# Trigeminal Neuralgia

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Neurosurgery Resident Teaching
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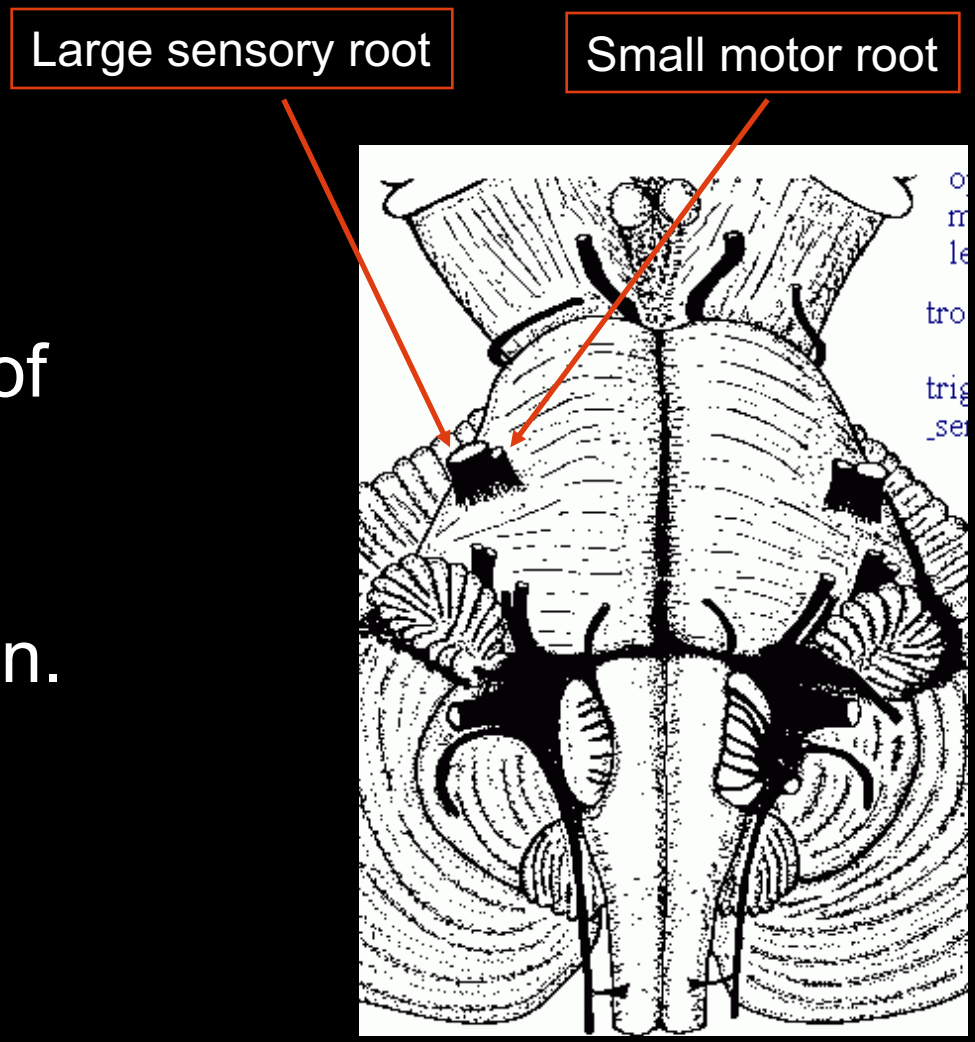
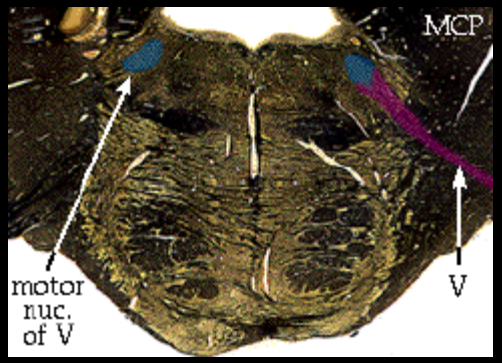
# Trigeminal Nerve Anatomy

- Largest cranial nerve.
- Great sensory nerve of the head and face.
- Motor nerve of the muscles of mastication.

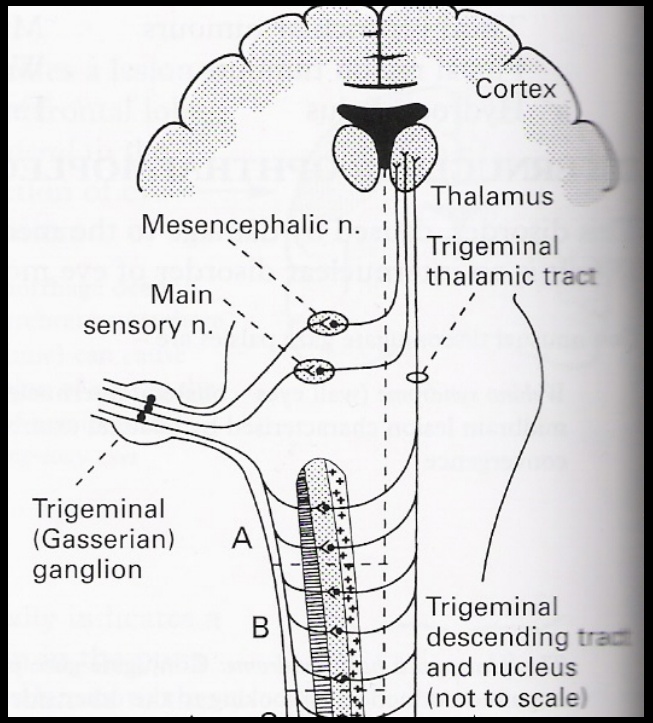


# Trigeminal Nerve Nuclei and Function

- Motor (masticator) nucleus:  Inervation of the muscles of mastication (ie, masseter, temporalis, medial and lateral pterygoid muscles, plus tensores tympani, tensores veli palatini, mylohyoid, and anterior belly of the digastric muscles



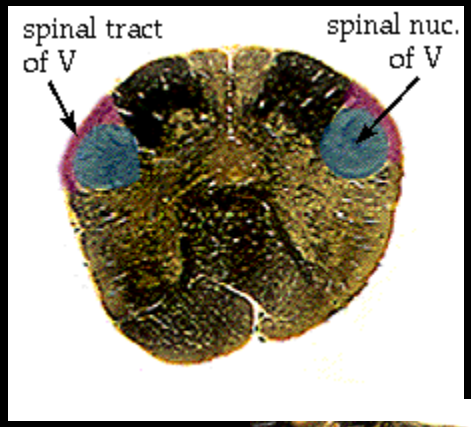
- Sensory roots arise from the trigeminal ganglion (gasserian ganglion, semilunar ganglion)

