ACOUSTIC NEUROMA: SURGICAL APPROACHES, CRANIAL NERVE PRESERVATION AND REHABILITATION

Presented by: Faiz Uddin Ahmad
• Surgical anatomy
• Approaches: SO, others- indications, advantages, problems
• Facial nerve and hearing preservation
• Facial nerve repair/transfer and facial reanimation
• Facial N- 4 landmarks
• Silvery white vs. dull yellow

• AICA-
• Premeatal - RPA, IAA
• Meatal - SAA
• Postmeatal -?

• Inferior displacement usually
Facial N displacement:
Ant 70%
Sup 10%
Inf 13%
Post 7%

Shape:
Thin bundle 2/3
Splayed over capsule 1/3
(Reverse in NF2)
• Transverse (falciform) crest
• Vertical crest (Bill’s bar)
Grading:

- **Koos**: (Grade 1-4) upto 1, 2, 3, >3 cm (intracanalicular+cisternal)
- **Ojemann**: (small, med, large)<2, 2-3 >3cm (intracisternal)
- **Samii**: >3×2cm large, rest small. (both intra+extrameatal), also T1, T2, T3ab, T4ab
- **Shekhar**: (small, med, large) <2, 2-3.9, >3.9 cm (only intracisternal)
Treatment options: No strict guidelines

- Observation: elderly patient with small tm and mild symptoms/ only auditory symptoms/ incidental finding
- Radiosurgery:
  - Enlarging tm, usually less than 2 cm, esp in elderly patient
- Residual/ recurrent tm after Surgery
- Patient decision
- Fractionated RT: large Tm in only hearing ear
- Surgery- all others
Only hearing ear:

- Stable hearing – FU with MRI and PTA
- Progressive hearing loss- choice discussed with patient
- **Options**: subtotal removal/complete removal with attempt to save hearing/ fractionated RT/Trans lab removal and placement of brainstem auditory implant!
Hydrocephalus

- Avoid shunt unless patient very sick from raised ICP
- Steroids/ intraop EVD
- Elderly patient with hearing loss and HCP-only VP shunt may s/m be required.
Suboccipital approach

- Sir Charles Balance 1894 – finger
- Cushing 35%, 11%, 2%
  bilateral craniectomies, subtotal removal
- Dandy 1925 - first total removal
  (advocated- ventricular tapping, open
cisterna magna, resect lateral third
 cerebellum, unroof IAC)
Mortality overall 22%, Later 9%
Adv:
- Good exposure
- Even large Tm
- Facial + hearing preservation
- Direct visualization of vessels

Disadv:
- Poor exposure of lat end of canal
- Cerebellar retraction
Position: Surgeon’s preference

- Sitting: air embolism, hypotension, surgeon discomfort, but clean field
- Semi sitting:
- Lateral: BPI
- Supine oblique: Cervical spondylosis
• Bone over lat 2/3 of cerebellum exposed

• Craniotomy vs. craniectomy

• Cerebellum retracted superomedially

• Drain CSF
Petrosal vein coagulated?

Stimulate capsule for 7th Nerve

If visible, identify LCN and protect them early, they have low threshold for neuropraxia

Dissection b/w double layer of arachnoid and capsule

Don’t coagulate arachnoid on surface
• Internal decompression (CUSA/laser/biopsy forceps) and centripital tm fall

• Push arachnoid with vessels back—“Arachnoid belongs to the pt”

• Debulk Tm

• Dissect upper pole first in large tm—5th nerve is easily identifiable
• Look for 7th nerve medially near the brain stem-stimulate
• Save AICA
• Dissect along the 7th nerve from medial to lateral
• sharp dissection
• Cut arachnoidal bands b/w tm and cranial nerves
• Drill post wall of IAC 180° (1 cm)
• IAC runs 5-10 mm below and parallel to attachment of tent
• Check distance from porus to PCC in CT (8-13mm)
• High jugular bulb 10-50% (def)
• Constant irrigation with fluids at body temp. and diamond drill later
Dissect medial to lateral

- Sharp dissection
- Most difficult part is at porus
- Dissect in easiest plane, so that least traction on nerve
- Change directions
- Dental mirrors/endoscope to confirm complete excision
• Go for subtotal removal in:
  • Hearing preservation in large tumors
  • Very thin facial N with thick adhesions to tm
  • Elderly debilitated patient with brain stem compression
Translabrynthine Approach

- Panse 1904
- House 1964

**Adv:**
- Early identification of facial N
- Absence of significant cerebellar retraction
- Short distance b/w surface and tumor

**Disadv:**
- Deafness
- Reduces exposure
- More CSF leak
- Middle ear infection is a CI
Middle fossa approach

• House 1961
• Indi: Small tumor in lat part of Internal Auditory canal, with facial and hearing preservation.

