Vestibular schwannoma is the most common tumor occurring in the CP angle (about 85-90%) 

- 6% of all intracranial tumors 
- Incidence in US: 10 per million / year 
- Peak incidence in 4th to 6th decade 
- M:F= 2:3 
- 95% Sporadic (unilateral) 
- 5% Neurofibromatosis type 2 (bilateral) 
- Slow growing tumors = Average 1.8 mm/year (0.2 to 4.0 mm)
Introduction

- Neither Neuroma nor Acoustic (auditory)
- Schwannoma: arising from vestibular nerve Schwann cells at transition zone of the peripheral and central myelin Obersteiner Redlich zone (at the lateral CPA/medial IAC)
- Majority originate within the IAC
- Equal frequency on Superior and Inferior vestibular nerves ???
- Rarely occur on the cochlear division of the 8th CN.
- VS occurs as a result of mutations in a tumor suppressor gene
  - Merlin
  - Located on chromosome 22q12
- VS requires both copies to be mutated
- People with NF2 inherit one mutated gene
Cerebello-pontine angle

- Superior limb of cerebellopontine fissure
- Inferior limb of cerebellopontine fissure
- Apex-located laterally where superior & inferior limbs meet
- Floor- Middle cerebellar peduncle
- Anterior: posterior surface of temporal bone
- Posterior: anterior surface of the cerebellum
- Medial: lateral surface of brainstem
- Lateral: petrous bone
Cerebello-pontine angle

- Cranial nerves:
  - V
  - VII & VIII
  - IX, X, XI

- Important structures:
  - Flocculus
  - Lateral aperture of 4th ventrical
  - AICA
### Grading

- **Koos**: (Grade 1-4) upto 1, 2, 3, >3 cm (intracanalicular +cisternal)
- **Ojemann**: (small, med, large)<2, 2-3, >3cm (intracisternal)
- **Samii**: >3 x 2 cm large, rest small (both intra + extrameatal also T1, T2, T3 AB, T4 AB)
- **Sekhar**: (small, med, large) <2, 2-3.9, >3.9 cm (only intracisternal)

### Jackler Staging System

<table>
<thead>
<tr>
<th>Stage</th>
<th>Tumor Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intracanalicular</td>
<td>Tumor confined to IAC</td>
</tr>
<tr>
<td>I (small)</td>
<td>&lt; 10 mm</td>
</tr>
<tr>
<td>II (medium)</td>
<td>11-25 mm</td>
</tr>
<tr>
<td>III (Large)</td>
<td>25-40 mm</td>
</tr>
<tr>
<td>IV (Giant)</td>
<td>&gt; 40 mm</td>
</tr>
</tbody>
</table>
What do patients complain of?

- **Hearing loss**
  - 95% of patients
  - Most have slowly progressive loss
  - 20% have sudden HL
  - Level of hearing loss is NOT a predictor of size

- **Tinnitus**
  - 65% of patients
  - Usually constant with a high buzzing pitch

- **Disequilibrium**
  - 60% of patients
  - Usually well-compensated
Hearing Loss

- Most frequent initial symptom
- Most common symptom ~ 95% AN patients
- Asymmetric SNHL
- High Frequency
- Decreased Speech Discrimination
- Lack of conclusive correlation between tumor size and hearing *

* Stipkovits EM et al., Am. J. Otology 1998: 19; 834-9

Pathophysiology of Hearing Loss

- Exact etiology is unknown
- Compressive effect on cochlear nerve
- Vascular occlusion of internal auditory artery
### Distribution of Hearing in AN

<table>
<thead>
<tr>
<th>Gardner-Robertson class</th>
<th>%age of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>21.1</td>
</tr>
<tr>
<td>B</td>
<td>27.9</td>
</tr>
<tr>
<td>C</td>
<td>15.3</td>
</tr>
<tr>
<td>D</td>
<td>35.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

*Forty-nine percent of patients had serviceable hearing.