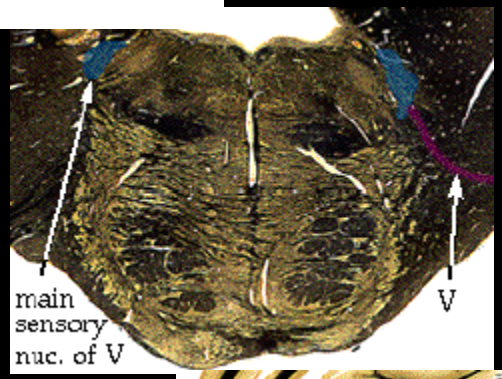


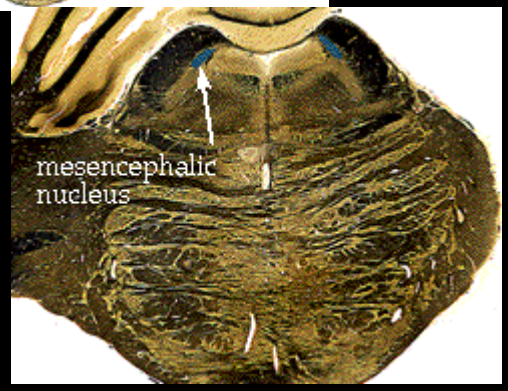
# Trigeminal Nerve Nuclei and Function

Sensory nuclei

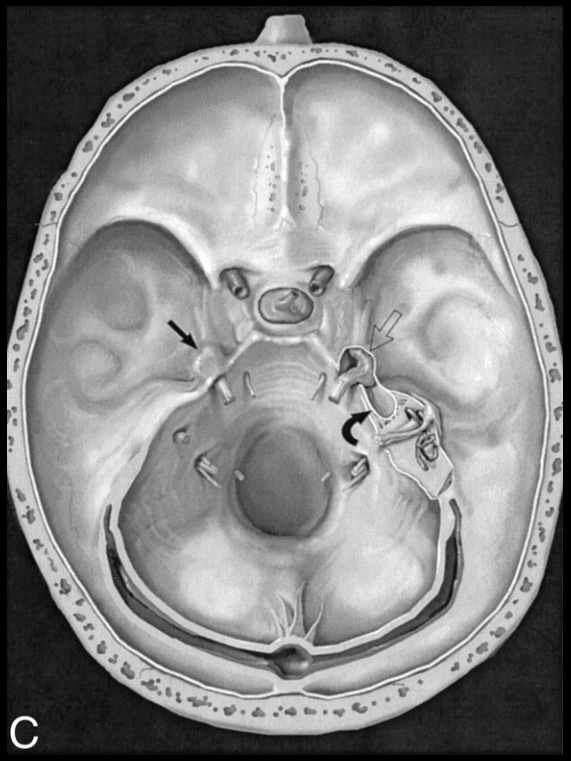
- Spinal trigeminal:
  Pain and temperature
  Simple touch
- Pontine trigeminal:
  discriminative touch
- Mesencephalic:
  Propioception
  Vibration sense