• Adv:
  • Extradural dissection
  • Total removal of Tm, even the lat part.
  • Hearing preservation

Dis Adv:
• Facial n comes first
• Limited access to post fossa, esp. if there is bleeding
• Only small tm
• Elderly patients with thin dura are less tolerant to temp. lobe retraction
Other approaches

• Combined SO - Translab- (Maddox) wider exposure in large tm, less cerebellar retraction
• Combined SO-transpetrosal- for large tm going into tentorial hiatus
• Subtemporal-transtentorial- (Rosomoff, Banerji et al)- for some larger tm going upwards
• Retrolab (Hitselberger 1972)- presigmoid exposure, less cerebrellar retraction, limited exposure
• Transcanal- For very small Tm- expose IAC through EAC


Other Tech

- Neuronavigation for drilling IAC: Samii et al – investigational, needs more studies
Choice of approach:

ACOUSTIC TUMOR

> 2.5 cm
  - Suboccipital

≤ 2.5 cm
  - Hearing Preservation
    - Yes
      - ≤ 1.0 cm
        - Middle Fossa
      - 1.0 - 2.5 cm
        - Suboccipital
    - No
      - Translabyrinthine
Facial N preservation

- $1^{st}$ - Cairns 1931
- Olivecrona - $1^{st}$ to attempt in a large series of patients
Facial EMG
(stimulation
0.1ms, 3 Hz,
0.05 to 1.0 mA)
Facial Motion sensor
House and Brackmann

1- normal
2- close eyelids with min efforts
3- no functional impairment, close eyes with max efforts, obvious synkinesis/ contracture/ hemifacial spasm
4- Normal symmetry and tone at rest, can’t close eyes, severe synkinesis etc
5- Asymm at rest, decreased/absent nasolabial folds, minimal movement of eyelids
6- No motion, loss of tone
Outcome

• Ojemann 1993:
  • Tm size 1cm-100%
    1-2 m- 95%
    2-3cm- 80%
    3-4cm- 60%
    >4 cm- 50-55%
  
  Samii: better results for same size
• Delayed Facial weakness: edema/inflammation-usually complete recovery by 6 mth
• Outcome assessed at one year
• Ebersold (1992): amplitude of CMAP on stimulation of facial N in lateral IAC predicts outcome of facial N
• Others- Intraop change in threshold of stimulation reflects amount of damage.
• Threshold of stimulation at REZ at brainstem reflects outcome.
Hearing preservation: Monitoring

- BAER: monitors pathways central to the tympanic membrane (TM)
- ECoG: CAP of auditory nerve monitors pathways distal to TM, cochlear microphonics indicates status of cochlea
- Cochlear N direct recording of CNAP

Elliot and McKissock first reported hearing preservation in 1954
BAER

• Wave V is most prominent – monitored

Disadv:

• BEAR unrecordable pre op in 1/3 patients
• Delay in response of upto 20-60 sec due to signal averaging
ECoG

• Monitors **CAP** of auditory nerve near the cochlea and **cochlear microphonics**, generated from hair cells.

• **Adv:**
  • Rapid feedback of N1
  • Not affected by anesthetic agents
  • Almost always detectable

• **Problems:** dislodgement of electrode, fluid in middle ear may block sound transmission
• Direct recording of CNAP from nerve- good predictor, but impairs surgical field,
• 8th nerve must be visible before it can be used

Recently:
• Direct recording of potentials from cochlear nucleus in lateral recess (Jannetta et al)
• Fast BAER response (10 sec) by using electrodes attached to cerebellar retractor (Samii et al)
Prognostic factors

- Small tm (<2cm)
- Good pre op hearing
- Lack of lateral tumor extension to fundus of IAC
- Absent caloric response (tm from sup vestibular N.)
- Sudden intra-op loss of potentials is a poor prognostic Factor
- Intraop presence of severe adhesions between nerve and tm- m imp. factor: Moriyama et al JNS 2002
Serviceable hearing?