---

**TABLE 1. Hearing on affected side in 190 patients with vestibular schwannoma**

<table>
<thead>
<tr>
<th>Gardner-Robertson class</th>
<th>PTA (dB)</th>
<th>SD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I (good-excellent)</td>
<td>0-30</td>
<td>70-100</td>
</tr>
<tr>
<td>Grade II (serviceable)</td>
<td>31-50</td>
<td>50-69</td>
</tr>
<tr>
<td>Grade III (non-serviceable)</td>
<td>51-90</td>
<td>5-49</td>
</tr>
<tr>
<td>Grade IV (poor)</td>
<td>91-max</td>
<td>1-4</td>
</tr>
<tr>
<td>Grade V (none)</td>
<td>not testable</td>
<td>0</td>
</tr>
</tbody>
</table>
More complaints....

- **Facial and trigeminal nerve dysfunction**
  - Usually V2 numbness
  - Sensory component of CN VII is usually involved first
    - *Hitselberger sign* – numbness of the posterior EAC
  - Facial weakness or spasm occurs in 17% of patients
- **Cerebellar:**
  - Wide gait, Falling to side of lesion
- **Brainstem:**
  - Headache, altered MS, nausea,
  - Visual Loss,
- **Other Cranial nerves:**
  - IX – dysphagia (large tumors, J F S)
  - X – hoarseness, aspiration (large tumors, J F S)
  - XI – shoulder weakness (large tumors, J F S)
Diagnostic Tests

- Audiometric Testing.
- Electrophysiologic Testing.
- Vestibular Testing.
  - ENG
  - Computerized dynamic posturography.
  - Rotary chair testing.
- CT & MRI.
Audiometric Testing

- **Pure-tone testing:**
  - SNHL - most commonly high frequency (65%).
  - Normal hearing (5%).

- **Speech discrimination:**
  - Scores out of proportion with pure-tone thresholds.
  - Some may score well.
  - Rollover phenomenon improve the sensitivity.

- **Acoustic reflex thresholds:**
  - typically elevated or absent.
  - If present then reflex decay measured.
  - The sensitivity is 85% for detecting retrocochlear problem.
BAER: Retrocochlear Pathology

- Most sensitive & specific audiologic test.
- Increased interpeak intervals
  - I-to-III interval of 2.5 ms, III-to-V interval of 2.3 ms, and I-to-V interval of 4.4 ms
- Interaural wave V latency difference (IT5)
  - Greater than 0.2 ms (40-60%).
- Poor waveform morphology i.e. only some of the waves are discernible
- Absent waveform in 20-30%.
- Wave 1 present but all remaining waves are absent in 10-20%.
- Normal in 10-15%.

Fraysse B et al. First International Conf. on Acoustic Neuroma. 1992
BAER: Diagnostic Efficiency

- Generally, Efficiency increases with Size
- Sensitivity: > 90 % for tumor > 3 cm
- False negative Rate:
  - 15 % (Wilson 1992 – 6/40)
    - 33 % (5/15) for Intracanalicular Tumor
- False positive Rate:
  - > 80 % (Jackler 2005)
- Positive predictive value:
  - 15 % (Weiss 1990 – 4/26)
  - 12 % (Walsted 1992 – 23/185)
90 patients with asymmetric audiovestibular symptoms, investigated prospectively with both ABR and gadolinium-enhanced magnetic resonance imaging (GdMRI).

6 were diagnosed with VS on GdMRI.

On ABR testing, 4 patients with VS had retrocochlear pathology and 2 with profound sensorineural hearing loss had no responses.

ABR was found to have a sensitivity of 100% and specificity of 61.9%. A protocol involving screening of all patients with asymmetric audiovestibular symptoms using ABR and only subjecting those patients with no responses or retrocochlear pathology to GdMRI would effect a savings of $1200 for every patient detected to have a VS.

**CONCLUSIONS:** Including ABR as the preliminary screen for patients with asymmetric audiovestibular symptoms is a cost-effective strategy.
MRI is the Gold Standard

- T1: Isointense to brain, hyperintense to CSF
- T2: Hyperintense to brain, hypointense to CSF
- T1 -Gad: Enhancing
## MRI characteristics of other lesions