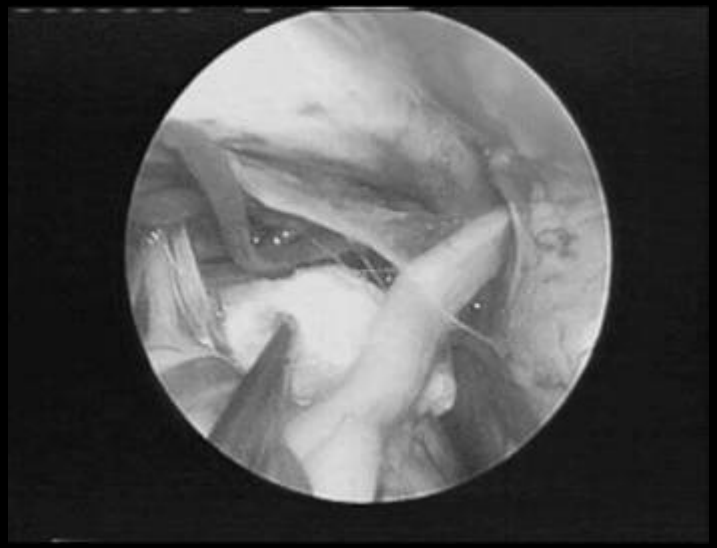


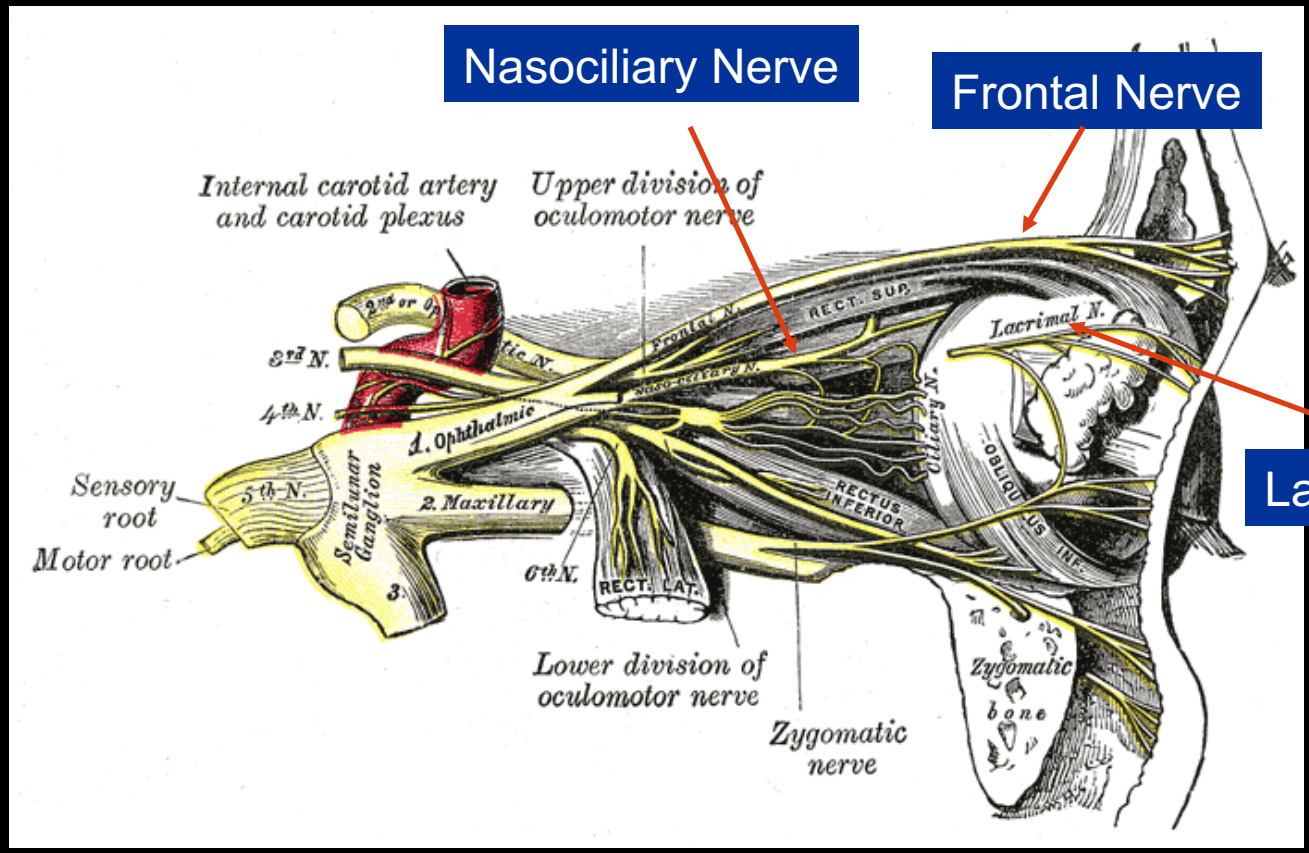



# Meckel's Cave



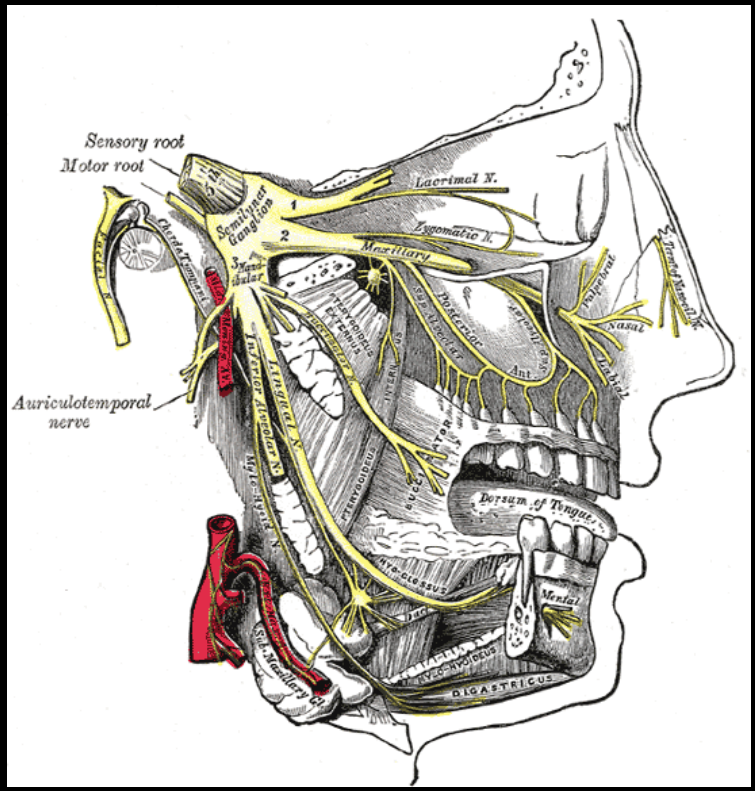
# Ophtalmic Nerve (V1)




Sensory nerve.
It supplies branches to the cornea, ciliary body, and iris; to the lacrimal gland and conjunctiva; to the part of the mucous membrane of the nasal cavity; and to the skin of the eyelids, eyebrow, forehead, and nose.

# Maxillary Nerve (V2)

- Sensory nerve
- It leaves the skull through the foramen rotundum into the pterygopalatine fossa.
- It enters the orbit through the inferior orbital fissure.
- It appears upon the face at the infraorbital foramen.



