

**EDITORIAL**

# FACIAL NERVE PARALYSIS

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Paralysis of seventh cranial nerve is termed as facial nerve paralysis, it may be supra nuclear or infra nuclear. Supra nuclear facial nerve involvement is rarely isolated, always in conjugation to cerebral or brain stem lesions, while infra nuclear facial nerve paralysis is isolated in majority of cases and will be discussed here in detail except the distinguishing feature of supra nuclear, where forehead is sparsely involved and lesion may be spastic, while infra nuclear is always flaccid.

## SURGICAL ANATOMY

Facial nerve arises from the Ponto medullary juncture at the lateral part of lower border of pons medial to vestibulo-cochlear nerve (VIII) in two roots motor and sensory (nervus intermedius). The nerve runs forward and laterally and after a short course of 15-17 mm enters the internal auditory canal (IAC) along with vestibulo cochlear nerve. In C.P. angle it is related to anterior inferior cerebellar artery. In IAC Facial nerve is in antero superior quadrant and it runs about 8 mm to enter fallopian canal at the fundus.

Piameter-durameter junction generally lies at the fundus of the meatus, but can reach geniculate ganglion.

CSF may bathe the nerve up to geniculate ganglion. Viral inflammatory process in the CSF may involve the geniculate ganglion. Labyrinthine segment ends at Geniculate ganglion.

## LABYRINTHINE SEGMENT

Lies beneath middle cr. fossa shortest (3-5 mm) & thinnest. Extends from fundus to distal portion of gen. ganglion, narrowest at the fallopian canal entrance (0.68 mm in diameter), nerve in jeopardy because no anastomosing arterial arcades. Cochlea is anterior to nerve and posteriolateral is ampula of horizontal superior semicircular canal. Nerve rests on the vestibule. This anatomical relationship between the labyrinthine portion of the facial nerve to the basal turn of the cochlea is less than 0.5 mm. The cochlea can be violated during the middle fossa dissection when one considers the smallest

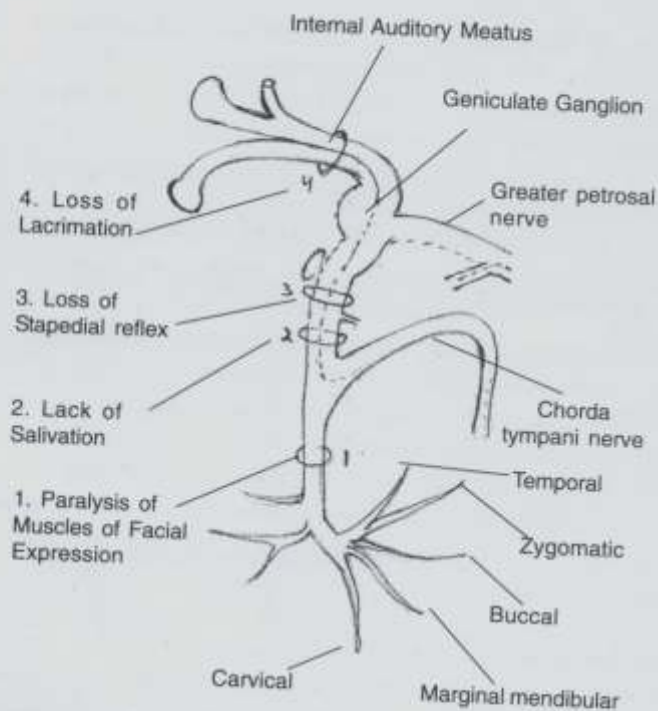


Figure I: Symptoms according to the level of injury to cranial nerve VII.

size of diamond drill burr, which is 0.6 mm. in diameter.

Geniculate ganglion gives rise to greater superficial petrosal nerve which supplies lacrimal gland. In the region of the geniculate ganglion there are ample pathways and connections for parasympathetic fibres to reach their terminations. Such alternate pathways explain how lacrimal flow may be unaffected by slow growing lesions at or proximal to the geniculate ganglion, and spontaneous recovery of tearing following resection of the geniculate ganglion or nerves intermedius. Upon surgical exposure, the geniculate ganglion appears as a pinkish blush because of its rich blood supply comparing with the luminous or glassy appearance of the other portions of the nerve. The nerve takes an abrupt turn posteriorly by 75 degree.

