Complications of Stapes Surgery

Garrett Hauptman, MD
Faculty Advisor: Tomoko Makishima, MD, PhD
The University of Texas Medical Branch
Department of Otolaryngology
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Overview

- History of stapes surgery
- Causes of stapes fixation
- Review of otosclerosis
- Patient evaluation
- Stapes surgical technique
- Complications of stapes surgery
  - Intraoperative
  - Post-operative
History of Stapes Surgery

- **Samuel Rosen**
  - 1953 – first suggest mobilization of the stapes
    - Immediately improved hearing
    - Problem with re-fixation
History of Stapes Surgery

- John Shea
  - 1956 – first to perform stapedectomy
    - Oval window vein graft
    - Nylon prosthesis from incus to oval window
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Causes of Stapes Fixation

- **Otosclerosis**
  - ≥ 95% of stapes surgery

- **Congenital stapes fixation**
  - Hearing outcomes worse with stapes surgery compared to otosclerosis
    - Groups stratified into ABG < 10 db and ABG < 20 dB

- **Tympanosclerosis**
  - Hearing outcomes worse with stapes surgery compared to otosclerosis
    - Mobilization through plaque removal –vs- stapedotomy
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Otosclerosis

- Bone disease only seen in otic capsule
- Causes progressive hearing loss
  - Conductive- primarily stapes involvement
  - Sensorineural- cochlear involvement
  - Mixed
Epidemiology

- 10% overall prevalence of histologic otosclerosis
- 1% overall prevalence of clinically significant otosclerosis
- Bilaterality more common
# Epidemiology

<table>
<thead>
<tr>
<th>Race</th>
<th>Incidence of otosclerosis</th>
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<tr>
<td>Caucasian</td>
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<tr>
<td>Asian</td>
<td>5%</td>
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<td>African American</td>
<td>1%</td>
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<td>Native American</td>
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Epidemiology

- **Gender**
  - Histologic otosclerosis – 1:1 ratio
  - Clinical otosclerosis – 2:1 (W:M)
    - Possible progression during pregnancy (10%-17%)
      - Studies demonstrating changes during pregnancy usually retrospective or lack audiometric data
      - Studies comparing multigravid –vs- nulligravid women with otosclerosis fail to show audiometric differences
Epidemiology

- **Age**
  - 15-45 most common age range of presentation
  - Youngest presentation 7 years
  - Oldest presentation 50s
  - 0.6% of individuals < 5 years old have foci of otosclerosis
Pathophysiology of Otosclerosis

- Osseous dyscrasia
  - Resorption and formation of new bone
  - Limited to the temporal bone and ossicles
  - Inciting event unknown
    - Hereditary, endocrine, metabolic, infectious, vascular, autoimmune, hormonal
Pathology

Two phases of disease

- Active (otospongiosis phase)
  - Osteocytes, histiocytes, osteoblasts
  - Active resorption of bone
  - Dilation of vessels
    - Schwartzze’s sign

- Mature (sclerotic phase)
  - Deposition of new bone (sclerotic and less dense than normal bone)
Pathology

- Most common sites of involvement
  - Fissula ante fenestrum
  - Round window niche (30%-50% of cases)
  - Anterior wall of the IAC
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Patient Evaluation

- History
  - Gradual onset with slow progression over several years
  - Typically presents during late teens or twenties
  - 70% are bilateral
  - Family history usually positive
Patient Evaluation

- **Physical examination**
  - **Otoscopy (often with the operating microscope)**
    - look for Schwartze sign: red blush over the promontory or area anterior to oval window
  - **Pneumo-otoscopy**
    - evaluates for middle ear effusion or small perforation
  - **Tuning fork exam**
    - may confirm or dispute finding of conductive hearing loss on audiometry
Patient Evaluation

- **Audiometry**
  - **Standard audiometry**
    - Air conduction
    - Bone conduction
    - Speech audiometry
  - **Immittance audiometry**
    - Tympanometry- lower peak than normal (As)
    - Static compliance
    - Acoustic reflexes- absent in advanced disease
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Stapes Surgery