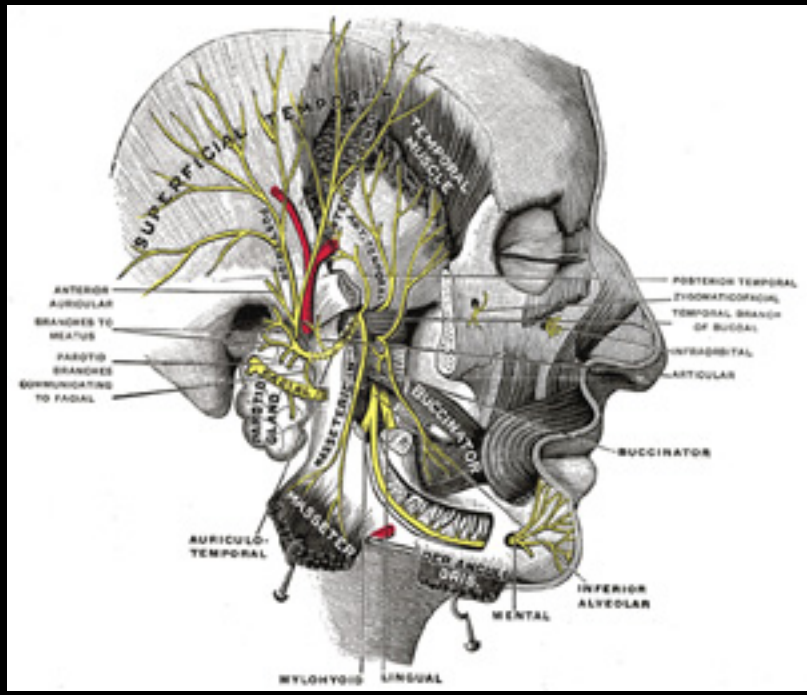

Branches

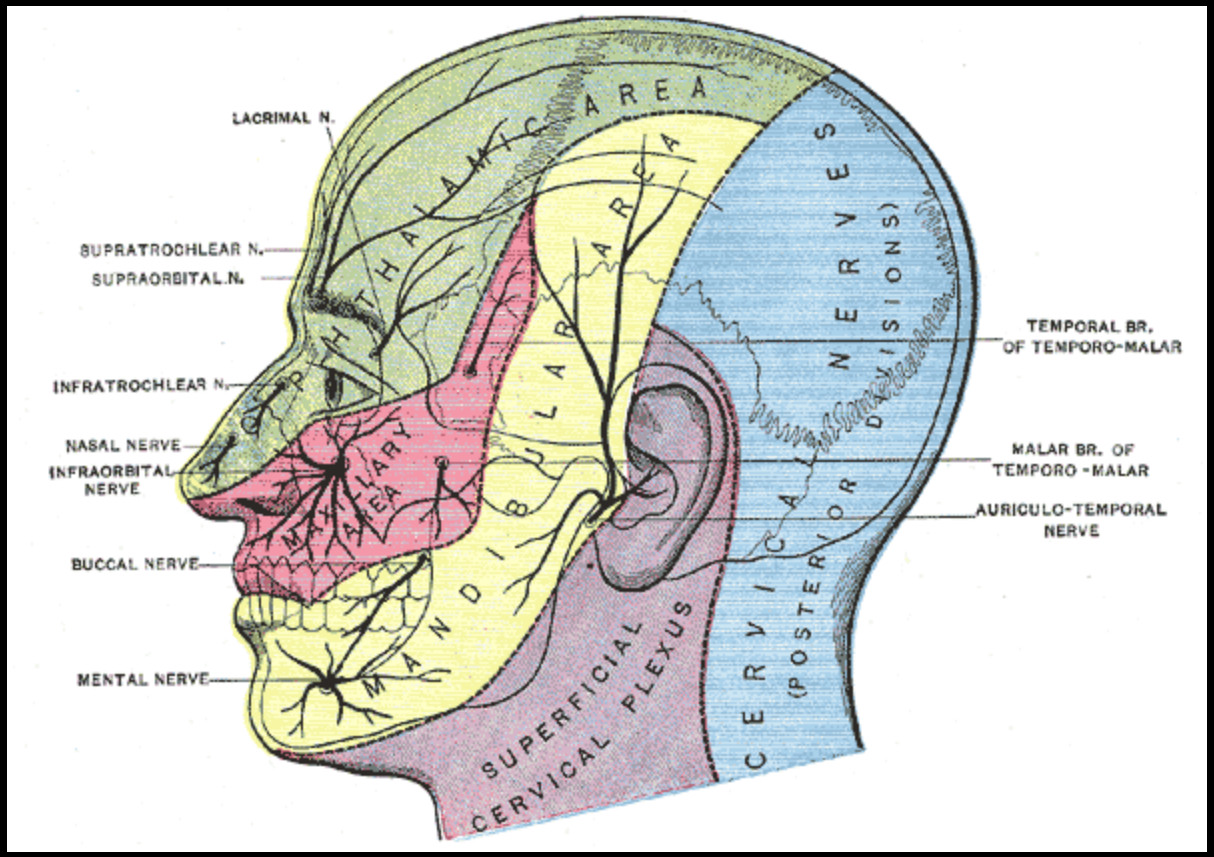
In the Cranium……Middle meningeal.
In the Pterygopalatine Fossa…Zygomatic.Sphenopalatine.Posterior superior alveolar.
In the Infraorbital Canal……Anterior superior alveolar.Middle superior alveolar.
On the Face……Inferior palpebral.External nasal.Superior labial.

# Mandibular Nerve (V3)

It supplies

- Teeth and gums of the mandible
- Skin of the temporal region, the auricula, the lower lip, the lower part of the face.
- Muscles of mastication.
- Mucous membrane of the anterior two-thirds of the tongue.




LACRIMAL N.
SUPRATROCHLEAR N.
SUPRAORBITAL N.
INFRATROCHLEAR N.
NASAL NERVE
INFRAORBITAL NERVE
BUCCAL NERVE
MENTAL NERVE
OPHTHALMIC AREA
MAXILLARY AREA
MANDIBULAR AREA
SUPERFICIAL CERVICAL PLEXUS
CERVICAL NERVES (POSTERIOR DIVISIONS)
TEMPORAL BR. OF TEMPORO-MALAR
MALAR BR. OF TEMPORO-MALAR
AURICULO-TEMPORAL NERVE

# Clinical Presentation

- Paroxysmal, “electric” pain in trigeminal distribution on one side of the face.
- Presence of trigger areas.
- Periods of remission and exacerbation.
- Pain is more severe in the morning and absent during sleep.
- Periodic pain relief when treated with an adequate trial of CBZ.

# Pathophysiology

- Demyelination of large-diameter A fibers at the trigeminal root entry zone.
- Ephaptic transmission from these fibers to poorly myelinated Aδ and unmyelinated C fibers, which results in paroxysmal facial pain.
- Demyelinitation may come from compression of the CN5 by an artery or vein at the root entry zone.

# Epidemiology

- Female-to-male ratio  2:1
- Age: ≥ 50 years.
- Incidence: 4 per 100,000 people per year.
- More common location: V2, V3 distribution.

# Neurological Exam

- It is usually normal.
- Remember:  Patients with MS or PC angle tumors can present with classic features of trigeminal neuralgia.

# Facial Pain Etiologies

| Structure | Examples |
|---|---|
| Nerve | Trigeminal neuralgia<br>Postherpetic neuralgia<br>Trigeminal neuropathic pain<br>Glossopharyngeal neuralgia<br>Sphenopalatine neuralgia<br>Geniculate neuralgia (Ramsay Hunt) |
| Teeth and Jaw | Dentinal, pulpal, or periodontal pain<br>Temporomandibular disorders |
| Sinuses and aerodigestive tract | Sinusitis<br>Head and neck cancer |
| Eyes | Tolosa-Hunt syndrome<br>Optic neuritis<br>Iritis<br>Glaucoma |
| Vessels | Giant cell arteritis<br>Migraine<br>Cluster headache |
| Psyche | Psychogenic facial pain<br>Atypical facial pain |