Here first genu or temporal segment begins which is about 11.0 mm long running between cog and process cochleiformis anteriorly and between lateral semicircular canal and oval window posteriorly. The geniculate ganglion lacks a bony covering in approximately 15% of temporal bones, an arrangement that makes the facial nerve quite vulnerable to injury during surgery

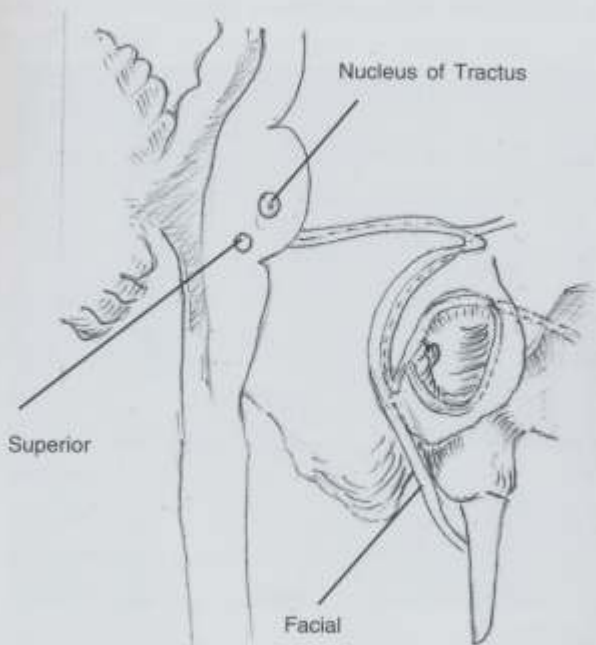


Figure II : Anatomy of Facial Nerve

involving the middle cranial fossa and also the bone being thin over the tegmen tympani, especially in children. The change in direction taken by the facial nerves at the first genu is another reason why this site is the most common focus of injury when severe traction is applied to the nerve along the axis of its tympanic segment as it may occur in longitudinal fracture of the petrous pyramid. fallopian canal may be dehiscant in 6 % cases, either at supra tubal recess (epitympanic recess) or at caudal surface at oval window. The cochleariform process and pyramidal process are a useful landmarks to find the facial nerve when other land marks are obscured by granulation tissues or cholesteatoma, or in cases of trauma. At the end of temporal segment or horizontal segment it turns postero inferiorly for 2-3 mm and second genu begins from here, vertical or mastoid segment commences which ends at stylomastoid foramen which is about 13 mm. long. The facial nerve exists the skull base through the stylomastoid foramen, between the mastoid tip laterally and the styloid process medially. Lower end of fallopian canal has got thick adherent periosteum, more vascularised sheath hence more vulnerable to compression and difficult to release surgically. In vertical segment the facial nerve gives origin to various branches. Nerve to stapedius which as name prompts supply the stapedius muscle, paralysis resulting in hyperacusis. The nerve to the stapedius muscle arises from the deep side of the facial nerve. Care must be taken not to avulse the stapedius tendon during the stapes surgery or to allow the cutting burr to tear the stapedius muscle in the mastoid surgery or during facial nerve decompression, because of the facial nerve proper could be injured by traumatic manipulation of the stapedius muscle. Chorda tympani nerve, which gathers taste sensation from ipsi lateral anterior two third of tongue cause altered or diminished taste. Chorda tympani nerve arises usually 6.0 mm. above the stylo mastoid foramen and runs

foreward and upward in bony canal close to posterior part of tympanic annulus and leaves the middle ear through petro tympanic fissure to infra temporal fossa to join the lingual nerve. Large chorda tympani nerve is also encountered. The chorda tympani nerve seems to play a prominent role in cases of Bell's Palsy and Herpes Zoster wherein the nerve is red & swollen. It also provides sensory supply to external auditory canal and secreto motor fibres to lacrimal, nasal, submandibular and sublingual glands. The facial nerve also supplies motor supply in its infra temporal course to stylo hyoid, posterior belly of diagastric, post auricular muscles and muscles of face via temporal, zygomatic, buccal, mandibular and cervical branches. The cervical branch also supplies the platysma.

