Facial nerve preservation in vestibular schwannomas

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Introduction

- Vestibular schwannomas- Most common of intracranial schwannomas
- Arise from the transition zone of myelin at the porus acusticus (Obersteiner-Reidlich zone)
- MC arise from the inferior vestibular nerve
- Peak incidence in 4th - 6th decade
- Sporadic/Familial
Grading

- **Koos**: (Grade 1-4) upto 1, 2, 3 and >3 cm (intracanalicular + cisternal)
- **Ojemann**: (small, med, large) <2, 2-3 >3 cm (intracisternal)
- **Samii**: >3×2 cm large, rest small. (both intra + extrameatal), also T1, T2, T3ab, T4ab
- **Shekhar**: (small, med, large) <2, 2-3.9, >3.9 cm (only intracisternal)
Facial nerve

- Seventh cranial nerve
- Motor and sensory components (motor- 70%, sensory- 30%)
  - Sensory part also called nerve of Wrisberg
- Branchiomotor- supplies muscles of second branchial arch
Structures supplied

- Motor
  - Muscles of facial expression
  - Muscles of scalp and ear
  - Buccinator, stapedius, stylohyoid, posterior belly of digastric, platysma
  - Parasympathetic secretory fibers to sublingual and submandibular salivary glands, lacrimal gland and mucous membranes of oral and nasal cavities
• Sensory
  • Taste- anterior 2/3 rd of tongue
  • Exteroceptive- eardrum and EAC
  • Proprioceptive- muscles it supplies
  • General visceral sensation- salivary glands and mucosa of nose and pharynx

• Anatomically, motor part is separate from the sensory and parasympathetic
3 parts

- Intracranial part- Pons to IAC (15-17 mm)
- Intratemporal part- IAC to stylomastoid foramen
  - Meatal segment (8-10 mm)- within meatus
  - Labyrinthine segment- from fundus of meatus to geniculate ganglion; here, facial nerve has the narrowest diameter (0.61-0.68 mm) and shortest segment (4 mm)
  - Tympanic/ horizontal segment- from geniculate ganglion to just above the pyramidal eminence (11 mm)
  - Mastoid/ vertical segment- from pyramid to stylomastoid foramen
- Extra-cranial part- from stylomastoid foramen to termination of branches
Nervus intermedius (Nerve of Wrisberg)

- Sensory and parasympathetic division
- Preganglionic parasympathetic fibres to
  - Submaxillary ganglion (to sublingual and submandibular glands)
  - Pterigopalatine ganglion (to lacrimal, palatal and nasal glands)
- Also receives sensory fibres from geniculate ganglion
<table>
<thead>
<tr>
<th>Branch</th>
<th>Place of origin</th>
<th>Structures supplied</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSPN</td>
<td>Geniculate ganglion</td>
<td>Secretomotor fibres to lacrimal and nasal glands</td>
</tr>
<tr>
<td>Nerve to stapedius</td>
<td>Level of second genu</td>
<td>Stapedius</td>
</tr>
<tr>
<td>Chorda tympani</td>
<td>Middle of vertical segment</td>
<td>Secretomotor fibres to salivary glands (SL, SM) Taste from ant 2/3 of tongue</td>
</tr>
<tr>
<td>Communicating branch</td>
<td>Just distal to N to stapedius</td>
<td>Joins auricular br of vagus and supplies concha, post meatus</td>
</tr>
<tr>
<td>Posterior auricular nerve</td>
<td></td>
<td>Muscles of pinna, occipital belly of occipito-frontalis</td>
</tr>
<tr>
<td>Muscular branches</td>
<td></td>
<td>Stylohyoid, posterior belly of digastric</td>
</tr>
<tr>
<td>Peripheral branches</td>
<td>Distal to stylomastoid foramen</td>
<td>Upper temporofacial-temporal, zygomatic, buccal Lower cervicofacial-marginal mandibular, cervical</td>
</tr>
</tbody>
</table>
Facial nerve identification-Imaging