<table>
<thead>
<tr>
<th>Lesion</th>
<th>T1WI</th>
<th>T2WI</th>
<th>Enhancement</th>
<th>Suggestive feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidermoid</td>
<td>Hypo</td>
<td>Hyper</td>
<td>No</td>
<td>Hyper on DWI</td>
</tr>
<tr>
<td>Dermoid</td>
<td>Hyper</td>
<td>Hypo</td>
<td>No</td>
<td>Fat and calcium</td>
</tr>
<tr>
<td>Arachnoid cyst</td>
<td>Hypo</td>
<td>Hyper</td>
<td>No</td>
<td>Iso to CSF, hypo on DWI</td>
</tr>
<tr>
<td>Anuerysm</td>
<td>Hypo</td>
<td>Hypo</td>
<td>Possible</td>
<td>Well circumscribed hypo- on T2</td>
</tr>
<tr>
<td>Cholestrol gran</td>
<td>Hyper</td>
<td>Hyper</td>
<td>No</td>
<td>Hypo- rim on T1 &amp; T2</td>
</tr>
<tr>
<td>Chondroma</td>
<td>Hypo</td>
<td>Hyper</td>
<td>Variable</td>
<td>Origin from synchondrosis</td>
</tr>
<tr>
<td>Chordoma</td>
<td>Hypo</td>
<td>Hyper</td>
<td>Yes</td>
<td>Intra tm septa</td>
</tr>
</tbody>
</table>
CT Brain with contrast

- Heterogeneous enhancement on contrast
- Indicated in: Contraindication to MRI (metallic implants), claustrophobic patients
- May not be able to detect small tumor < 1.5cm
- Radiation risks

Pre-op Thin cut CT of post fossa
(Samii: Essen In Nsx)

Identify bone destruction
Expansion of IAC
Position of labyrinth-relation to fundus
Position of sigmoid sinus and emissary vein
Management options - No strict guidelines

- Surgery

- Radiosurgery or Fractionated RT

- Observation (with careful audiologic and radiologic monitoring)

- Management of Preoperative Hydrocephalus –
  - Asymptomatic – Steroids/Intraop EVD
    - No special treatment
  - Obviously sick; gross hydrocephalus with symptoms of raised ICT like headache, vomiting, papilloedema – Ventriculoperitoneal shunt
Historical perspective

- **Sandifort**- 1777, earliest description of AN
- **Sir Charles Balance**, 1894 – finger enucleation
- **Annadale**- 1895, first true AN removal (Cushing)
- **Cushing** 1905- subtotal intracapsular removal
  - Hemostasis: silver clips, bone wax, electrocautery
  - Mortality: 20 % (1917) ➔ 4% (1931)
- **Dandy**, 1925- first total removal unilat SOC (advocated- ventricular tapping, open cisterna magna, resect lateral third cerebellum, unroof IAC for complete resection) . Mortality 10%
- **William House** (1960)
  - Translabyrinthine approach using surgical drill and operating microscope
- **Givre & Olivecrona** – pioneered facial nv. Preservation
- **Rand and Kurze** – 1968-cochlear + facial n. preservation
- **Delgado**- intraop VII nv monitoring, 1979
Surgical approaches

- Retromastoid suboccipital transmeatal approach
- Middle fossa approach
- Translabyrinthine approach
Retromastoid suboccipital transmeatal approach

• **Position – Surgeon’s preference**
  - Lateral oblique
    - Comfort of the surgeon
    - Excellent visualization of CPA, direct visualization of vessels
    - Ease of tumor removal
    - Prevention of hypotension
    - No concern about air embolism
  - Semisitting/sitting: air embolism, hypotension, surgeon discomfort, but clean field
  - Prone
  - Lateral: BPI
  - Supine oblique: Cervical spondylosis
Retromastoid suboccipital transmeatal approach

- Incision —
  - Vertical linear (1 cm medial to the mastoid process)
  - ‘S’ / Lazy ‘S’
  - Inverted ‘J’-shaped/ Hockey-stick

- Anatomical variants-
  - Dolichoectatic VA/Occipital artery
  - Hypoplastic VA
    (20 %)- Avoid extreme flexion
Retromastoid suboccipital transmeatal approach

- Landmarks of Cerebellopontine angle and extent of craniotomy

<table>
<thead>
<tr>
<th>Extradural landmarks</th>
<th>Intradural landmarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse sinus superiorly</td>
<td>Tentorium superiorly</td>
</tr>
<tr>
<td>Sigmoid sinus &amp; tranverse – sigmoid junction laterally</td>
<td>Petrous bone laterally</td>
</tr>
<tr>
<td>Mastoid tip/ digastric groove inferiorly</td>
<td>Flat floor of posterior fossa inferiorly</td>
</tr>
</tbody>
</table>
Retromastoid suboccipital transmeatal approach