Surgically facial nerve can be divided into first *intra cranial* (IC), second *inratemporal* Labyrinthine upto first Genu, tympanic or horizontal upto second Genu and mastoid or vertical segment from second genu to stylo mastoid foramen, third is *extra temporal* segment from stylo mastoid foramen to muscles of face.

#### **Facial nerve communicates with**

Vestibulocochlear nerve within internal auditory canal, Otic ganglion, Sympathetic fibres in the area of geniculate ganglion and auricular branch of vagus.

#### **Outside the stylomastoid foramen**

Glossopharyngeal nerve, Vagus nerve, Greater Auricular nerve, Auriculotemporal nerve. These peripheral branches communicate behind the ear with lesser occipital nerve.

On the face with trigeminal nerve. In the neck- Cervical cutaneous nerves.

#### **Blood Supply of Extra Medullary Part**

Cortical motor area of the face is nourished by Rolandic branch of middle cerebral artery. Within the pons, the facial nucleus receives blood supply from anterior inferior cerebral artery and short and long circumferential arteries.

#### **Blood is supplied with Intracranial Part**

Anterior inferior cerebellar artery which enters the IAC with VII & VIIIth nerves. Petrosal branch of middle meningeal artery along with greater petrosal nerve. Stylomastoid branch of posterior auricular artery which enters stylomastoid foramen. However, despite the richness of the blood supply to most areas of the facial nerve, vascular occlusion may still be a factor in the pathogenesis of Bell's palsy :

Area proximal to the geniculate ganglion is vulnerable to ischaemic compression since there are no anastomoses. It is the narrowest part of the fallopian canal. This might have bearing on the pathogenesis of facial paralysis following embolisation of the middle meningeal artery.

#### **Facial Nerve Decompression**

Decompression is performed once the complete cortical mastoidectomy has been performed and tegmen plate, sinodural angle, sinus plate, diagastric ridge, lateral semicircular canal, fossa incudis and short process of incus bone if available is identified. In sclerotic bone anterior end of diagastric ridge or diagastric ridge itself may be difficult to identify hence dissection should begin below the level of meatal floor and coming medially and upward like a funnel one can reach the stylo mastoid foramen.

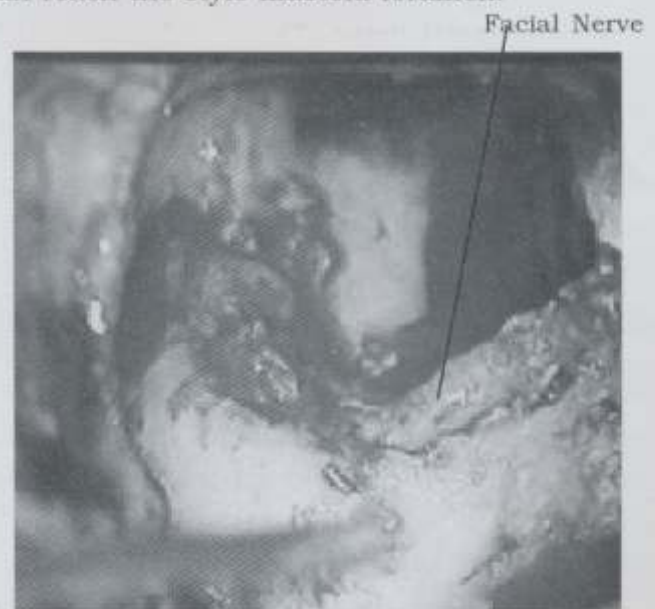


Figure V : Facial Nerve released from fallopian canal

### Vertical Segment

One must revise the anatomy that is vertical segment starts from second genu medial to short process of incus (which should not be disturbed in surgery) and anterolateral to horizontal semicircular canal at the inferior end of fossa incudis.