- Routine T2WI not sufficient for identifying facial nerve
- DTI based tractography can be utilized to know the relation of facial nerve (also other cranial nerves) to the tumour
  - Gerganov et al, Diffusion tensor imaging–based fiber tracking for prediction of the position of the facial nerve in relation to large vestibular schwannomas. JNS Dec 2011- 22 patients- DTI to surgical correlation was 90%
  - Chen et al -DTI with tractography- 3 patients; could identify facial and trigeminal nerves. Neurosurgery Apr 2011-3 patients-only imaging identification.
History

- Sir Charles Ballance first successfully resected an acoustic neuroma in 1894
- Harvey Cushing - advocated subtotal removal
- Walter Dandy (1925) - first surgeon to totally resect acoustic tumours successfully
  - Dandy himself wrote that "paralysis of the facial nerve must usually be accepted as a necessary sequel of the operation."
- Cairns (1931) - first surgeon to document facial nerve function preservation
- Olivecrona (1940) - Performed surgeries by observing facial twitches to guide tumour resection
• Goal of surgery has changed from prolongation of life to cranial nerve function preservation.
• Loss of facial nerve function is a debilitating and psychologically devastating condition.
• According to the Acoustic Neuroma Association, facial nerve dysfunction remains the number one concern among patients undergoing cerebellopontine angle surgery.
Facial nerve palsy-Pathogenesis

- Most common cause of postoperative facial nerve palsy is direct trauma or nerve stretching during surgery (mostly neuropraxia/axonotmesis)
- Devascularization of nerve segments that are effaced by large tumors.
- Thermal injury (both hot and cold)
How to minimize?

- Initial debulking f/b dissection
- Dissect the tumour from the nerve and not vice-versa
- Excessive pressure on facial nerve to be avoided
  - Cottoinoids and microsuction devices to be used
  - Sharp dissection is a must until clear plane is identified
- Avoid excessive cerebellar retraction to avoid undue tension on the nerve
Arterial supply of facial nerve

- Labyrinthine art of AICA
- Greater superficial petrosal branch of MMA
- Stylomastoid branch of ECA
  - Maintaining blood supply is critical
  - Avoid inadvertent vascular injury
  - Blunt dissection near all vascular structures
  - *Maintain arachnoid plane*
  - Topical papaverine after resection to prevent vasospasm
Thermal injury

- Both hot and cold can lead to facial paresis
  - Lasers (CO₂) can cause permanent damage
  - Caution while using bipolar cautery near nerves
  - During drilling of IAM, continuous warm saline irrigation is recommended.
- Overly cold irrigation may "stun" the nerve and is avoidable with use of warmed saline solutions.
• If facial nerve disrupted during surgery
  • Immediate repair is advisable
    • Direct proximal to distal anastomosis
    • Intracranial- intra-temporal (by drilling the temporal bone)
    • Intracranial- extracranial techniques
• If no function returns- then facial reanimation
  • Not later than 1 year
Intra-op facial nerve monitoring

- Olivecrona was the first to monitor facial function during surgery-1950
- Practical neurophysiologic monitoring first introduced by Delgado in 1979
- Now considered a standard in VS surgery.
- VII nv monitoring
  - EMG monitoring of muscles innervated by VII nv
  - Displayed on an oscilloscope connected to an audio amplifier
  - Statistically significant difference in anatomical & functional VII nv preservation
  - Enables the surgeon to obtain instantaneous feedback on facial nerve firing during tumor dissection
- Stimulation of the facial nerve at the brainstem with a threshold <0.05 mA predicts good facial nerve outcome.
• Allows definitive and early identification of facial nerve and thereby speeds up the dissection
• Reduced the operative times substantially, although not enhanced the facial nerve preservation substantially
• Stimulation should be used liberally throughout the operation.
• Electrical status of the nerve to be always determined immediately before closure by stimulation at the brainstem and the entire course.
• Immediately postoperatively, 75% of the 0.1 mA threshold group, 42% of the 0.2 mA group and 18% of the >= 0.3 mA group had good (Grade I or II) facial nerve function.

• One year postoperatively, 90% of the 0.1 mA group, 58% of the 0.2 mA group and 41% of the >= 0.3 mA group had Grade I or II function.