# Diagnostic Clues in Facial Pain

| Diagnosis | Pain Character | Pain Distribution | Pain Triggers | Other clues |
|---|---|---|---|---|
| Trigeminal neuralgia | Paroxysmal, lancinating | Trigeminal only<br>V2 most frequent | Touch, chewing, talking, etc | |
| Glossopharyngeal neuralgia | Paroxysmal, lancinating | Ear, throat | Swallowing | |
| Trigeminal neuropathic pain | Constant, burning, dull throbbing | Trigeminal only | None | Hx of trigeminal nerve injury |
| Postherpetic neuralgia | Constant, crawling<br>May have paroxysmal component | Trigeminal only<br>V1 most frequent | Touch | Hx of herpes zoster ophtalmicus |
| Anesthesia dolorosa | Constant, burning, itching in an insensate region | Trigeminal only | None | Hx of trigeminal nerve lesion |
| Malignancy | Constant<br>May have paroxysmal component | In area of neoplasm or referable to nerve compression | Possible if trigeminal nerve involved | Head/neck neoplasm |
| Atypical facial pain | Constant | Nonanatomic, often bilateral | None | Prominent psychiatric component |

# Consider the difference between…..

- Typical trigeminal neuralgia.
- Atypical trigeminal neuralgia.
- Atypical facial pain.

# Medical Management

*The initial treatment is usually medical*

Carbamazepine:

- Initial response of TN to CBZ is virtually universal. Lack of response ⟹ Reassessment
- A small percentage of patients cannot tolerate its side effects.
- Efficacy may have a gradual decline.
- Dosing: Starting dose: 100-300 mg/day Therapeutic range: 800-1200 mg/day
- Before initiating administration, a baseline complete CBC and liver and renal function tests should be obtained.
- Side effects: 20-40% of patients.
  Early dose-related side effects: somnolence, dizziness, nausea, and nystagmus.
  Dermatologic reactions: 5%-10% of patients.
  Rash, erythema multiforme, and Steven-Johnson syndrome.
  Hematologic: 2%-6% Aplastic anemia.
  Others: hepatotoxicity, hyponatremia, and CHF.
- Interactions: other AEDs. No significant interaction with baclofen.

# Phenytoin

- Pain relief starts within 2 days of onset of therapy.
- Dose: 5-7 mg/Kg/day
- No controlled trials comparing CBZ to phenytoin.
- Response rate: 25%-60%.
- Side-effects:  ataxia, drowsiness, nystagmus, and diplopia.
- Other side effects:  gingival hyperplasia, acne, hirsutism, morbilliform rash, Steven-Johnson syndrome, hepatitis, lupus-like syndrome, and folate-responsive megaloblastic anemia.
- Drug interactions: loosely bound to hepatic cytochrome P-450 ⇒ susceptible to competitive displacement ⇒ monitoring of serum levels.

# Baclofen

- GABA analogue
- Rapid gastrointestinal absorption: serum peak achieved in 2-3 hours.
- Half life 3-4 hours.
- Dose: initial dose: 10 mg TID. Incrementally increased until pain relief/toxicity. Usual maintenance dose in TN: 50-60 mg/day.
- Synergism of baclofen with CBZ and phenytoin supports the use of combination therapy.
- Side effects: somnolence, dizziness, and gastrointestinal distress.
- Baclofen does not have the life-threatening side effects of CBZ or phenytoin.
- Withdrawal of medication: should be gradual to prevent seizures and hallucinations.
- Interactions: Not known.

# Oxcarbazepine

- Keto derivative of CBZ.
- Metabolized to an active compound whose half-life is 14 to 26 hours.
- Small series have shown benefit in patients refractory to CBZ.
- Less significant toxicity compared to CBZ.
- Dosing is similar to that for CBZ.

Zakrzewska JM et al. J Neurol Neurosurg Psychiatry 52:472-476, 1989.

# Surgical Treatment Options

Denervating Procedures (Rhizotomy)

- Supraorbital
- Infraorbital
- Submental
- Subtemporal
- Posterior fossa

Nerve-sparing Procedures

- Percutaneous Procedures
  - Radiofrequency
  - Glycerol
  - Balloon compression
- Microvascular decompression

Radiosurgery

# Percutaneous Trigeminal Nerve Compression

## History

- 1950s Taarnhoj, Shelden, and Pudenz: observed that patients with numbness (nerve injury) after middle fossa craniectomy had better results. They proposed middle fossa surgery for compression of the ganglion.
- John Mullan developed the percutaneous approach for compression.

## Indications

- Medically refractory TN
- Patient suitable for a brief general anesthesia
- Patient understands and accepts that compression is an ablative procedure that will cause facial numbness

# Percutaneous Trigeminal Nerve Compression

## Preoperative considerations

- Brain MRI
- EKG:  Identification of patients at risk of intraoperative arrhythmias.
- Appropriate plan to discontinue warfarin and antiplatelet medications.
- Consider preoperative acyclovir for patients with known history of HSV infections.

## Anesthesia

•Avoid atropine before surgery.
•General anesthesia is induced with propofol and maintained with isoflurane.
•External pacemaker on the patient's chest.

# Percutaneous Trigeminal Nerve Compression

## Positioning and equipment placement

- Neck in neutral position with a soft support.
- Avoid neck manipulation – mean age of the patients: 65 year old.
- Keeps the area of the head free to provide space for the imaging unit.

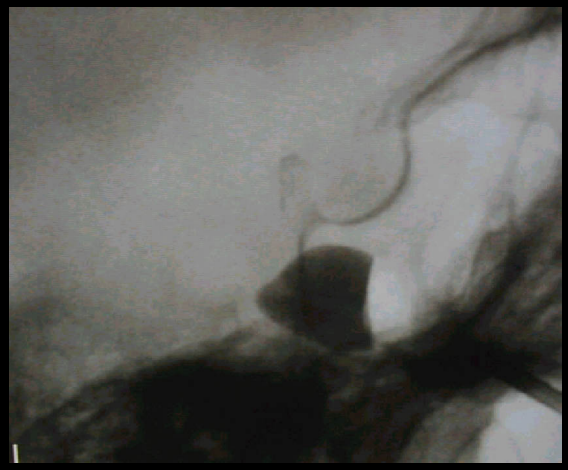
## Intraoperative imaging

Three views are used:  modified sub-mental, modified anteroposterior (AP), and lateral view.