An imaginary line drawn upto anterior end of diagastric ridge and deep or medial to the tympanomastoid suture. The bony posterior auditory canal is thinned out to its maximum but preventing button holes. The dissection starts from either end till the fallopian canal is visible. All dissection is carried out on posterior surface of fallopian canal. Always working parallel to the facial nerve.

Remember that dissection is more safe with diamond burr but it produces much more heat hence higher risk of temporary thermal injury to facial nerve, which can be avoided by practically submerging the field in irrigating fluid, which also provides better and early identification of fallopian canal. Always remember that after second genu facial nerve becomes lateral towards stylo mastoid foramen. During drilling of posterior auditory canal, surgeon should be careful not to injure chorda tympani nerve which is usually 3.0 to 4.0 mm. above the facial nerve. The chorda tympani is

always superior. To short process of incus at the level of annulus tympanicus.

At this step, one must revise the anatomy of facial recess, which is bounded superiorly by fossa incudis and short process of incus laterally by chorda tympani, medially by facial canal and inferiorly by acute angle of facial nerve and chorda tympani. The facial recess should be extended superiorly to fossa incudis to access the horizontal segment of facial nerve .

For decompression, posterior 180° of vertical segment should be opened, hence the bony fallopian canal is drilled till the sheath becomes visible but an egg shell bone remains over it which is removed at the end to exploration and sharply cut the sheath if required.

If complete exposure for grafting is required canal wall down mastoidectomy is performed and in vertical segment of nerve is exposed posteriorly to avoid injury to chorda tympani nerve and at second genu always lateral to nerve to avoid injury to the horizontal semicircular canal.

### Horizontal Segment

The facial nerve is approached initially through the extended facial recess after dislocating the incudo stapedial joint and removing the incus. Facial nerve lies inferior to horizontal semicircular canal and above the oval window