- Informed consent
  - Total sensorineural hearing loss occurs 0.2% of cases
    - Less than 2% chance of further hearing loss
  - Dizziness may occur post-operatively
    - Usually transient and brief
    - May persist for short time
    - Rarely could be permanent
  - Possible facial paralysis/palsy
  - Tinnitus
  - Recurrent conductive hearing loss
Middle Ear Examination

- Mobility of ossicles
  - Confirm stapes fixation
  - Evaluate for malleus or incus fixation

- Abnormal anatomy
  - Dehiscent/overhanging facial nerve
  - Deep narrow oval window niche
  - Ossicular abnormalities
Stapedectomy – vs – Stapedotomy

**Stapedectomy**

- **Uses**
  - Extensive fixation of the footplate
  - Floating footplate

- **Disadvantages**
  - Increased post-op vestibular symptoms
  - More technically difficult
  - Increased potential for prosthesis migration

**Stapedotomy**

- **Originally for obliterated or solid footplates**
  - Europe
  - 1970-80

- **First laser stapedotomy performed by Perkins (1978)**
  - Less trauma to the vestibule
  - Less incidence of prosthesis migration
  - Less fixation of prosthesis by scar tissue
Stapedotomy

- **Microdrill**
  - 0.7mm diamond burr
    - Motion of the burr removes bone dust
    - Minimizes smoke production/surrounding heat production

- **Laser**
  - Avoids manipulation of the footplate
  - Argon and Potassium titanyl phosphate (KTP/532)
    - Wave length 500 nm
    - Visible light
    - Absorbed by hemoglobin
    - Surgical and aiming beam
  - **Carbon dioxide (CO2)**
    - 10,000 nm
    - Not in visible light range
    - Surgical beam only
      - Requires separate laser for an aiming beam (red helium-neon)
Stapedectomy – vs - Stapedotomy

- ABG closure < 10dB (PTA)
Sequence of Stapes Surgery

- Retrospective review
  - 376 patients
  - 420 stapedotomies

- Measured incidence of:
  - Incus subluxation
  - Floating footplate

- Results
  - Footplate perforation before stapes arch removal ↓ risk of floating footplate
  - Incus subluxation ↓ when prosthesis placed prior to stapes arch removal

Classic Stapes Surgery Approach

1. Stapes superstructure removed
2. Fenestration of footplate
3. Prosthesis placement
Modified Stapes Surgical Approach

1. Fenestration of footplate
2. Stapes superstructure removal
3. Prosthesis placement
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Problems During Stapes Surgery

Exposed overhanging facial nerve

- Occurs ~9% of stapes procedures
- May block footplate access making completion impossible
- Prosthesis touching facial nerve generally does not create problem
  - May displace nerve superiorly while performing stapedotomy
Problems During Stapes Surgery

Floating Footplate
- Footplate dislodges from surrounding oval window niche
  - Usually iatrogenic
  - Incidental finding
- Prevention
  - Laser
  - Footplate control hole
- Management
  - Abort
  - Proceed
    - Total stapedectomy
    - Laser fenestration/microdrill fenestration
Problems During Stapes Surgery

**Diffuse Obliterative Otosclerosis**

- Occurs when footplate, annular ligament, and oval window niche are involved
- Closure of air-bone gap < 10 dB less common
- Refixation commonly occurs
- Fenestra created with microdrill
Problems During Stapes Surgery

Fixed malleus

- Rare problem
- Must always check
- Must check mobility of prosthesis after placement
Problems During Stapes Surgery

**Perilymph Gusher** - profuse flow of perilymph immediately upon opening vestibule

- Rare – 0.03% incidence
- Associated with congenital footplate fixation
- Possibly due to:
  - Widened vestibular aqueduct
  - Defect in IAC fundus
- Management
  - Tissue graft over oval window
  - Complete procedure if possible
  - Consider lumbar drain
Problems During Stapes Surgery

Intraoperative vertigo

- **Causes**
  - Prosthesis too long
  - Checking prosthesis mobility

- **Management**
  - Shorter prosthesis (try 0.25mm shorter piston)
Post-operative Complications

Sensorineural Hearing Loss

- Most devastating complication of stapes surgery
- Ranges from mild to total loss or may be isolated to high frequencies
- <1% - 3% incidence of profound permanent SNHL
  - Surgeon experience
  - Extent of disease
    - Cochlear
  - Prior stapes surgery
Post-operative Complications

Sensorineural Hearing Loss (cont.)