# Percutaneous Trigeminal Nerve Compression

## Operative Procedure

- Entry point: 2.5 cm lateral from the angle of the mouth.
- The cannula is passed percutaneously and directed to the foramen ovale by using fluoroscopic imaging.
- Confirmation that the cannula has engaged the foramen ovale:  images, tactile feedback, and depressor response (bradycardia).
- The cannula should not pass beyond the foramen ovale.
- The blunt obturator is replaced by a straight guiding stylet which is pointed to the center for V2, lateral for V3, and medial for V1.  The stylet is advanced to the entrance of the Meckel's cave (17 to 22 mm beyond the foramen ovale).
- The stylet is withdrawn and the balloon is inserted.
- The balloon is inflated with 0.7 to 0.75 mL of 180 mg% of iohexol to reach a compression pressure of 1065 to 1215 mmHg.  Pear shape is observed.  The balloon is left inflated for 1 to 1.5 min.
- The needle and catheter are removed.



# Percutaneous Trigeminal Nerve Compression

Results

- Initial success: 93%
- Preserves poorly myelinated and unmyelinated fibers of the blink reflex:  especially indicated in V1 pain distribution.
- Subjective numbness after surgery: 61%
- Jaw weakness: 19%.  More common than with thermal rhizotomy or glycerol injection.
- Recurrence at 2 years 21%.  Higher risk in patients with little sensory loss after surgery.
- Unusual complications:  SAH, carotid-cavernous fistula.

# Percutaneous Glycerol Rhizotomy

- Jefferson: First injection of phenol mixed with glycerol for the ablation of TN in 1963.
- Håkanson: injected glycerin and tantalum into the trigeminal cystern as a radiographic marker for subsequent gamma knife radiosurgery. Patients improved before the radiosurgical procedure was performed.
- Mechanism of action:  Glycerol injures both myelinated and unmyelinated axons when injected into the nerve.
- Injection of 0.1 to 0.4 mL of glycerol into the trigeminal cistern.

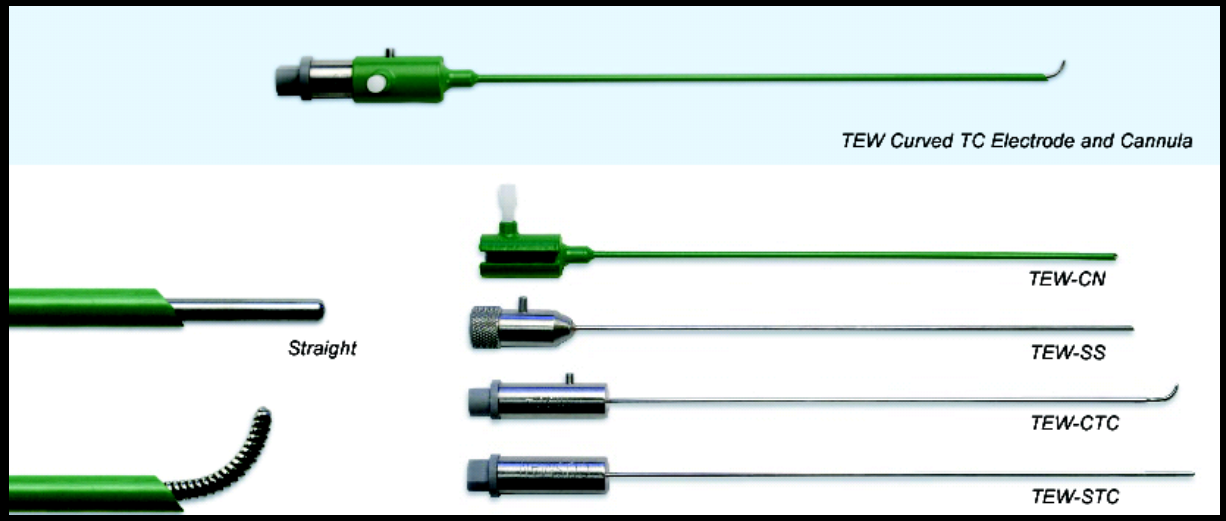
# Percutaneous Glycerol Rhizotomy

- Anesthesia: Sedation. GA is required in less than 1%
- Pain relief is immediate or within the next seven days.
- Recurrence is common: 92% at six years.
- Complications:  meningitis, sensory loss, anesthesia dolorosa, posterior fossa injury (deafness) and persistent pain.

# Percutaneous Radiofrequency Rhizotomy

- RF energy is used to cause a thermal injury in a selected rootlet of the TN.
- Introduced by Sweet 40 years ago.
- Results are better in V2 and V3 distribution cases.
- Avoid in V1 cases  higher risk of corneal problems.
- Anesthesia: Sedation.  Verbal feedback from the patient is required.

# Percutaneous Radiofrequency Rhizotomy

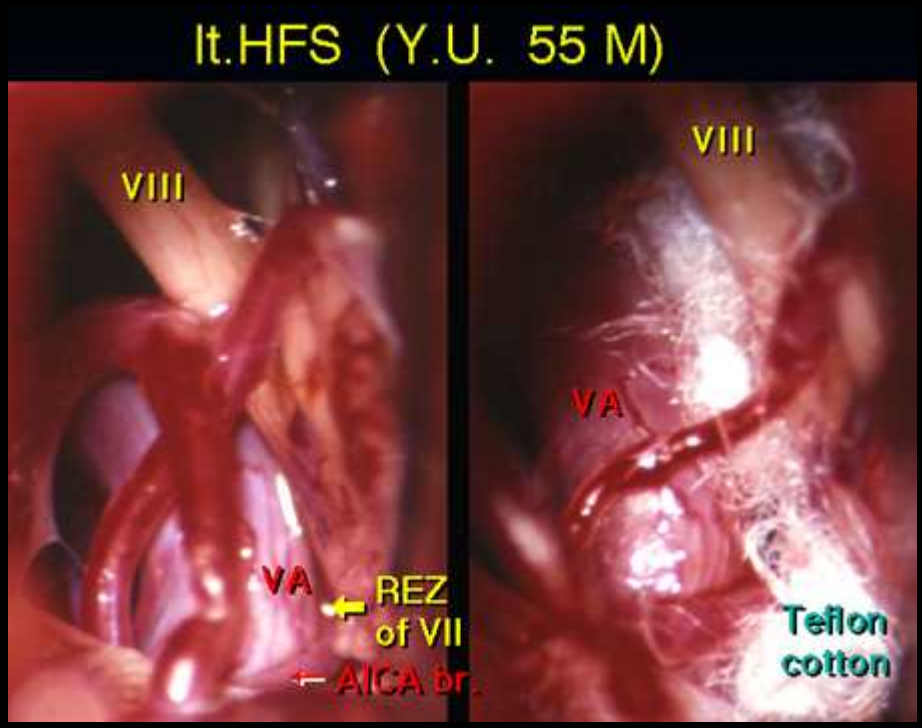



A 20 gauge needle is placed in the foramen ovale following regular landmarks. The electrode is inserted and its tip is placed depending on the targeted division.
Electrical stimulus with the patient awake confirms the selective placement of the electrode.
Lesion: increase of sedation; repeat until the desired effect is achieved.
Immediate pain relief: 99%.
Pain recurrence: 15%-20% in 10 to 15 years.