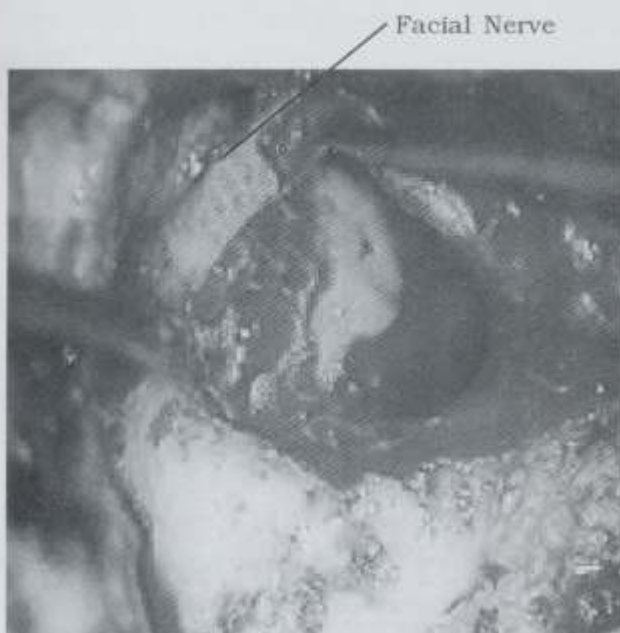


Figure VI : Transmastoid Facial Nerve Exposure

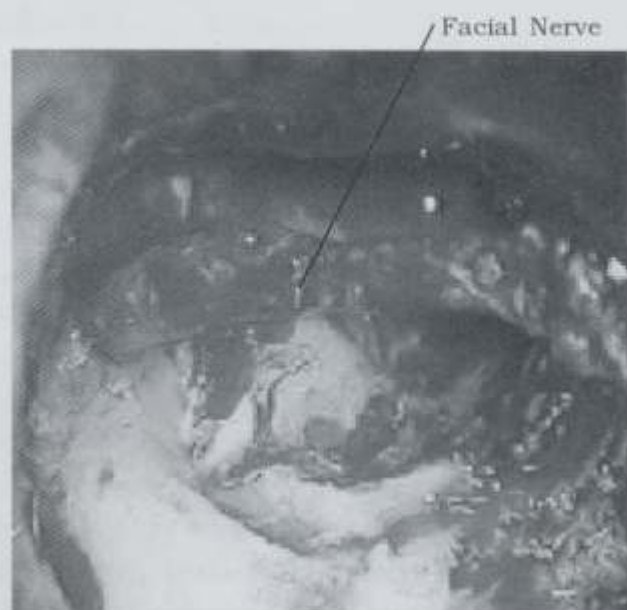


Figure VII : Facial Nerve rerouted

posteriorly and process cochleoformis and cog anteriorly a possible site of facial nerve involvement in cholesteatoma. Since facial recess is narrow space, drilling is performed with diamond drill with copious irrigation. Middle ear cavity is packed with moist gelfoam to avoid collection of bone dust. Inferior surface of fallopian canal is drilled with 1 mm diamond burr. Superior or lateral surface is avoided to prevent the injury to lateral semicircular canal. The nerve can be explored upto geniculate ganglion and greater superficial petrosal nerve can be explored too. If nerve grafting is required, it is better to perform a modified radical mastoidectomy lowering the facial ridge to the level of horizontal semicircular canal and anterior end of diagastric ridge. Incus bone and head of malleus bone has to be removed for better visualization. Nerve grafting along with tympanoplasty may be performed in one or two sitting.

#### Labyrinthine Segment

It can be exposed after scarifying the ampulla of horizontal semicircular canal. In cholesteatoma cases, horizontal semicircular canal fistula may be associated with dehiscent fallopian canal or facial nerve paralysis, fistula may suggest the area but fistula must be differentiated from fallopian canal. It should not be handled at this stage, specifically a suction may result in injury to labyrinth. Remember that basal trum of cochlea must be taken care of which is 0.5 mm away from nerve.

#### Nerve Decompression

Once the nerve is exposed in entire tympano mastoid segment an attempt is made to identify any compression by bone chip, cholesteatoma matrix, polyp or a growth from nerve itself even it may be the prosthesis placed over supra structure or foot plate of stapes. There is no need to incise the sheath if causative factor is identified and pressure can be released.

The nerve sheath is opened from within outward. Remember that it has got abundant blood supply and bipolar cautery may be required along with hypo tensive anaesthesia to control the bleeding.



Figure VIII : Shape bevelled cut made at either end of facial nerve

The sheath is very tough and blended with periosterm 1.0 cm each side at stylo mastoid foramen, hence if not required it should not be opened which may result in facial nerve injury followed by paralysis.



Figure IX : Approximation of graft.

#### Transmastoid total nerve exposure

This includes trans labyrinth exposure along with horizontal and vertical segment. Surgery is performed when vestibular and cochlear function have been lost preoperatively or can be sacrificed as in congenital cholesteatoma extending into internal auditory canal. Surgery is usually performed in transverse fracture of temporal bone with facial nerve paralysis.

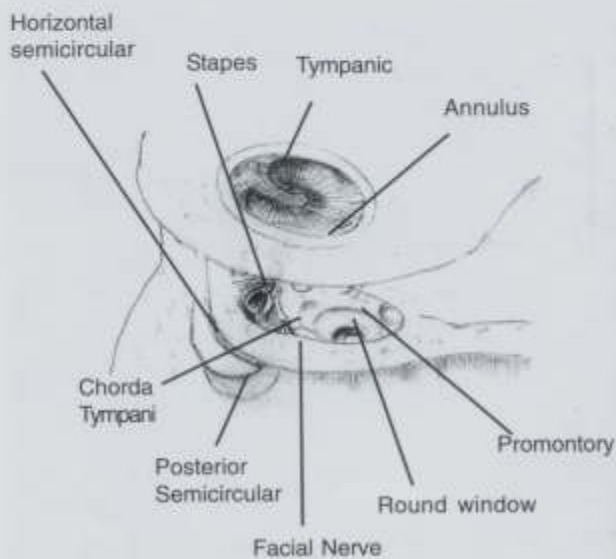


Figure IV : Surgical anatomy of Facial Recess

An extended post aural incision is given usually 3.0 cm behind the crease and wide radical mastoidectomy is performed and labyrinthectomy is performed by exposing sigmoid sinus, jugular bulb, posterior fossa dura and endolymphatic sac. Bone is removed to expose the pores acoustic. Facial nerve can be identified supero medial to superior vestibular nerve. Wound is closed with temporal fascia and abdominal fat.