- Maintain the arachnoidal plane & dissect it from the tumor superiorly, inferiorly & medially
- Dissect sup pole first in large tm- Vth nerve is easily identifiable
  - V nerve- typical flat appearance with prominent fascicles, located at the junction between the tentorium & temporal bone
  - Arachnoidal bands b/w tumor capsule & the nerve cut by meticulous technique
  - Superior petrosal vein. coagulated, if needed
Retromastoid suboccipital transmeatal approach

- Internal decompression (CUSA/laser/biopsy forceps)
- Push arachnoid with vessels back
- Debulk Tumor
- Tumour capsule separates from the arachnoid
- Sharp dissection
- Cut arachnoidal bands between tumor and cranial nerves, dissect into the cleft between the tumor & brainstem
- Identify VII & VIII nerve
- All the pressure to be placed on the tumor capsule while separating it from the cr. nerves & brainstem
Retromastoid suboccipital transmeatal approach

- **Facial nerve landmarks**-
  - Lateral end of pontomedullary sulcus, 1-2mm ant to VIII n
  - VII n arises 2-3 mm above the most rostral rootlet of IX n
    - *Choroid plexus* protruding from the foramen of Luschka
      - VII n lies just anterosuperior
    - *Flocculus* lies just posterior to the site where VII & VIII nerves join the pontomedullary sulcus
    - Silvery white, very shiny vs. dull yellow (Vestibular nv)

- **Facial N displacement**:
  - Ant 70%
  - Sup 10%
  - Inf 13%
  - Post 7%

- **Shape**:
  - Thin bundle 2/3
  - Splayed over capsule 1/3
RMSOC – Intrameatal part

- Drill the posterior meatal wall
- Continuous irrigation to prevent thermal injury
- Prevent bone dust dissemination in subarachnoid space
- High projection of the jugular bulb, mastoid air cells. Identify neural structures in IAC after opening the dura
- Care taken not to enter the labyrinth
- The dissection along the eighth nerve is done in a **medial to lateral direction**
- **Meticulous dissection to prevent VII n injury as it turns the corner over the medial and ant lip of IAC to enter the subarachnoid space**
Retromastoid suboccipital transmeatal approach

- **SUBTOTAL REMOVAL**
  - Hearing preservation in large tumors.
  - Very thin 7th nerve with thick adhesions to tumor.
  - Elderly debilitated pt with brainstem compression.
Retromastoid suboccipital transmeatal approach

**Advantages:**
- Good exposure of the CPA cistern
- Good for medial tumors
- Even large Tumor
- Facial preservation
- Hearing preservation (50% in tumors <2cm)
- Direct visualization of vessels

**Disadvantages:**
- Poor exposure of lateral end of the internal auditory canal
- Cerebellar retraction
- CSF leak (7-21%)
- Persistent postop headache
Complications of RMSOC approach

- Post-operative cranial nerve dysfunction – V, VII, VIII, LCN
  - VII nerve paresis- Artificial tears, Lubricant eye gel, Lateral tarsorrhaphy, reanimation
  - LCN paresis- RT feeds/ Feeding gastrostomy
- CSF leak from the wound
  - Rule out Hydrocephalus
    - Stitch + Temporary LP drain
- CSF oto-rhinorrhoea
- Meningitis
- Wound infection
- Post-operative hematoma
Complication avoidance

- **VIII nerve dysfunction-**
  - Intra-op BAER
  - Identify cochlear division at the transverse crest
  - Arachnoid over the cochlear nerve to be preserved
  - Minimal manipulation of the nerve
  - Preservation of auditory artery

- **VII nerve dysfunction-**
  - Intraoperative monitoring
  - Identify nerve at the nerve root exit zone and at the transverse crest
  - Sharp dissection
  - Minimal manipulation of the nerve

- **V nerve dysfunction-**
  - Debulk large mass-remove tumor from the nerve, not nerve from the tumor

- **LCN dysfunction-**
  - Minimal manipulation of the nerve
  - Leave arachnoid over the nerves intact
  - Protect with gelfoam
  - Sharp dissection
Complication avoidance

- **Injury to AICA-**
  - Never coagulate any vessel until proximal/distal directions and supply is determined