- Temporary
  - Serous labyrinthitis
  - Reparative granuloma

- Permanent
  - Suppurative labyrinthitis
  - Extensive drilling
  - Basilar membrane breaks
  - Vascular compromise
  - Sudden drop in perilymph pressure

- Management
  - Prednisone taper started immediately
Post-operative Complications

Sensorineural Hearing Loss (cont.)

- Prospective study with Otology-Neurotology Database
  - 3050 stapedotomies for otosclerotic stapes fixation (2525 patients)

- Results
  - Significant post-op SNHL (> 15dB)
    - 0.5% overall
    - 4.8% in obliterative otosclerosis
    - 0 cases with simultaneous malleus ankylosis

Post-operative Complications

Recurrent Conductive Hearing Loss

- Slippage or displacement of the prosthesis
  - Most common cause of failure
  - Immediate
    - Technique
    - Trauma
  - Delayed
    - Slippage from incus narrowing or erosion
    - Adherence to edge of oval window niche
    - Stapes re-fixation
    - Progression of disease with re-obliteration of oval window
    - Malleus or incus ankylosis
Post-operative Complications

Recurrent Conductive Hearing Loss (cont.)

- **Prospective study**
  - 260 pts with ABG ≥ 20dB after stapedotomy or stapedectomy
  - 1 month to 35 years after surgery

- **Cause of CHL**
  - 81% prosthesis displacement
  - Other causes:
    - Residual footplate fixation
    - Malleus fixation
    - Incus fixation
    - Incus dislocation

Post-operative Complications

Recurrent Conductive Hearing Loss (cont.)

- Recommendations
  - Laser stapedotomy
  - Teflon/platinum stapedotomy prosthesis
  - Prosthesis 0.25mm longer than distance between incus undersurface and footplate
  - Clotted blood oval window seal
  - Minimize mechanical trauma
  - Use tissue seal
    - Perilymph gusher
    - Footplate fracture
    - When stapedotomy too large

Conductive Hearing Loss
Mechanism: After Stapedotomy

- Collagen tissue seal contracts
- Prosthesis lifts out of stapedotomy
- Prosthesis migrates to fixed stapes footplate
Conductive Hearing Loss
Mechanism: After Stapedectomy

- Collagen tissue seal contracts
- Neomembrane lateralizes
- Erosion of incus causing loosening of wire loop
Post-operative Complications

Serous labyrinthitis

- Common following surgery secondary to inner ear inflammation

- Symptoms
  - Unsteadiness
  - Positional vertigo
  - Slight high frequency hearing loss

- Management
  - Expectant
Post-operative Complications

Vertigo

- More common with stapedectomy than stapedotomy
  - Due to serous labyrinthitis
- Occurs ~5% of cases
- Rarely prolonged or severe
- Usually lasts a few hours to one week
  - Rapidly subsides
- Supportive management
**Post-operative Complications**

Vertigo (cont.)

- **Intraoperative or immediately post-op:** lasts up to 1 week without intervention
  - Inner ear trauma
    - Prosthesis/instrument contact with membranous labyrinth (utricular macula)
    - Perilymph aspiration
  - Isolated delayed vertigo
    - Trauma to otolith organs creating BPPV-like picture
    - Perilymphatic fistula
Post-operative Complications

**Delayed Vertigo**

- Retrospective review
- 9 pts with delayed vertigo (1 month to 7 years post-op) underwent exploratory tympanotomy
  - Suspected perilymph fistula in all pts
  - 3 pts had perilymph fistula
- Fibrin glue placed in oval window area in all pts
- No post-operative vertigo

Post-operative Complications

Perilymph Fistula

- Rare complication after stapes surgery
- Presents with:
  - Mixed hearing loss
  - Vague unsteadiness
  - Vertigo
- Management
  - Remove prosthesis carefully → tissue seal the oval window → prosthesis replaced
Mechanism of Post-operative Perilymph Fistula: Stapedotomy

- Incus medially displaced by contracture adhesions between incus and promontory
- Prosthesis medializes into vestibule
Mechanism of Post-operative Perilymph Fistula: Stapedectomy

- Prosthesis migration from center to edge of oval window
- Vibration tears weaker shortened edge of membrane
Post-operative Complications

Tinnitus

- Possibly related to serous labyrinthitis

Management

- Reassurance
- Routine tinnitus measures
Post-operative Complications

Facial paralysis/palsy

- Rare
- Delayed onset
- Typically lasts several weeks
  - Occurs in 5-day post-op setting
- Usually incomplete paralysis

Management
- Prednisone - usually complete response
Post-operative Complications

Facial paralysis/palsy (cont.)

