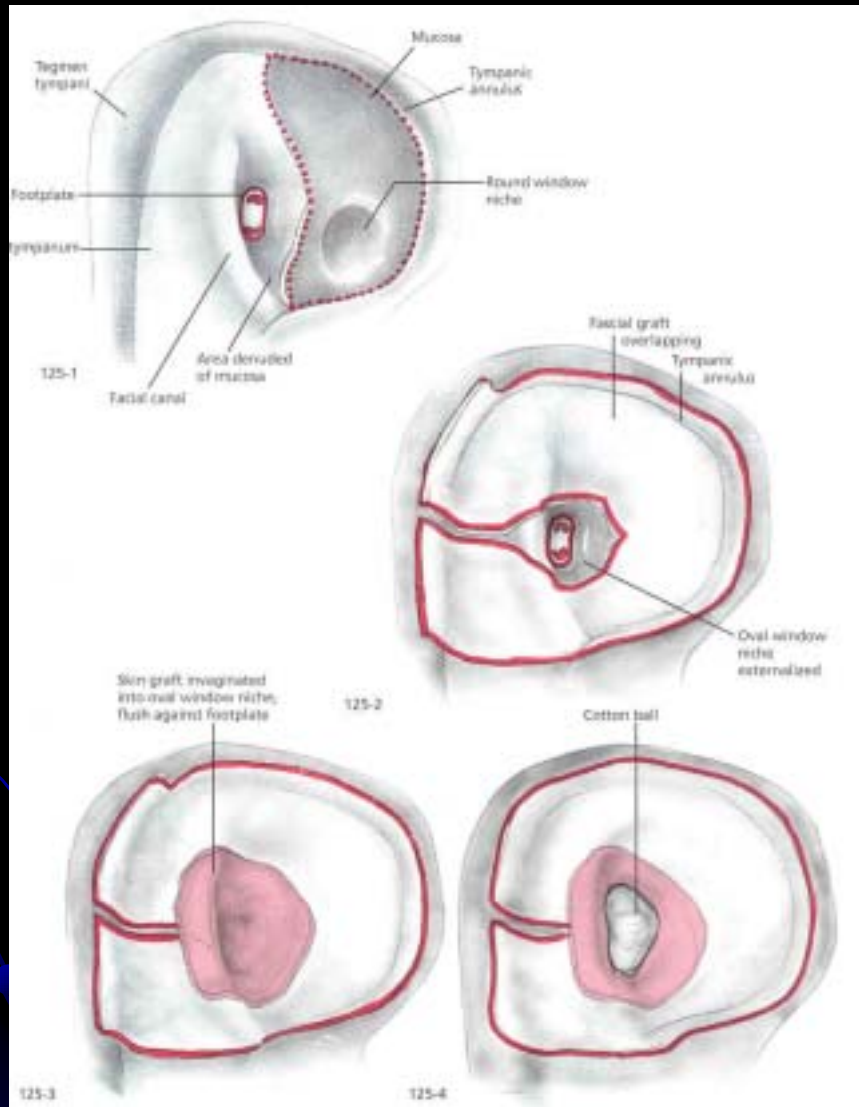
Type III tympanoplasty



TORP using cartilage stiffener



Type IV Tympanopasty



Classification of Tympanoplasty

- Belluci

- Proposed a dual classification
- Added status of middle ear
 - Group I – Dry ear
 - Group II – Occasional drainage
 - Group III – Persistent drainage with mastoiditis
 - Group IV – Persistent drainage and nasopharyngeal malformation (cleft palate and choanal atresia)

Classification of Tympanoplasty

- Austin's classification
 - Describes the residual ossicular remnants
 - (M+/I+/S+) – intact ossicular chain
 - (M+/S+) or (M+/S-) – good prognosis
 - (M-/S+) or (M-/S+) – poor prognosis

● M – malleus

● S – stapes

● I - incus

Postoperative Care

- Day surgery
- Mastoid dressing removed postop day one
- Incisions cleaned bid with H₂O₂ and topical abx
- Patient instructions
 - Avoid nose blowing
 - Sneeze with mouth open
 - Avoid heavy lifting (>10 lbs) or straining
 - Dry ear precautions
- One week staples or steri-strips are removed and ear drops are started
- Three weeks, gelfoam is removed from the EAC
- 2-3 months, postop audiogram is performed