Taha JM et al, J Neurosurg 83:989-993,1995

# Microvascular Decompression

- Goal: treatment the underlying cause compression of the nerve by arteries or veins from the root entry zone to the exit into Meckel's cave.

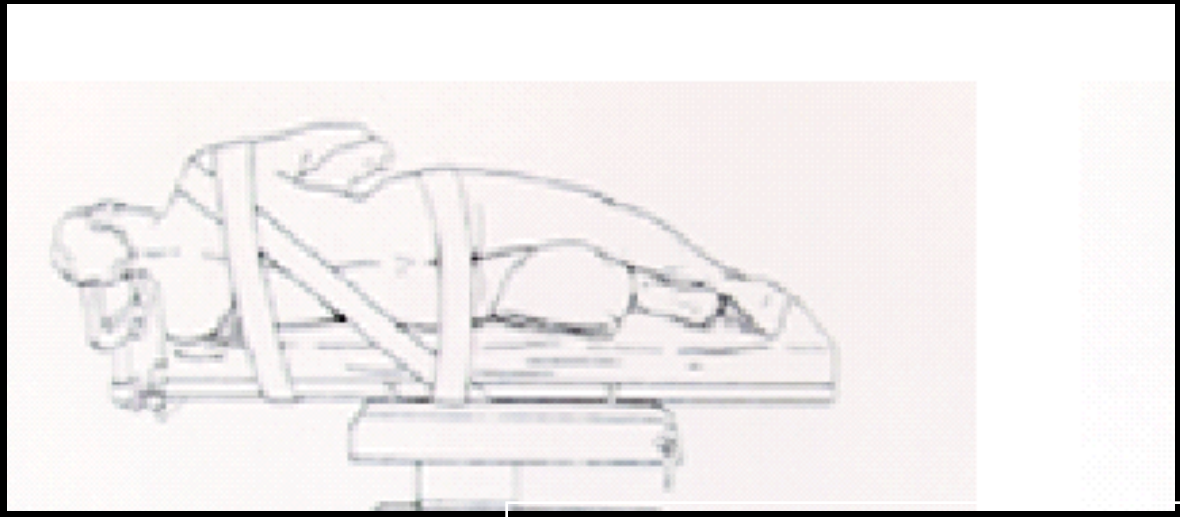


# Microvascular Decompression

## Technique

- General anesthesia.
- Monitoring of brain stem and CN 8 function: BSAEPs.
- Positioning:

  Lat. decubitus
  Three-point head holder.
  Pressure points are padded.
  Axillary roll.
  Neck: minimally stretched, mild flexion and rotation (10°) , vertex is tilted down (10°).
  The point of these maneuvers is to expose the occipitalboss.
  Shoulder: taped down and out of the way.

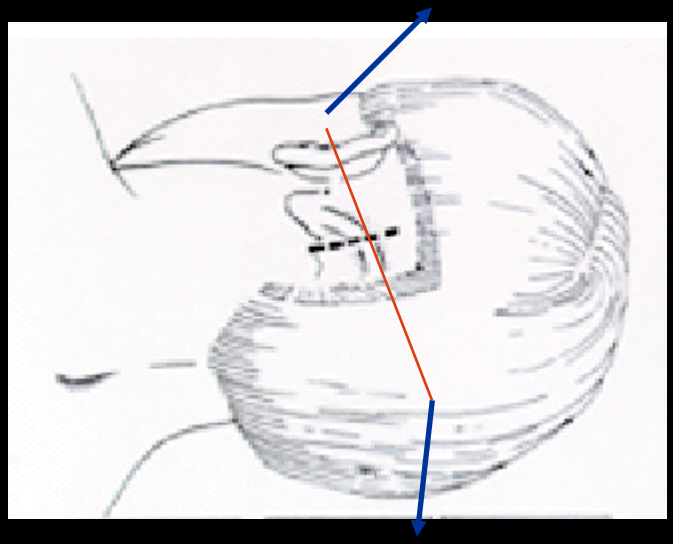


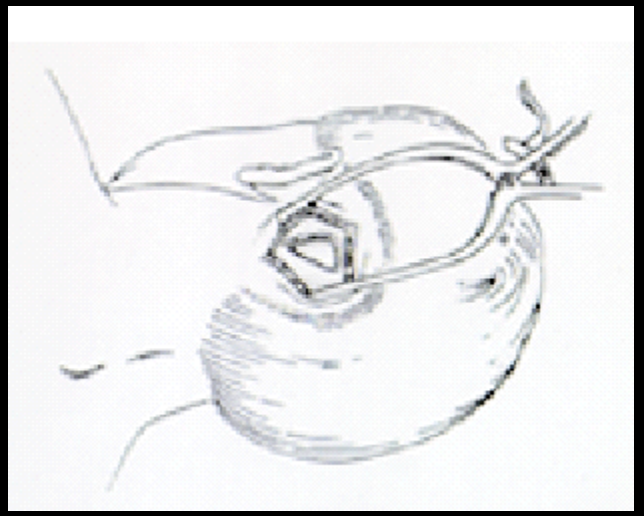
Jannetta PJ, et al. Neurosurg Focus 18(5):E5, 2005

# Microvascular Decompression

## Technique

- Retromastoid region: shaving and cleaning.
- Incision:  straight or slightly curved, 5-6 cm, behind the hairline.
- Landmarks to keep in mind: Position of sinuses, digastric groove (intersection of the sinuses).
- Burr hole: a finger-breadth posterior and caudal to the junction of sinuses.
- Craniectomy: Isosceles triangle with the hypotenuse facing away from the sinuses.
- Mastoid air cells should be waxed.
- Durotomy: curvilinear.