- **CSF otorhinorrhoea (Paradoxical CSF rhinorrhoea)-**
  - Knowledge of pneumatized temporal bone and porus
  - Waxing of mastoid air cells

- **Cerebellar swelling/infarction-**
  - Adequate size of craniotomy
  - CSF to be released from cisterna magna
  - Periodic release of pressure from retractor
  - Craniectomy
  - Lasix/mannitol

- **CSF leak from the wound-**
  - Clean sharp incision
  - Careful handling of wound edges
  - Meticulous closure of the fascial layers, esp. along the inferior aspect of the wound overlying the mastoid tip, where clear fascial layers are not always present
  - Strict antisepsis, minimizing chances of wound infection
Middle fossa approach

- House, 1961
- **Indication**: Small intracanalicular tumor, especially in lat part with the aim of facial nerve & hearing preservation.
- Extradural subtemporal approach with microneurosurgical unroofing of IAC
Middle fossa approach

- IAC exposed by following GSPN to the geniculate ganglion
- The bone is then drilled off the arcuate eminence until only a thin layer of bone remains over superior semicircular canal → Posterior boundary of the dissection of IAC
- VII nv. followed from geniculate ganglion to the lateral end of the IAC
**Middle fossa approach**

**Advantages:**
- Extradural dissection
- Complete exposure of the IAC
- Avoid blind dissection in lateral IAC
- Total removal of Tumor even the lateral part- good for small tumors.
- Hearing preservation (50-70%)
- No risk of CSF leak

**Disadvantages:**
- Facial nerve comes first- more manipulation
- Limited access to post fossa, esp. if there is bleeding
- Only small intracanalicular tumor
- Elderly patients with thin dura are less tolerant to temporal lobe retraction

**Postop Complications:**
- Bleeding
- Stroke
- SIADH
- CSF leak
- Meningitis
Translabyrinthine approach

- Panse, 1904
- House, 1964
- Exposes posterior fossa in the retromeatal trigone (Trautmann’s triangle)
  - Sigmoid sinus
  - Jugular bulb
  - Superior petrosal sinus
- Moderate sized tumor $\rightarrow$ 1-2.5 cm
- Auditory function lost
Translabyrinthine approach

Adv:  
- Early identification of facial nerve – 97% preservation
- Direct approach to the CPA, absence of significant cerebellar retraction
- Short distance between surface and tumor
- Excellent exposure of the lateral end of IAC
- Less postop headaches

Disadv:  
- Deafness
- Reduces exposure
- **More CSF leak – 27%**
- Middle ear infection is a contraindication.
- Limited in patients with anterior sigmoid sinuses and high-riding jugular bulbs
Choice of approach

ACOUSTIC TUMOR

> 2.5 cms

Suboccipital approach

<= 2.5 cm

Hearing preservation

No

Translabyrinthine

<= 1 cm

Middle fossa

Yes

1-2.5 cms

Suboccipital
Facial N preservation

- 1st - Cairns 1931
- Olivecrona - 1st to attempt in a large series of patients

- VII nerve monitoring
  - EMG monitoring of muscles innervated by VII nerve
  - Displayed on an oscilloscope connected to an audio amplifier.
  - Statistically significant difference in anatomical & functional VII nerve preservation

- Facial Motion sensor
- Others-
  - Intraop change in threshold of stimulation reflects amount of damage.
  - Threshold of stimulation at REZ at brainstem reflects outcome.
- Delayed Facial weakness: edema/inflammation- usually complete recovery by 6 month
- Outcome assessed at one year
House and Brackmann Grading

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- Asymmetry 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
Facial nerve anatomically preserved in 78%, last follow up- 82% patients showed acceptable facial function.

GTR in 24.2%, NTR 47.2% and STR 28.6%.

The preoperative tumor size was not statistically related to the extent of resection.

Meningitis and Chest infection—major causes of morbidity. Mortality 2.2%.

Intraoperative facial nerve monitoring: definite adv in anatomical preservation.

Learning curve of surgeons, large tumor size, preoperative lower cranial nerve involvement, altered sensorium at the time of admission, cystic nature of the tumors and low general condition at the time of surgery were the main factors contributing to morbidity and mortality.
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 Mc Kissock first reported hearing preservation in 1954
• 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.