Graft Materials

- FTSG, STSG
 - Initial good results
 - Subsequent desquamation and infection with high delayed failure rate
- Canal skin
 - Similar to STSG
- Vein grafts (Shea)
 - Atrophy

Graft Materials

- Temporalis fascia
 - Hermann (1960) and Storrs (1961)
 - Large quantity
 - No separate incision
 - Sturdy
 - Low metabolic rate
- Homograft TM
 - Excellent success similar to fascia
 - Theoretic risk of infectious disease transmission (prions, HIV)
 - Availability

Cartilage Tympanoplasty

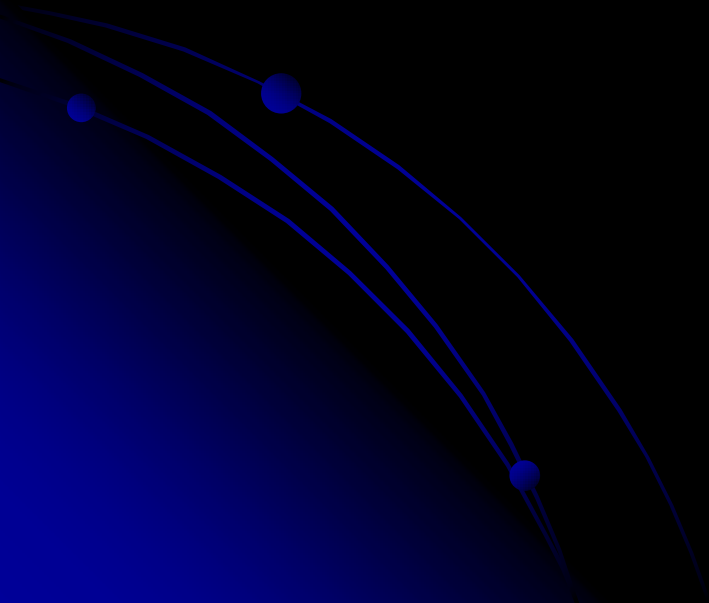
- 1958 – Jansen
 - First used cartilage in the middle ear
- 1963 – Salen and Jansen
 - First reported use of cartilage for reconstruction of the TM
- Excellent for prevention of recurrent retraction pockets
 - Most successful when placed posteriosuperiorly and pars flaccida (Poe and Gadre, 1994)
- Recommended by Vrabec (2002) to be placed over TORP or PORP to prevent extrusion