- Retrospective review
- 2152 stapes surgeries (2106 pts)
- 0.51% delayed facial palsy
- Occurred 5-16 days post-op

Measurements

- House-Brackmann grade
- Serum antibody titer (HSV1, HSV2, VZV)

Conclusion

- Serology suggests activation of latent herpesvirus

Post-operative Complications

Facial paralysis/palsy (cont.)

- Retrospective review
- 706 stapes surgeries (580 pts)
- 0.01% delayed facial palsy

Measurements

- House-Brackmann grade
- Serum antibody titer (HSV1)

Conclusion

- Serology suggests activation of latent herpesvirus
- Treat with acyclovir

Post-operative Complications

Reparative granuloma

- Very rare- associated with Gelfoam use

Patient presentation

- Initial hearing improvement followed by gradual/sudden deterioration over 1 to 6 weeks
- Reddish discoloration in posterosuperior quadrant
- Occasional vertigo

Management

- Granuloma removal
Post-operative Complications

Chorda Tympani damage

- Occurs ~30% of cases due to nerve stretching/mobilization
- Causes temporary (3-4 months)
  - Dry mouth
  - Tongue soreness
  - Metallic taste
- Symptoms less severe with sectioning of nerve
Post-operative Complications

**Tympanic membrane perforation**

- May occur during elevation of tympanomeatal flap
- Does not preclude completion of operation
- Repair involves myringoplasty or tympanoplasty with either synthetic material or autologous tissue
Meningitis

- Creation of fistula introduces route for potential meningitis
- Case report
  - 33yo ♀ POD 1 with vertigo, n/v, hearing loss, severe pain
  - Later developed neck stiffness
  - LP with cloudy CSF
  - Blood Cx with *streptococcus pneumoniae*
  - Treated with IV antibiotics

Post-operative Complications

Psychiatric complication

- Case report
  - Underlying schizoaffective disorder
  - Stapedectomy performed with complete closure of ABG
  - Pt believed surgery resulted in:
    - Improved sound perception
    - Thought broadcasting

Prosthesis Selection

- **Robinson piston**
  - Relatively heavy – may increase risk of displacement into vestibule
  - Handle can cause necrosis

- **Wire piston**
  - Incus necrosis due to:
    - mass
    - crimping tightness
  - Crimping angle may favor movement resulting in displacement over time

Prosthesis Selection

- Vertigo assessment
- Randomized-blinded controlled trial
- 174 original Fisch prosthesis –vs- 108 modified prosthesis
  - No difference in closure of ABG
  - Post-operative vertigo reduced

Modified Prosthesis

- 45 degree slope at distal piston end
- Anatomically configured to avoid saccule
Revision Stapes Surgery

- Retrospective review
- 63 surgeries (56 pts)
- Revision reason
  - Recurrent or persistent ABG > 20dB post-surgical treatment for otosclerosis
  - Prosthesis malfunction was primary failure cause

Revision Stapes Surgery

- Results
  - 52.4% ABG ≤ 10 dB
  - 9.5% without change
  - 6.3% decreased hearing ≥ 5 dB

- Recommendations
  - Examine
    - Prosthesis attachment to incus
    - Oval window niche
  - Pistons can be removed easily
  - Tissue wire prostheses
    - Difficult to remove- laser helps with removal
    - Increased risk of SNHL

Stapes Surgery by Residents

- Retrospective review
- 71 stapedotomies (laser-assisted fenestra)
- 87% with closure of air-bone gap ≤ 10 dB

Complications

- High-frequency SNHL of 15-30 dB in 3 pts
- Transient vertigo in 3 pts
- No sensorineural deafness

Conclusion

- Stapes surgery
  - Delicate structures
  - Small area
  - Important surroundings

- Surgeon must be aware of potential complications and management

- Informed consent is essential
Bibliography