• Direct recording of CNAP from nerve- good predictor, but impairs surgical field, 8th nerve must be visible before it can be used

**Problems:** dislodgement of electrode, fluid in middle ear may block sound transmission.
Recent Advances

- *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)
• **Mech 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- nervosum circulation
  - Increased permeability of endoneural vessels after mech. compression trauma
  - Progressive scarring of IAC with compression of cochlear N or microvasculature
Technical points avoiding cochlear nerve injury

- *Jannetta et al*:  
  - Elevate cerebellum, avoid medial retraction!  
  - Sharp dissection with scissors (No CUSA/laser/forceps)  
  - Alternate dissection in all directions  
  - Preserve even small vessels going into the IAC
Hearing preservation: Prognostic factors

- **GOOD**
  - Small tm (<2cm)
  - Good pre op hearing
  - Lack of lateral tm extension to fundus of IAC
  - Absent caloric response (tm from sup vestibular N.)

- **POOR**
  - Sudden intra-op loss of potentials is a poor prognostic factor
  - Intraoperative presence of severe adhesions between nerve and tm- m imp. factor: *Moriyama et al JNS 2002*
## Results

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

<table>
<thead>
<tr>
<th>Size</th>
<th>Facial (Grade 1/2)</th>
<th>Hearing (Grade 1/2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;2</td>
<td>96%</td>
<td>48%</td>
</tr>
<tr>
<td>2-3.9</td>
<td>74%</td>
<td>25%</td>
</tr>
<tr>
<td>&gt;4</td>
<td>38%</td>
<td>0</td>
</tr>
</tbody>
</table>
Conservative management

- 2nd radiologic exam in 6 months, then yearly
- If the tumor grows 2-3 mm in the first year, then they will likely need treatment

**Indications**
- Advanced age (> 65 yrs)
- Short life expectancy (< 10 yrs)
- Poor general health
- Small tm with minimal / no symptoms especially intracanalicular
- Tm in the only or better hearing ear.
- NF 2
- Patient preference

**Contraindications**
- Young patient
- Healthy patient
- Symptomatic progression
- Compression of brainstem structures
Conservative management

- Disadvantages
  - Risk of hearing loss even in non-growing tm.
  - Loss of patient compliance
  - Chances of hearing preservation better in cases short symptom duration
Result of conservative management

- Prospective cohort study of 72 patients
  - Age at presentation: 60.8 years
  - Mean follow-up: 80 months
- Mean tumor size at diagnosis: 9.4 mm
- Mean tumor growth rate: 1 mm/year
- 87% growth rate < 2 mm/year
- Tumor growth
  - + : 39%
  - 0: 42%
  - - : 19%
- No correlation between growth and age, gender, size at presentation, or presenting symptoms
- 32% failed conservative management

Role of Endoscopy

- Tm<3cm
- 1.5-cm "keyhole" retrosigmoid craniotomies
- 95% tumors were completely removed
- Anatomic preservation of the facial nerve – 100% & of the cochlear nerve in 82% cases
- No LCN paresis
- No death

Quality of life (QOL) after VS surgery

- Factors contributing to QOL-
  - Hearing loss
  - Facial paresis
  - Postoperative ataxia
  - Dysguesia
  - Post-operative headache

Quality of life after acoustic neuroma surgery.

- 33% required postoperative home help
- Suboccipital surgery-
  - Poorer facial nerve function
  - More reports of pain & incapacity to work
- Translabyrinthine approach-
  - More severe pain, postoperative vertigo
- Larger the tm, more no. of patients unfit to work
Taste dysfunction in vestibular schwannoma

- n = 142.
- Pre-op decreased sensation - 40.8%, Sensory disturbance - 33-45%
- Post-op disturbance - 45.8%
- Improved taste - 6.9%
- Conclude
  - Dysguesia must be included in pre-op counselling.
  - Dysguesia to be included in facial nerve function assessment.