Cartilage Tympanoplasty

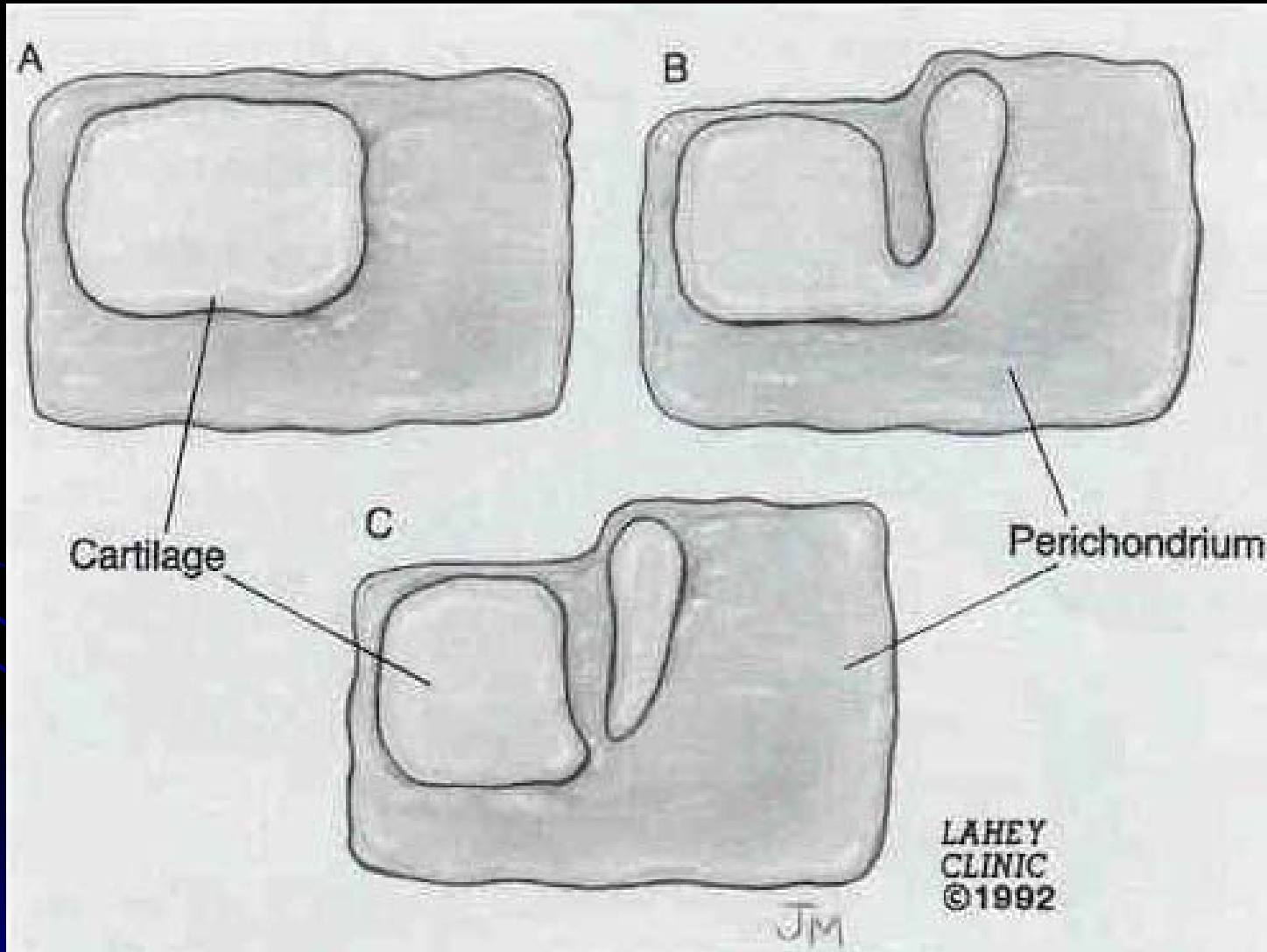
- Results

- Gerber (2000) and Dornhoffer (1997)