# Microvascular Decompression

## Technique

- Cerebellar relaxation: opening of lumbar drain, opening of subarachnoid space in the basal cisterns.
- Entering the supralateral angle of the posterior fossa: bridging veins are visualized.
- The superior petrosal venous complex may have to be partially or totally sacrificed to expose the CN5 which is underlying these vessels.
- CN5 should be exposed entirely from pons to the Meckel's cave entry site.
- Identification of arteries and veins that may be compressing the CN5:  SCA, veins, ectatic basilar artery.
- Placement of Teflon.
- Hemostasis – Valsalva maneuver.
- Dural closure.

# Microvascular Decompression

## Complications

- Complication rate is less than 5%
- Hematoma (0.1%)
- Significant edema (0.4%)
- Infarction (0.1%)
- Hydrocephalus (0.1%)
- Seventh CN paralysis (1.7%)
- Eighth CN injury (1.4%)
- CSF leak (1.6%)
- Meningitis (0.2%)
- Death (0.2%)

## Results

- Complete immediate pain relief in 84%
- Partial relief in 13%
- Complete relief at 5 years in 75%.
- Partial relief at 5 years in 8-10%.

Kassam A, and Horowitz M. Posterior fossa procedures for cranial neuralgias. In Follet KA (ed). Neurosurgical Pain Management. 2004,pp 232-236

The New England
Journal of Medicine



Volume 334 APRIL 25, 1996 Number 17

**THE LONG-TERM OUTCOME OF MICROVASCULAR DECOMPRESSION FOR TRIGEMINAL NEURALGIA**

FRED G. BARKER II, M.D., PETER J. JANNETTA, M.D., D.SC., DAVID J. BISSONETTE, P.A.-C., MARK V. LARKINS, M.D., AND HAE DONG JHO, M.D., PH.D.

- 1185 patients during a 20 year period (median follow-up 6 years)
- Immediate post-operative results: complete relief in 82%, partial relief in 16%, and absent in 2%.
- One year after surgery: complete relief in 75% (excellent outcome), and partial relief in 9% (good outcome).
- Ten years after surgery: excellent results in 64% and good results in 4%.
- Predictors of recurrence: female gender, symptoms lasting more than eight years, venous compression, and lack of immediate pain relief.

# Systematic Review of Ablative Neurosurgical Techniques for the Treatment of Trigeminal Neuralgia

- Comparison of the different ablative techniques: radiofrequency thermocoagulation, glycerol rhizolysis, balloon compression and stereotactic radiosurgery.

TABLE 2. Characteristics of the patient population included in the outcome analysis[a]

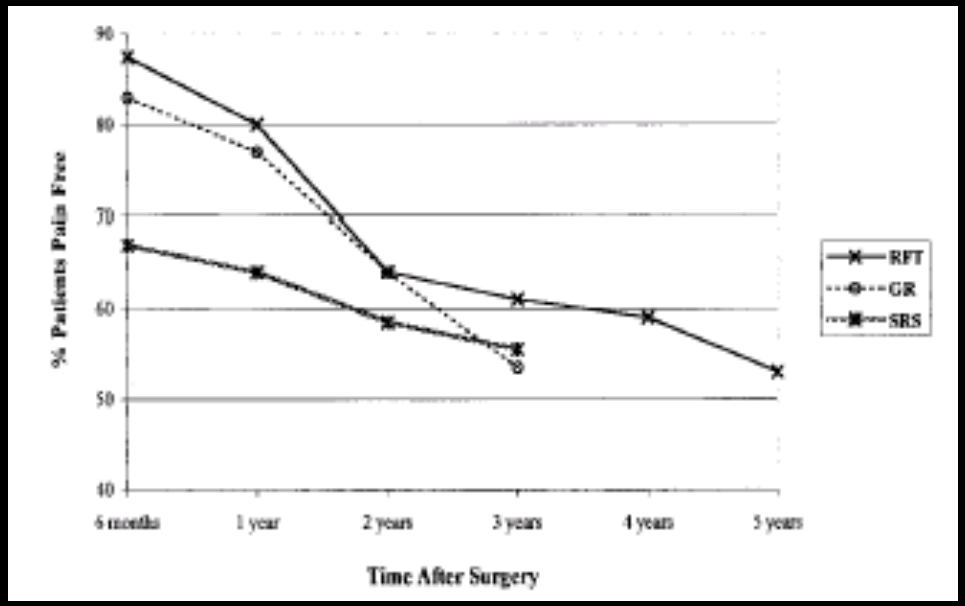
| Series (ref. no.) | Technique | No. of patients | Follow-up period (mo) | MS (%) | Atypical (%) | Preop. dysf. (%) | Prev. Sx (%) | Ops |
|---|---|---|---|---|---|---|---|---|
| Latchaw et al., 1983 (22) | RFT | 96 | 60 | 5 | 45 | NS | 51 | NS |
| Kanpolat et al., 2001 (18) | RFT | 1216 | 60 | 4.5 | NS | NS | 25 | 0.3 |
| Oturai et al., 1996 (36) | RFT | 185 | 96 | NS | NS | NS | 28 | NS |
| Zakrzewska et al., 1999 (57) | RFT | 48 | 30 | 0 | 35.4 | 0 | 0 | 0 |
| North et al., 1990 (34) | GR | 85 | 36 | 4.7 | 12.9 | NS | 38.8 | NS |
| Slettebo et al., 1993 (45) | GR | 60 | 54 | 10 | 15 | 15 | 65 | 0.86 |
| Brown et al., 1993 (6) | BC | 50 | 36 | 10 | NS | NS | 52 | NS |
| Maesawa et al., 2001 (28) | SRS | 220 | 22 | 0 | 7.3 | 37.8 | 61.4 | 1.5 |
| Pollock et al., 2002 (39) | SRS | 117 | 26 | 0 | 7 | 42 | 58 | 1.6 |

[a] RFT, radiofrequency thermocoagulation; GR, glycerol rhizolysis; BC, balloon compression of the gasserian ganglion; SRS, stereotactic radiosurgery; NS, not stated; follow-up period, median/mean follow-up period for the series; MS, percentage of patients with multiple sclerosis included in the analysis; Atypical, percentage of patients with atypical trigeminal neuralgia included in the analysis; Preop. dysf., percentage of patients with preoperative sensory deficits; Prev. Sx., percentage of previously surgically treated patients; Ops, mean number of previous operations per patient.

Lopez BC et al. Neurosurgery 54:973-983,2004

## Systematic Review of Ablative Neurosurgical Techniques for the Treatment of Trigeminal Neuralgia

- RFT provides better rates of complete pain control.
- SRS is associated with the fewest complications.
- Insufficient good quality data on BC

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