- 45.5% - experienced worsened facial weakness caused by surgery, and of these, 72% reported that it was permanent.
- 28% felt significantly affected by facial weakness
- The factor most often associated with poor outcome was a large tumor

Quality of life (QOL) after VS surgery

- Treatment for VS results in a significant reduction in QOL.
- Major effect is in the psychological area, with increased rates of emotional distress and impaired social functioning
- Patients with facial weakness are at the greatest risk of a poorer psychological outcome.
Role of Radiosurgery

• Low-morbidity alternative to microsurgery
• Similar long term tm control rate
• Indications-
  • Hearing loss/enlarging tumor in the only hearing ear
  • Functional hearing
  • Residual/recurrent tumor after subtotal removal
  • Patient with a tumor having ≤ 2cm intracranial extension
  • Major medical illness
  • Older patients (>75)
  • Patient’s decision

• Contraindications
  • Tumors > 3 cm
  • Prior radiotherapy
  • Tumor compressing brainstem
Role of Radiosurgery

- Multiple iso-centers (6-13) to achieve high degree of conformality
- Prescription doses most commonly used today – 12-13 Gy

Outcome
- Local control (non-progression): 94%
- Transient swelling in the first two years
- Hearing preservation: 47 – 77% - decreases each year after radiation and stabilizes after 3 years in 50% of patients

Complications
- Facial nerve injury: 5 - 17%
- Trigeminal nerve injury: Numbness 2 - 11%
- Hearing loss
- Hydrocephalus: 3%
- Radiation induced tm
Radiosurgery experience-

<table>
<thead>
<tr>
<th>Institute</th>
<th>n</th>
<th>Median FU (months)</th>
<th>Median Marginal tm dose</th>
<th>Tm control</th>
<th>V nv complication</th>
<th>VII nv</th>
<th>VIII nv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pittsburgh</td>
<td>313</td>
<td>24m</td>
<td>13 Gy</td>
<td>98.6%</td>
<td>4 %</td>
<td>0 %</td>
<td>30 %</td>
</tr>
<tr>
<td>Osaka</td>
<td>51</td>
<td>60m</td>
<td>12 Gy</td>
<td>92%</td>
<td>2 %</td>
<td>0 %</td>
<td>44 %</td>
</tr>
<tr>
<td>Marseille</td>
<td>97</td>
<td>36-108</td>
<td>12-14 Gy</td>
<td>97 %</td>
<td>4%</td>
<td>0%</td>
<td>30%</td>
</tr>
<tr>
<td>Jefferson</td>
<td>69</td>
<td>27m</td>
<td>12 Gy</td>
<td>98%</td>
<td>5%</td>
<td>2%</td>
<td>67%</td>
</tr>
<tr>
<td>Amsterdam</td>
<td>49</td>
<td>33m</td>
<td>12.5Gy</td>
<td>100%</td>
<td>8%</td>
<td>7%</td>
<td>25%</td>
</tr>
<tr>
<td>AIIMS (10 yrs)</td>
<td>198</td>
<td>27m</td>
<td>12 Gy</td>
<td>95.50 %</td>
<td>0.5 % (1)</td>
<td>2% (4)</td>
<td></td>
</tr>
</tbody>
</table>
Management decisions

- Depend upon-
  - Size of tumour
  - Symptoms of the patient
  - Age
  - Hearing preservation
  - Patient’s wish

- Intracanalicular tm $\leq 5\text{mm}$-
  - tV, haemangioma
  - Usually asymptomatic
  - Observation with regular audiologic and radiological monitoring

- Intracanalicular tm $5-10\text{mm}$-
  - GK
  - If patient wishes surgery- Middle fossa approach
VESTIBULAR SCHWANNOMA: SURGERY OR GAMMA KNIFE RADIOSURGERY? A PROSPECTIVE, NONRANDOMIZED STUDY. Neurosurgery. 2009 Feb 4

- Tm with CP angle extension,

  10-25mm-
  - GK
  - Surgery- Suboccipital if hearing salvagable
    - Translabyrinthine if hearing already gone

25-35mm-
  - Surgery – Suboccipital

35-50mm-
  - Surgery – Suboccipital – Total microsurgical excision/ Subtotal excision
    + Post-op GK to small residual
Only hearing ear?

- Stable hearing – FU with MRI and PTA
- Progressive hearing loss- choice discussed with patient
- Options:
  - GK/fractionated RT
  - Subtotal removal/complete removal with IAC decompression with an attempt to save hearing
  - Translabyrinthine removal and placement of brainstem auditory implant
NF-II

- B/L vestibular schwannoma is the hallmark
- Autosomal Dominant, 22q
- More difficult to remove surgically (more invasive, higher growth rate)
- Young patients, Faster tm growth
- Multilobulated tm, arising from multiple cranial nerves
- Poor VII and VIII nerve outcomes with both surgery and GK

**Goal:** decompression of brainstem followed by preservation of facial and auditory function

**In general, the larger tm is operated on first**

- If facial paralysis after first surgery → surgery on opposite side is delayed until the nerve recovers or facial reanimation is performed
Chances of good outcomes are best when surgery is performed early and when there is good preoperative hearing function.