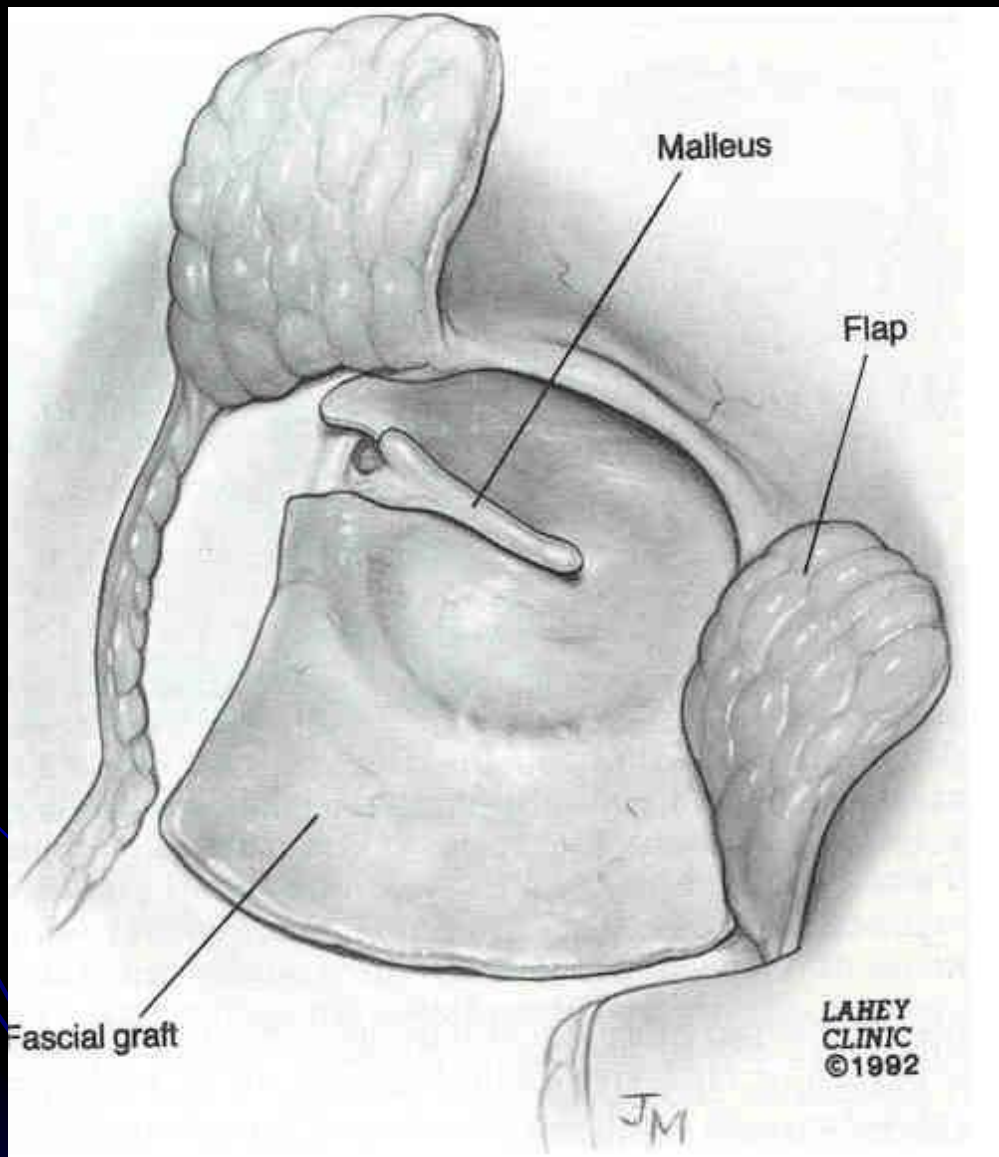
- Hearing results comparable to temporalis fascia and perichondrium even with complete TM reconstruction with cartilage