- Gardner Robertson 1988

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<th>Class</th>
<th>PTA</th>
<th>SDS</th>
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<td>1</td>
<td>0-30</td>
<td>70-100</td>
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<tr>
<td>2</td>
<td>31-50</td>
<td>69-50</td>
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<td>3</td>
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<td>4-1</td>
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<tr>
<td>5</td>
<td>no response</td>
<td>No response</td>
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• AAO-HNS 1995

• Class  PTA  SDS

• A  <30  >70

• B  31-50  >50

• C  >50  >50

• D  any  <50

• Others: Shelton et al 1989, Sanaa et al 1995
Technique:

- *Jannetta et al:*
- Elevate cerebellum, avoid medial retraction!
- Sharp dissection with scissors (No CUSA/laser/forceps)
- Alternate dissection in all directions
- Rostral-caudal retraction of CN 8 does not usually hamper function
- Preserve even small vessels going into the IAC
• **Mechanism of hearing loss:**
  - Direct damage to cochlear nerve
  - Involvement of cochlear nerve by tm
  - Interruption of blood supply to cochlea/nerve
  - Injury to Labyrinth
• **Delayed hearing loss:**
  Nerve edema,
  Impairment in vasa-nervorum circulation,
  Increased permeability of endoneural vessels after mech. compression trauma,
  Progressive scarring of IAC with co compression of cochlear N or microvasculature
Results

- **Gormley, Shekhar et al, NS 1997** (179 patients, 5yr FU, 99% complete removal)

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<tr>
<th>Size</th>
<th>Facial (Gr 1/2)</th>
<th>Hearing (Gr 1/2)</th>
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<tr>
<td>&lt;2</td>
<td>96%</td>
<td>48%</td>
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<td>2-3.9</td>
<td>74%</td>
<td>25%</td>
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<tr>
<td>&gt;4</td>
<td>38%</td>
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• Issue--Recurrence of tm after hearing preservation ??
  Samii/ Ojemann- none in FU of 1-8 yrs
Rehabilitation:

- First published Facial N repair: Charles Ballance 1895 (Spinal acc-facial)
- Korte (Berlin) – Hypoglossal-facial anas. 1903
- Best results of surgery – within 1 yr
Management of facial paralysis

- Nerve preservation/nerve reconstruction/nerve reanimation/physiotherapy and static measures
- Intact Facial N-
- Physiotherapy
- Gold weight, ocular spring, other static procedures
- Facial n. not intact
- Add- cranial nerve anastomosis
Nerve reconstruction

- Direct repair at surgery
- Intracranial- intratemporal repair, after drilling the temporal bone, if distal stump is lost
- Intracranial- extracranial repair at stylomastoid foramen, if mastoiditis/previous petrous bone trauma disallows this method
• Reanimation with a donor nerve if proximal nerve stump is lost.
• Hypoglossal N identified below digastric muscle
• Full thickness graft (classical)
• Anastomosing ansa hypoglossi to distal hypoglossal N does not give further benefit
May tech: “Jump graft”- preserves tongue function in 90% patients

- Without graft: intratemporal mobilization of facial N
• **Others:**
  • Spinal accessory-facial anastomosis
  • Phrenic
  • Glossopharyngeal
  • Contralateral facial branches with graft
  • (best results with hypoglossal- large cortical representation, close to face)

• **Results:**
  • If H&B Gr 1-2 excellent, Gr 3- good
  • Reconstruction 60-70%, Reanimation >70%
• Temporalsis/ Masseter muscle transposition: (when Vth nerve is preserved)-

• Alone after 2 years or along with jump graft to prevent sagging of facial muscles till graft starts functioning

• Adv: immediate results
Static procedures for eyelid:

- Gold weight

- 0.9-1.1 gm

- 1×5×10 mm plate

- Palpebral sling placement
Other procedures

- Correct lower eyelid ectropion with auricular cartilage - improves lacrimal puncta position
- Face lift
- Eye brow lift
Physiotherapy

- Fu every 3-6 months, till 3 yrs (Samii et al)
- Daily exercises performed 6 times for 5-10 min.
- Training in front of mirror
- Active and passive individual muscle exercise (eyebrow, eyelid, blowing, smiling)
- Combine eye closure with strong biting
- After anastomosis- pressing tongue against teeth
- Avoid electrical stimulation
- EMG biofeedback
Multichannel auditory brain stem implant (ABI)

- Indi: NF-2 patients >12yrs
- Tech: direct stimulation of cochlear nucleus
- Multichannel implant placed in lateral recess
- Results: 80% patients can hear sounds
- Most patients can recognize >70% of sentence along with lip reading
- Learning period of 6-12 months
NF-2

- Younger age with longer life expectancy
- More difficult to remove surgically (Tm are more invasive, have higher growth rate)
- Faster tm growth
- Multilobulated tm, arising from multiple cranial nerves
- Poor 7th and 8th nerve outcomes with both surgery and GK
- Samii, NS 1997 (120 NF-2 schwannomas): No permanent cure for them.
- Goal: decompress brainstem and prolong period of cranial nerve functions