Ideal: - complete of resection with functional cochlear nerve preservation

Subtotal microsurgical resection with functional cochlear nerve preservation in the last hearing ear.

NF II: MARSEILLE GUIDELINES

- Operate worst hearing side first.
- SRS favoured whenever possible.
- One ear deaf: deaf ear 1st especially if tm larger.
- Both ear deaf: larger first.
Tumor control and hearing preservation after Gamma Knife radiosurgery for vestibular schwannomas in NF2

MS Sharma, R Singh, SS Kale, D Agarwal, BS Sharma, AK Mahapatra

Journal of Neuro-Oncology Volume 98, Number 2, 265-270

- 1997 to 2008: 30 patients with 54 VS
- Tumor control rate: 87.5% (33.3% tumor regression)
- Hearing preservation: 66.7%
- One patient: worsening of facial function.
- CONCLUSION: GKS for VS provides satisfactory tumor control and hearing preservation in patients with NF 2
Rehabilitation

- **Problems after Vestibular Schwannoma Surgery:**
  1. Facial paresis
  2. Hearing impairment
  3. Cerebellar ataxia
  4. Lower cranial nerve paresis
  5. Post-operative headache
  6. Cognitive impairment and depression
Facial Reanimation

- **Factors to be considered-**
  - Cause & Extent of facial paralysis
  - Duration of facial paralysis
  - Likelihood of recovery from facial paralysis

- **Timing of surgery after post-op VII nv paralysis**
  
  - VII nv anatomically severed, not repairable intracranially
    - XII-VII nv Anastomosis after 3-4 weeks
    - Adequate, though delayed Functional recovery
  
  - VII nv anatomically & physiologically preserved
    - Wait till 1 yr
    - 90% pts will have
    - Functional recovery
Facial reanimation procedures

**Dynamic procedures** - improve facial tone & motor function
- Primary nerve repair
- Nerve grafting
- Neuromuscular pedicle grafts
- Regional ms. Transposition
- Microvascular muscle transfers

**Static procedures** - add support and symmetry to the patient’s face at rest
- supplement results of nerve grafting/ dynamic procedures
  - Gold weight implantation in upper eyelid
  - Lower lid ectropion correction

**Ideal** - directly re-establishing facial nerve continuity

**Nerve interposition grafting** -
- Can be performed upto 1 year after injury
- Results best if performed within 30 days
- Results poor if performed > 2yrs after injury, consider ms. transposition in such cases
  - Hypoglossal-facial anastomosis
  - Spinal accessory-facial anastomosis
  - Phrenic-facial anastomosis
Hypoglossal-facial anastomosis

- **Classical**
  - Baker & Conley
  - Entire proximal XII nv sutured to distal main trunk of VII nv
  - Improvement in eye closure, facial tone & facial asymmetry
  - Variable degree of tongue paralysis with resultant deglutition dysfunction

- **Modified**
  - May et al
  - *End-to-side*(jump) interposition nerve graft between XII nv and VII nv
  - Preserved tongue function in > 90% cases
Muscle transposition

- **Temporals/ 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 paralyzed eyelids

- Lateral tarsorrhaphy (cosmetic concern)
- Gold weight implantation in upper eyelid – to restore eyelid closure
- Palpebral sling placement
- Procedure to correct lower lid ectropion – implant a piece of auricular cartilage in the lower eyelid

- 1-cm incision at the tarsal-supratarsal fold region, centered just medial to the midpupillary line
- Subcutaneous pocket
- 0.9.1, 1.1 gm weights, 1mmx5mmx10mm
Hearing Rehabilitation
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
Lower cranial nerve rehabilitation

- RT feeds/ Feeding gastrostomy
- Nurse with intact side down
- Tracheostomy
- Chest physiotherapy
- Deglutition training

Cognition/ depression

- Psychological counseling
- Patient support group- Acoustic neuroma association
- Family support group
Thank you