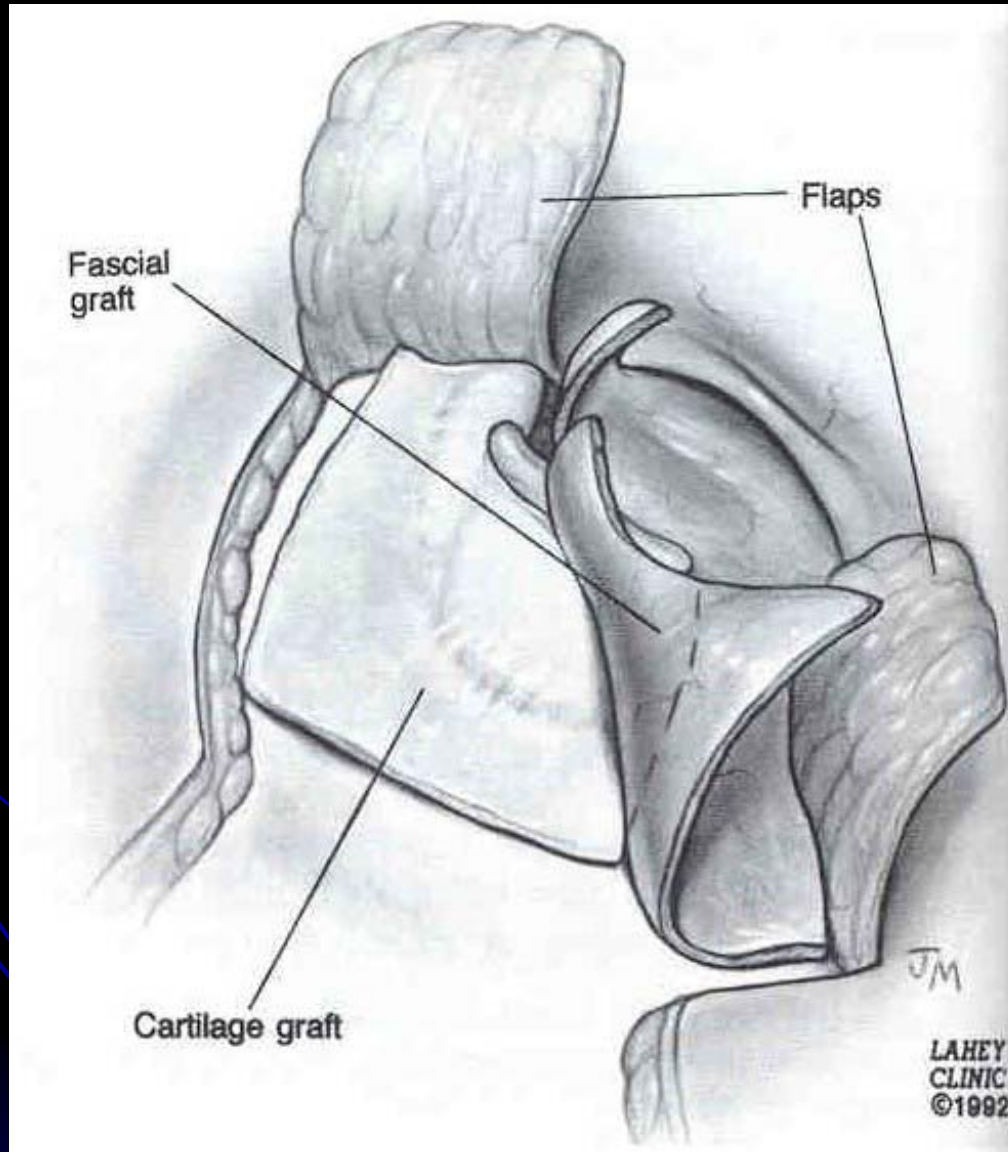
Cartilage Tympanoplasty



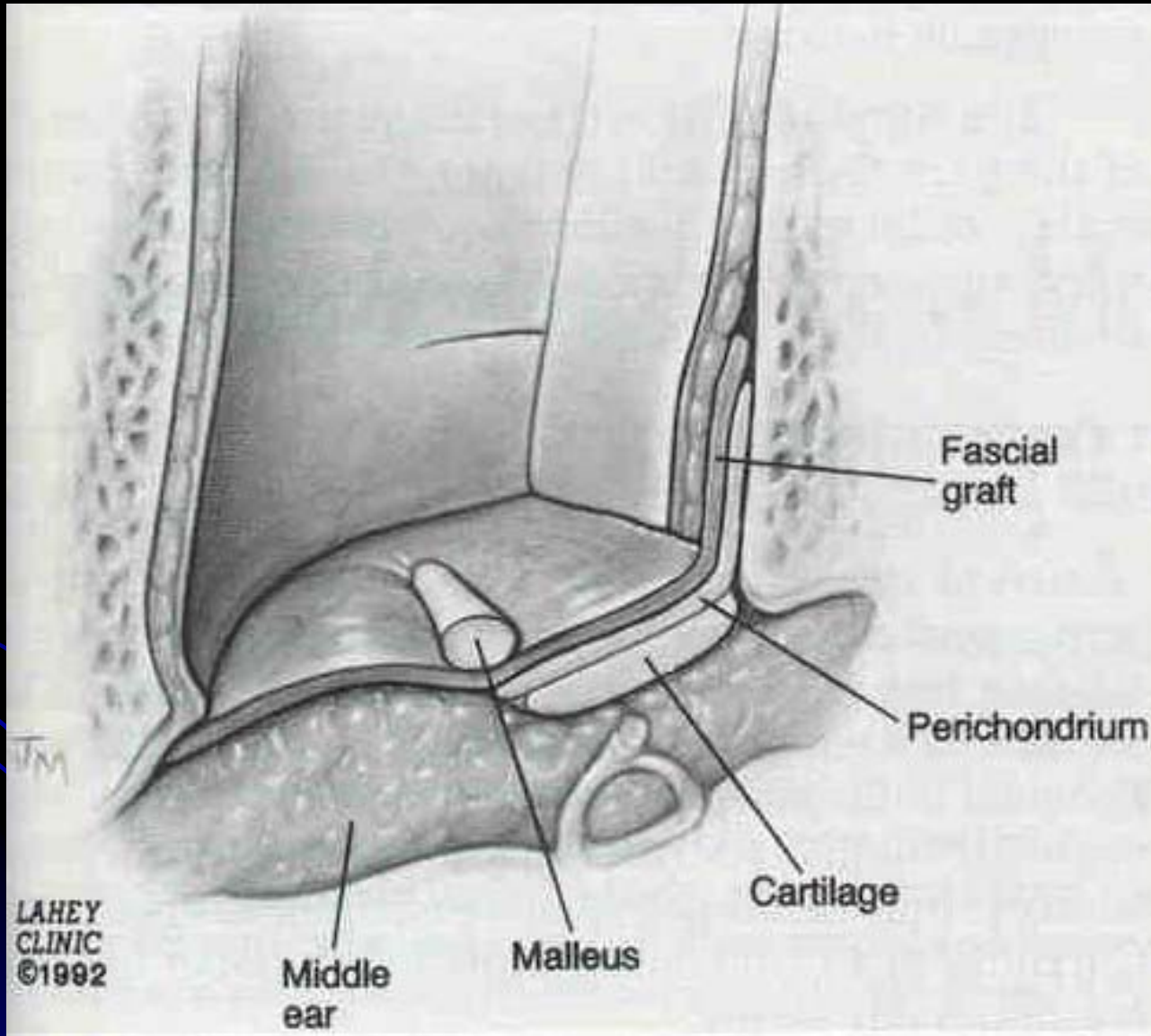
Cartilage Tympanoplasty



Cartilage Tympanoplasty



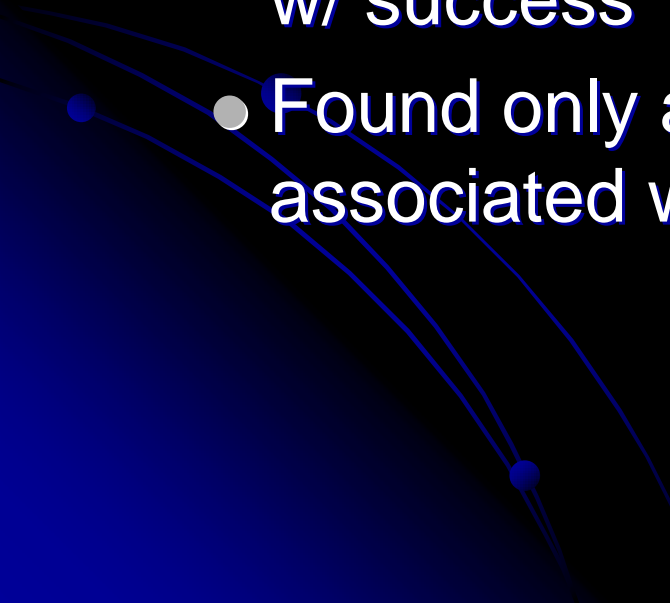
Cartilage Tympanoplasty



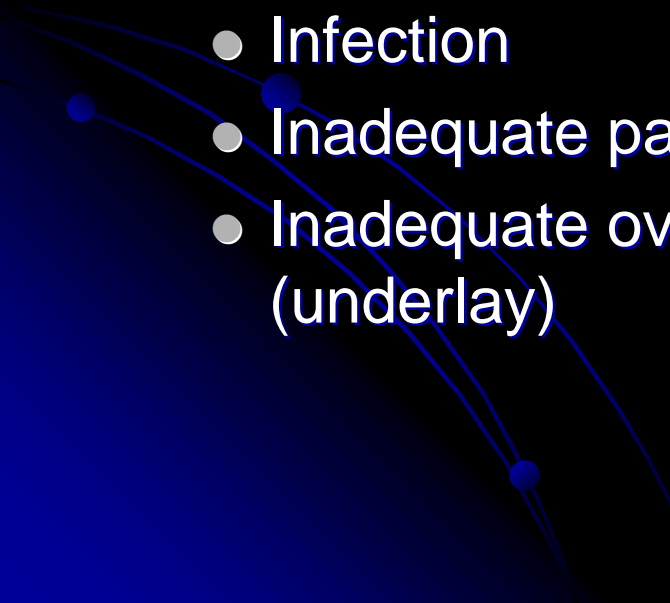
Tympanoplasty in Children

- Controversial
- Considered less successful than adults
 - Higher incidence of ETD and otitis media
- Wide range of success rates
 - 35% to 93%
- Tos and Lau (1989)
 - Found comparable success rates compared to adults for all ages in children (92%)
 - Helps to lessen progression of ossicular pathology

Tympanoplasty in Children

- Manning
 - 78% success
 - Deskin and Vrabec (1999)
 - Meta-analysis of all common variables assoc. w/ success
 - Found only advancing age was statistically associated with improved outcomes.
- 

Complications

- Infection
