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 acousticus (Obersteiner- Reidlich zone)
- MC arise from the inferior vestibular nerve
- Peak incidence in 4^{th} -6^{th} decade
- Sporadic/Familial

Grading

- *Koos*: (Grade 1-4) upto 1, 2, 3 and >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)

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(0.61-0.68mm) and shortest segment (4 mm)
  - Tympanic/ horizontal segment- from geniculate ganglion to just above the pyramidal eminence (11mm)
  - 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

Branch	Place of origin	Structures supplied
GSPN	Geniculate ganglion	Secretomotor fibres to lacrimal and nasal glands
Nerve to stapedius	Level of second genu	Stapedius
Chorda tympani	Middle of vertical segment	Secretomotor fibres to salivary glands(SL, SM) Taste from ant 2/3 of tongue
Communicating branch	Just distal to N to stapedius	Joins auricular br of vagus and supplies concha, post meatus
Posterior auricular nerve		Muscles of pinna, occipital belly of occipito-frontalis
Muscular branches		Stylohyoid, posterior belly of digastric
Peripheral branches	Distal to stylomastoid foramen	Upper temporofacial-temporal, zygomatic, buccal Lower cervicofacial-marginal mandibular, cervical

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 artery branch 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 n paresis
  - Lasers (CO_2) 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
  - *Sampath et al: Facial nerve injury in acoustic neuroma (vestibular schwannoma) surgery: etiology and prevention. Neurosurg Focus 1998*
- 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

Author	Year	No of cases	Anatomical preservation	Functional preservation	Total removal
House	1979	500	96.6%	48%	93.4%
Lalwani	1994	129	99.2%	90%	77%
Sami	1997 2006	1000 200	93% 98.5	90% 81% (overall) 100% in T1,T2,T3	98%
Sampath	1998	611	97.5%	89.7% (< 2.5 cm-100%; > 3 cm-90%)	99.5%

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%.
  - *Microsurgical management of giant acoustic neuromas: An institutional series of 400 cases: Sinha S, Sharma B S, Asian Journal of Neurosurgery 2008*

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%)
    - *Sughrue ME et al:* ***Preservation of facial nerve function after resection of vestibular schwannoma.*** *Br J Neurosurg 2010 Dec*
    - *79 studies, 11873 pts*
    - *Grade 3 or higher facial palsy were excluded.*

- Radiosurgery: **(96.2%)**
  - Tumour volume- <1.5 cm^3
  - Marginal radiation dose</=13 Gy
  - Age< 60 yrs
    - *Yang I et al:* ***Facial nerve preservation after vestibular schwannoma Gamma Knife radiosurgery.*** *J Neurooncol 2009 May*
    - *23 studies, 2200 pts.*
    - *Average F/U-54.1+/- 31.3 mts*

Facial nerve sparing approach for VS

- Small tumours (<2.2 cm^3)- 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%
  - *Haque R et al: Efficacy of facial nerve–sparing approach in patients with vestibular schwannomas. JNS Nov 2011.*

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