

# ACOUSTIC NEUROMA: SURGICAL APPROACHES, CRANIAL NERVE PRESERVATION AND REHABILITATION

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- 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%

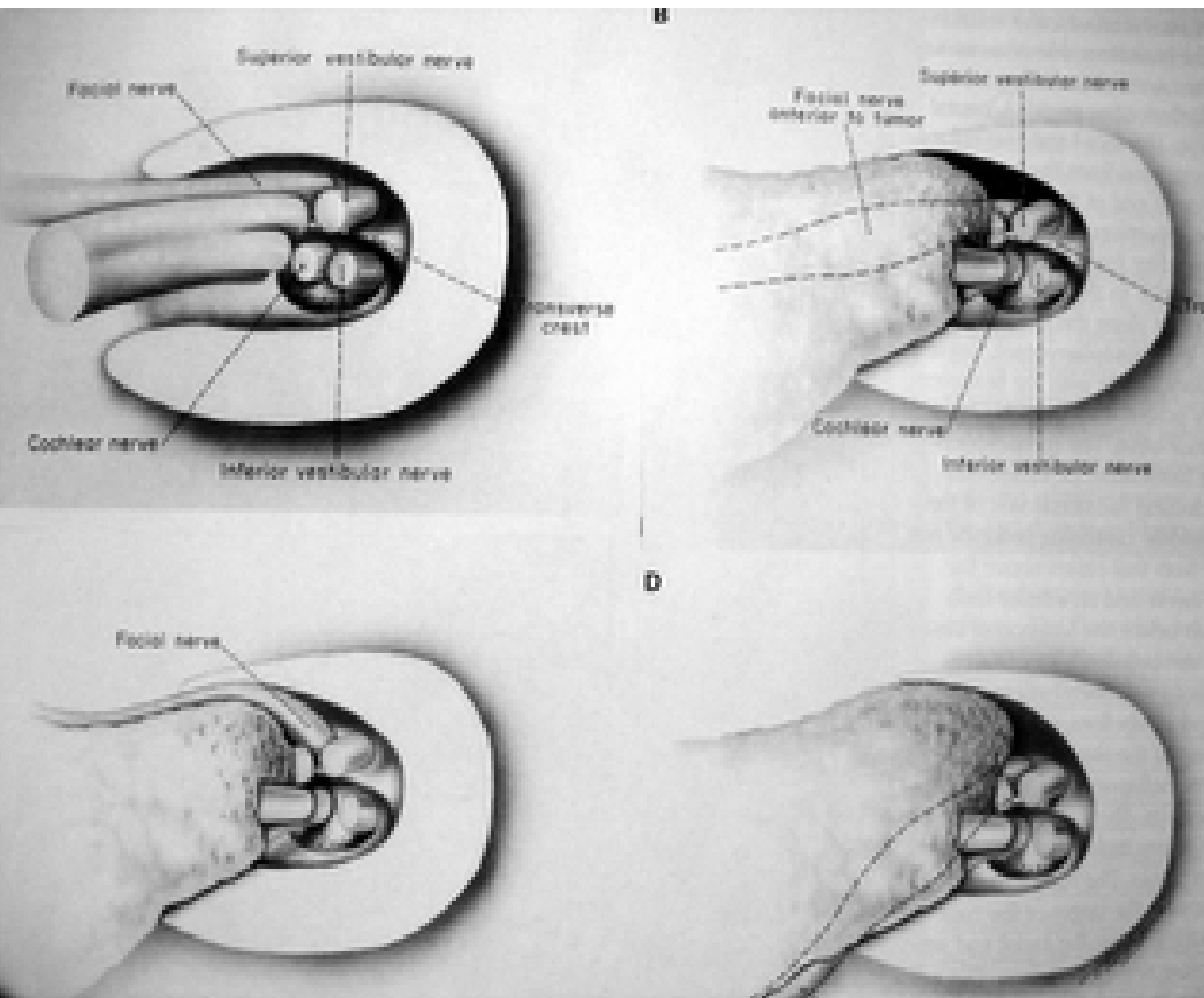
Post 7%

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

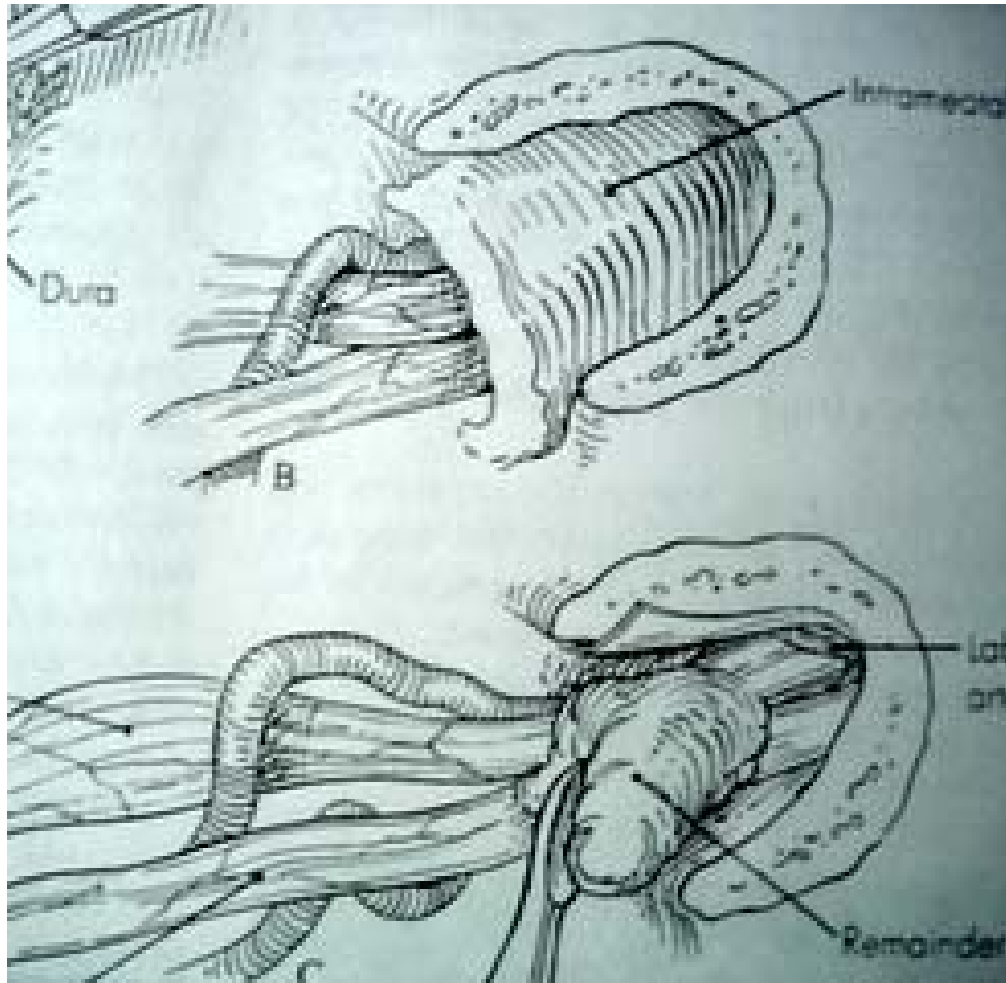


- Internal decompression (CUSA/laser/biopsy forceps) and centripetal tm fall
- Push arachnoid with vessels back-“Arachnoid belongs to the pt”
- Debulk Tm
- Dissect upper pole first in large tm- 5<sup>th</sup> nerve is easily identifiable

- Look for 7<sup>th</sup> nerve medially near the brain stem-stimulate
- Save AICA
- Dissect along the 7<sup>th</sup> 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