 - Poor aseptic technique
 - Prior contamination
 - Graft failure is associated with postop infection
 - Graft failure
 - Infection
 - Inadequate packing (anterior mesotympanum)
 - Inadequate overlay of graft with TM remnant (underlay)
- 

Complications

- Chondritis
- Injury to the chorda tympani nerve
- SNHL and vertigo
 - Excessive manipulation of the ossicles
- Increased conductive hearing loss
 - Unrecognized eroded ISJ
 - Blunting
 - Thick graft extending onto the anterior canal wall in lateral grafting
 - Lateralization of the TM from the malleus handle
- External auditory canal stenosis
 - Lateral grafting

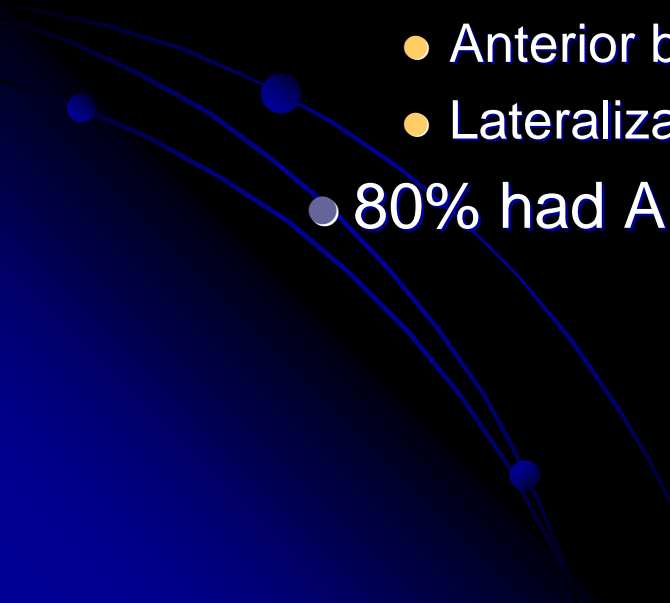
Results – *closure of perforations*

- 1992 – Smyth (Toynbee Memorial Lecture)
 - Stated that most series report 90% success
 - Majority of studies have only one year f/u
 - Most do not report atelectatic pockets
- Halik and Smyth
 - 60% success in revision cases
 - Found improved results in patients with dry ears
 - Similar success with temporalis fascia versus homograft
 - Worse results with anterior perforations
 - Recommend using fascia
 - Anterior TM is less vascular
 - Fascia less susceptible to anoxia and is less antigenic than homograft

Results – *hearing*

- Albu et al.
 - Three most important prognostic indicators
 - Status of the middle is the most important predictive factor
 - Presence of the handle of the malleus
 - Perforations > 50%
- Halik and Smyth
 - 80% success rate closing ABG to within 10 dB at 5 years

Results – *overlay grafting*

- Sheehy and Anderson (1980)
 - Compared 472 overlay
 - 97% success with fascia grafts
 - 84% success with canal skin
 - 1.3% complication rate
 - Anterior blunting
 - Lateralization
 - 80% had ABG within 10 dB
- 