• Statistically significant breakpoint of 0.2 mA was found to predict good postoperative facial function.
<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>No of cases</th>
<th>Anatomical preservation</th>
<th>Functional preservation</th>
<th>Total removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>House</td>
<td>1979</td>
<td>500</td>
<td>96.6%</td>
<td>48%</td>
<td>93.4%</td>
</tr>
<tr>
<td>Lalwani</td>
<td>1994</td>
<td>129</td>
<td>99.2%</td>
<td>90%</td>
<td>77%</td>
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<tr>
<td>Sami</td>
<td>1997</td>
<td>1000</td>
<td>93%</td>
<td>90%</td>
<td>98%</td>
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<tr>
<td></td>
<td>2006</td>
<td>200</td>
<td>98.5%</td>
<td></td>
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</tr>
<tr>
<td>Sampath</td>
<td>1998</td>
<td>611</td>
<td>97.5%</td>
<td>89.7%</td>
<td>99.5%</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>(&lt; 2.5 cm-100%; &gt; 3 cm-90%)</td>
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<td>(overall) 100% in T1,T2,T3</td>
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AIIMS data

- 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%.
Literature review

- Microsurgical resection: (78-85%)
  - Age < 65 yrs (84% v/s 71%)
  - Approach: Middle fossa approach (85%) > Translabyrinthine (81%) > Suboccipital (78%)
  - Tumour size: < 20 mm (90% v/s 67%)
  - Use of intra-op nerve monitoring (76% v/s 71%)
    - 79 studies, 11873 pts
    - Grade 3 or higher facial palsy were excluded.
Radiosurgery: (96.2%)
- Tumour volume- <1.5 cm³
- Marginal radiation dose</=13 Gy
- Age< 60 yrs
  - 23 studies, 2200 pts.
  - Average F/U-54.1+/- 31.3 mts
Facial nerve sparing approach for VS

- Small tumours (<2.2 cm³) - Primary GKRS
- Larger tumours (>3 cm) / severe symptoms - Primary microsurgical resection
  - GTR - if feasible and facial nerve not at risk (by IOP monitoring)
  - Or else STR f/b GKRS for significant residual/recurrent tumour.
- Rate of preservation - around 97%
Facial nerve re-animation

• Refer to interventions that restore facial symmetry, resting tone, voluntary movement, or a combination of these.
• Several broad categories of facial reanimation techniques exist
  • Reinnervation techniques
  • Muscle transfers and
  • Static procedures
• Dynamic procedures-
  improve facial tone & motor function
  - Primary nerve repair
  - Nerve grafting
  - Neuromuscular pedicle grafts
  - Regional muscle 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
    - Palpebral sling placement
    - Lower lid ectropion correction
Re-innervation techniques

- Also termed *nerve substitution techniques*
- Provide neural input to the distal facial nerve through motor nerves other than the ipsilateral facial nerve
- Nerves used:
  - Hypoglossal nerve-MC used
  - C/L facial nerve
  - Others
    - Spinal accessory
    - Trigeminal nerve
    - Glossopharyngeal nerve
Muscle transposition techniques

- Indicated in cases of significant atrophy of facial musculature
- Muscles used
  - Temporalis- MC used
  - Others
    - Masseter
    - Digastric
  - Free muscle transfers
    - Gracilis
Static facial reanimation procedures

Indications:

- Patients who are poor candidates for prolonged general anesthesia for medical reasons
- Patients with a poor prognosis in whom reanimation over a long time is not appropriate
- Dynamic reanimation failures.
- Patients with partial recovery following Bell’s palsy, Ramsay Hunt syndrome, or other conditions leading to aberrant regeneration
• Nasal valve repair-for dilator nares paralysis
• 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
Conclusions

- Goals of surgery- changed from prolongation of life to preservation of cranial nerve function
- Sound anatomical knowledge, good microsurgical techniques, especially maintenance of anatomical planes- very crucial
- Pre-op tumour size- significant factor in facial nerve outcome
- Use of intra-op nerve monitoring- valuable adjunct in acoustic tumour surgeries.
- Facial palsy complications to be dealt with aggressively including reanimation techniques
Thank you