#### Indication for Surgery

Facial nerve injury is usually caused by aggressive, brisk use of drill or by practically obsolete gouge and hammer. Surgical injury is more common at second genu or vertical segment or tympanic segment by excessive manipulation and placing a prosthesis over an exposed nerve.

#### Opening of nerve sheath or aponeurosis

Transaction of nerve upto 30 percent recovers usually by nerve decompression. The fallopian canal should be opened at least 4.00 mm. on each side of injury.

If more than 40 percent is injured, either mobilize the segment and suture the freshened ends or place an interposition graft.

Second intraoperative opinion on paper saves legal hassles and builds confidence.

Delayed postoperative paralysis should be given a chance to recover. Loss of electric excitability greater than 90 percent requires exploration by exposure of the sheath of fallopian canal while acute injury should be dealt within 72 hours.

One can correctly judge the depth of injury by nerve excitability test hence surgical intervention could be done accordingly.

#### Facial nerve grafting

Facial nerve grafting can be done in all cases where viable proximal end of nerve can be traced and sutured to graft and distal end of nerve is identifiable. Graft should be placed loose, absolutely tension free to handle postoperative fibrosis.

Nerve sheath merges with periosteum at stylomastoid foramen, hence it is a difficult

region for decompression of 1.0 cm on each side of the foramen.

Though sural nerve and medial antebrachial cutaneous nerve can be used, but greater auricular nerve is the choice of majority of otologists which can be identified on posterior surface of sternocleidomastoid between tip of mastoid and angle of mandible, upto 10.0 cm nerve can be harvested. The greater auricular nerves, size and fascicular pattern matches with facial nerve.

Monofilament suture 9.0 or 10.0 on 75 to 100 micron needle is used for suturing which is passed through the epineurium only to avoid injury to nerve at place of stitches; subject to availability, acrylic glue may be considered with equal result in temporal segment of nerve.

#### Other options

Hypoglossal nerve transposition end to side anastomosis is gaining popularity.

Nerve graft may be attached to denuded portion of muscles, which will allow neurotization to occur.

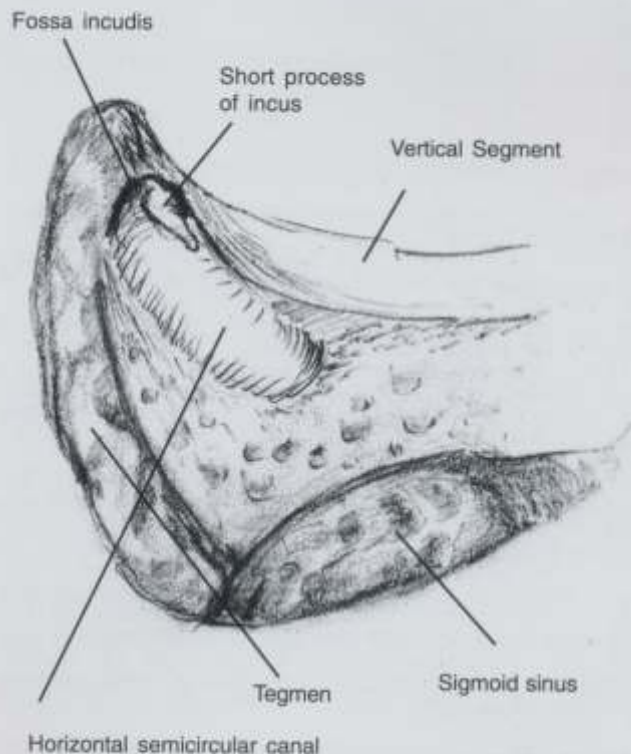


Figure III : Surgical Anatomy of Second genu of Facial Nerve