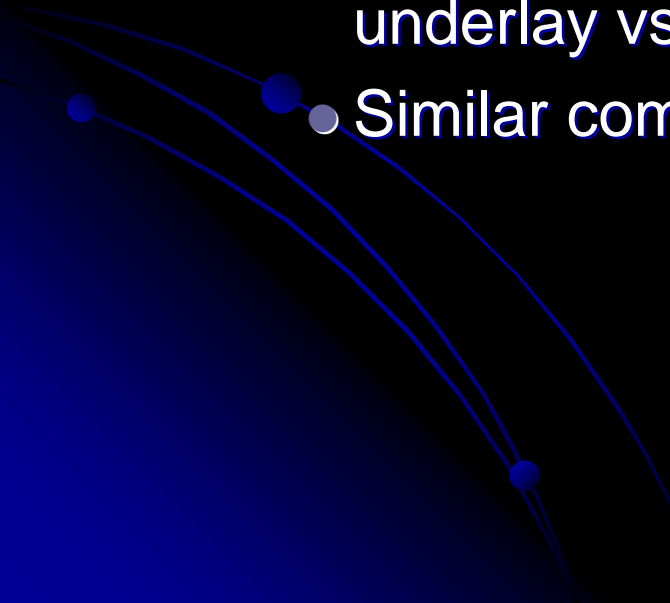
Results – *overlay vs. underlay*

- Doyle et al. (1972)
 - Compared 52 overlay to 79 underlay at a teaching institution
 - Overlay
 - 36% re-perforation
 - 27% with hearing improvement (15db ABG or better)
 - Underlay
 - 14% re-perforation
 - 62% hearing improvement
 - > complication rate with overlay group

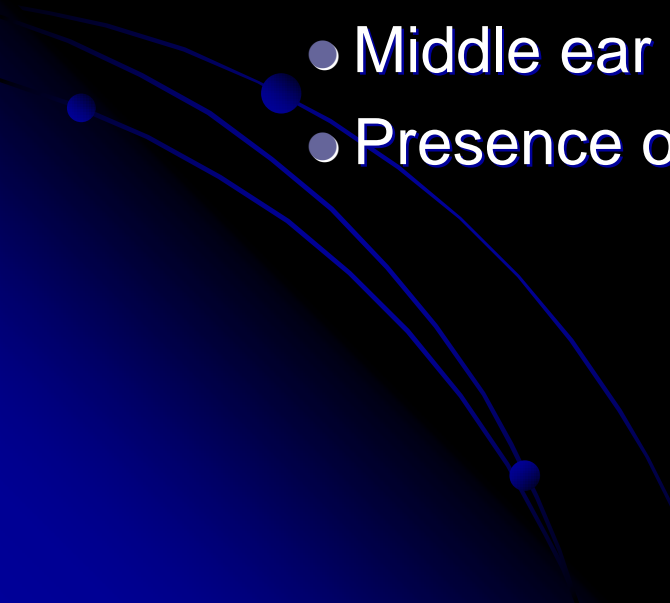
Results – *overlay vs. underlay*

- Doyle et al. (1972)
 - Conclusions
 - In experienced hands either technique can be equally successful
 - Residents and otolaryngologist of limited experience
 - Medial grafting gives better healing and fewer complications
 - All cases utilized endaural approach with is more technically demanding

Results – *overlay vs. underlay*

- Rizer (1997)
 - Compared 551 underlay to 158 overlay
 - Closure in 88.8% of underlay versus 95.6% of overlay
 - Closure of ABG to 10 dB or less in 84.9% of underlay vs. 80.4% of overlay
 - Similar complication rates
- 

Results – *overlay vs. underlay*

- Rizer (1997)
 - Both groups – no relationship in re-perforation with:
 - Age of patient
 - Perforation size or location
 - Middle ear status
 - Presence of cholesteatoma
- 

Conclusion

- Tympanoplasty has a high rate of success in closing tympanic membrane perforations and improving hearing
- Patients should be chosen carefully based on the indications discussed and attempts at attaining a dry ear prior to surgery should be made
- Patients should be thoroughly counseled preoperatively about the expectations and goals of the surgery
- Tympanoplasty in the pediatric age group is controversial
- Both underlay and overlay techniques for grafting are effective, however, the surgeon should do what he/she is most experienced and successful with