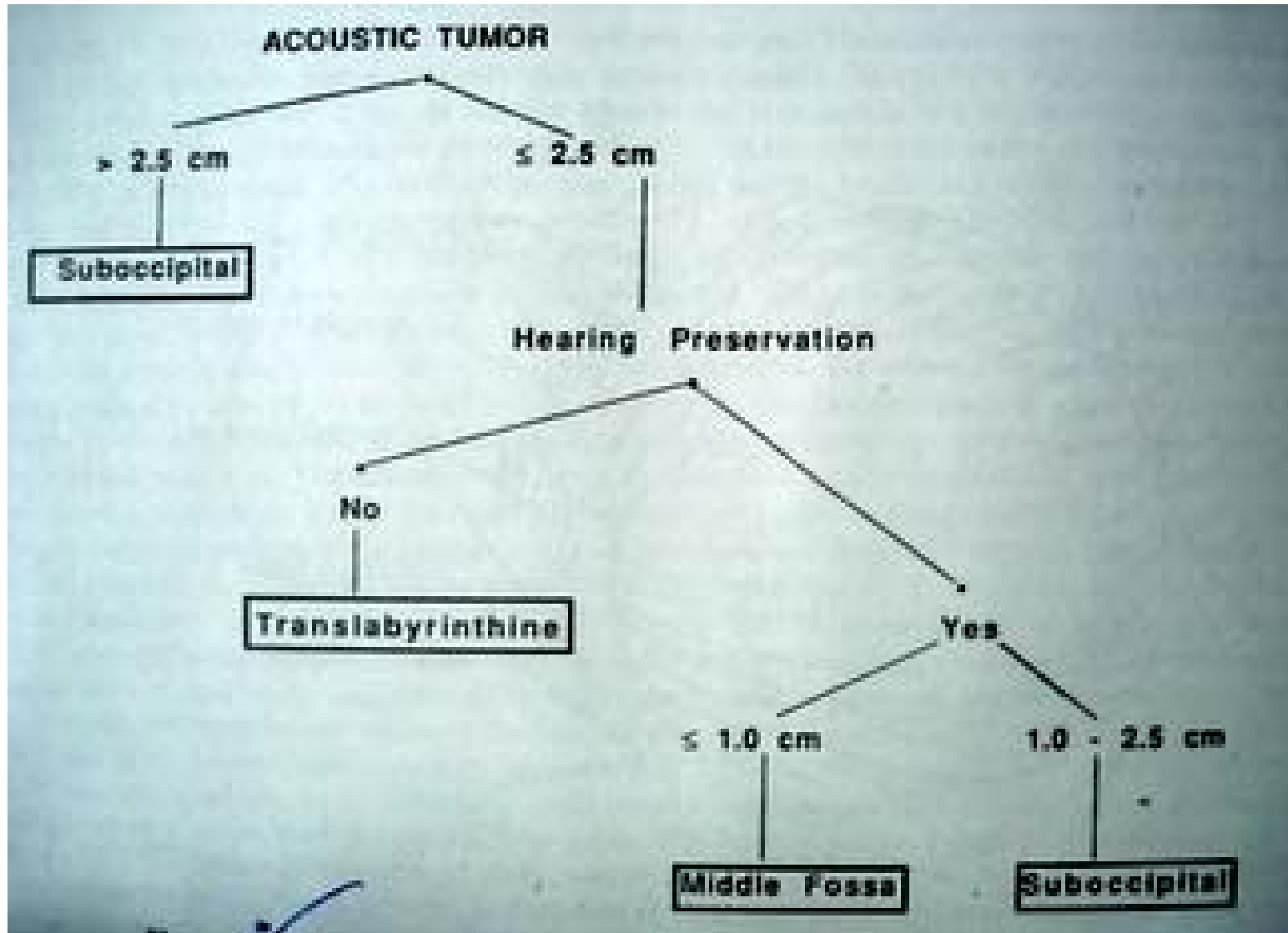
# Other approaches

- 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 cerebellar 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:

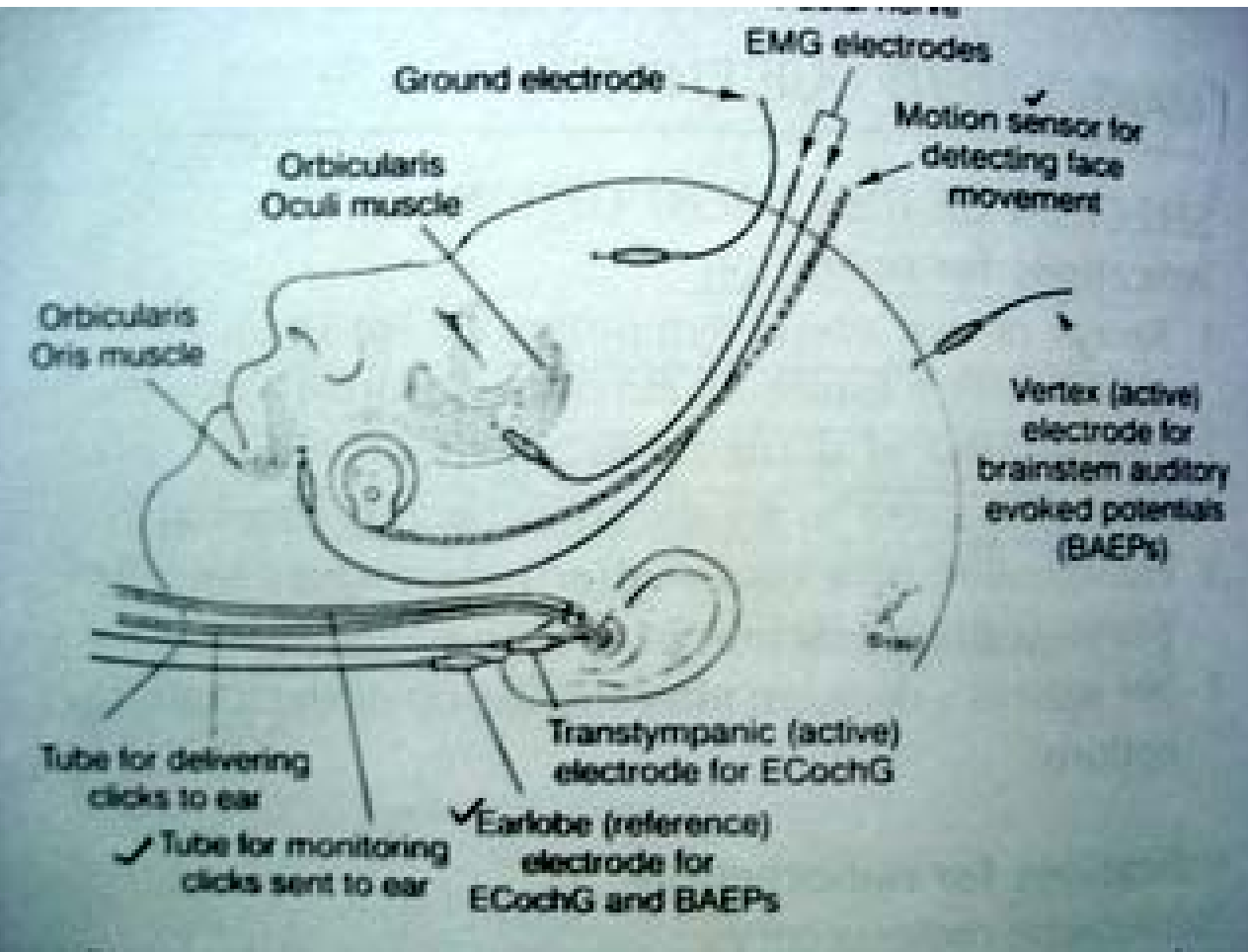




# Facial N preservation

- 1<sup>st</sup>- Cairns 1931
- Olivecrona- 1<sup>st</sup> to attempt in a large series of patients

# monitoring



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

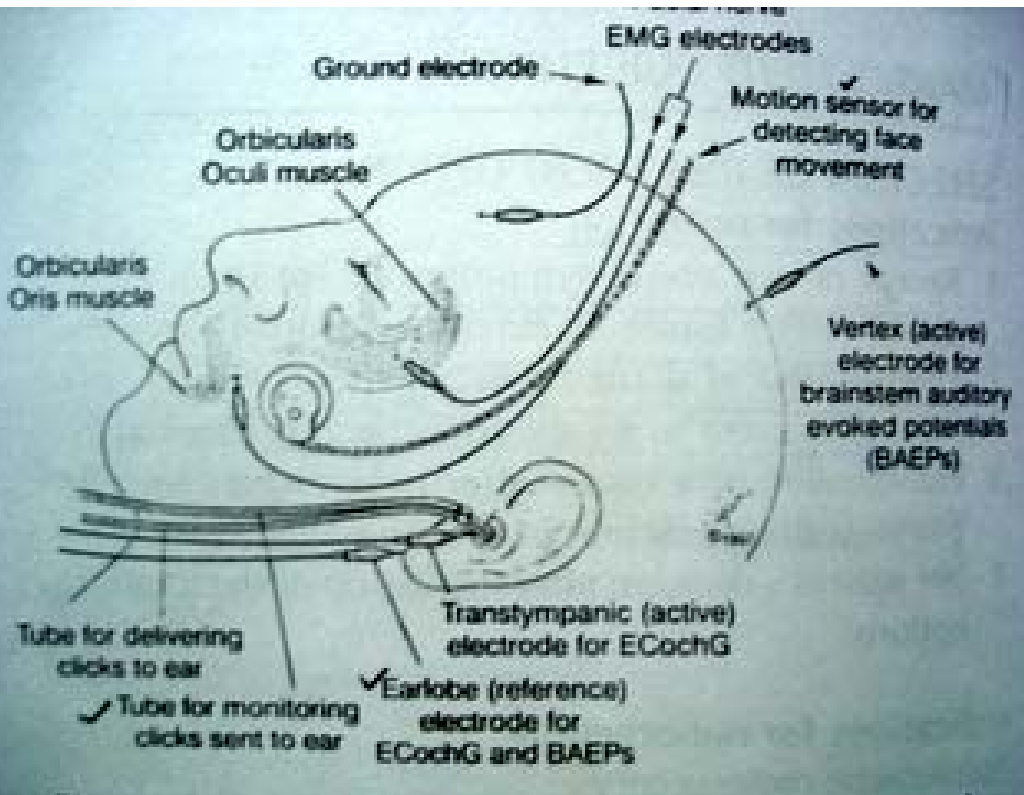
# Outcome

- 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 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 feed back 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,
- 8<sup>th</sup> 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

Class	PTA	SDS
• 1	0-30	70-100
• 2	31-50	69-50
• 3	51-90	49-5
• 4	91-max	4-1
• 5	no response	No response

- 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)
- | Size  | facial(Gr 1/2) | Hearing (Gr 1/2) |
|-------|----------------|------------------|
| <2    | 96%            | 48%              |
| 2-3.9 | 74%            | 25%              |
| >4    | 38%            | 0                |



- 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%

- Temporalis/ 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 7<sup>th</sup> and 8<sup>th</sup> 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*