

Trigeminal Neuralgia: Case Report and Review

Benjamin M. Zussman, BS¹; Yaron A. Moshel, MD PhD²

¹Jefferson Medical College, Philadelphia, PA

²Neurosurgery Department, Thomas Jefferson University Hospitals, Philadelphia, PA

PATIENT VIGNETTE

We report the case of an 86-year-old female who described 15-years of sharp, stabbing pain that radiated down the distribution of the second and third divisions of her right trigeminal nerve. She described two trigger points, one on her right cheek and a second intra-oral trigger. Her symptoms were often triggered by eating and she had begun to lose weight secondary to the pain. She denied having any baseline pain between the episodes of lancinating pain. She denied any contralateral pain, dysaesthetic pain or any burning pain sensation. She denied any pain along the first trigeminal division and did not recently undergo any dental work or have a history of dental carries. Her symptoms had been initially well controlled with Carbamazepine 200 mg BID, but had recently worsened despite increasing the dosage to 600 mg BID when she started to develop medication-related side effects. Her past medical history was unremarkable, and on examination she was neurologically intact. Her brain magnetic resonance imaging (MRI) showed no masses or gross abnormalities, and she was diagnosed with trigeminal neuralgia.

Neurosurgical intervention was pursued because the patient was refractory to medical therapy and had worsening symptoms. Non-invasive Gamma Knife radiosurgery was recommended because of the patient's surgical risk profile and preference for a non-invasive procedure. Using Leksell stereotactic frame, a stereotactic MRI dataset was generated with a gradient echo and CISS sequence. On the Leksell gamma planning workstation we identified the right trigeminal nerve and prescribed 90 Gy to the 100% isodose line using a single 4-mm shot such that the 20% isodose line was tangential to the brainstem. The patient tolerated the procedure well and reported complete resolution of her symptoms at one-month follow-up.

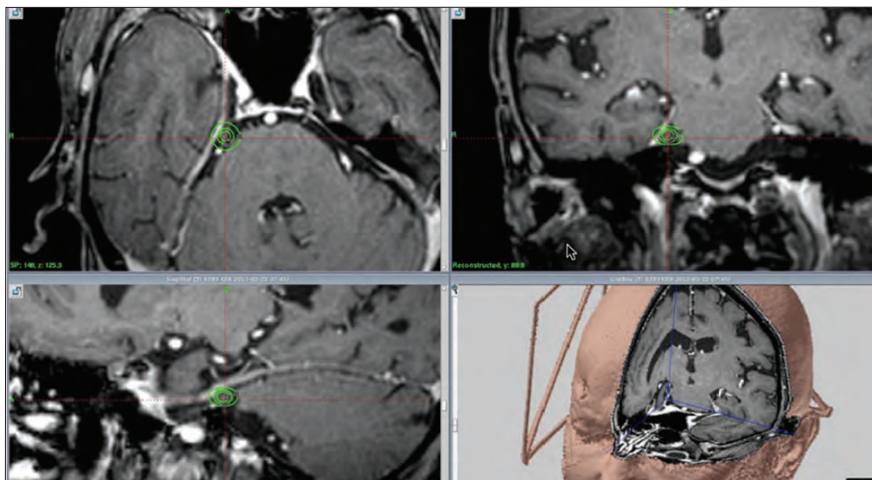


Figure 1

Gamma Knife Radiosurgery treatment plan screen shot

DISCUSSION

For patients complaining of facial pain, the differential diagnosis is broad. It includes dental abnormalities, such as caries, root abscesses, and broken teeth; temporomandibular joint pain; eye pain due to glaucoma, orbital cellulitis, or trauma; facial trauma including bony fractures; tumors of the facial bones or infiltrating the trigeminal nerve; giant cell arteritis; trigeminal autonomic cephalgias, such as cluster headache and paroxysmal hemicrania; primary headache syndromes including migraine and tension types; postherpetic neuralgia; systemic autoimmune disorders including lupus erythematosus; and other structural pathology, such as cerebellopontine angle tumors and cysts.¹

The International Headache Society (ihs-classification.org) defines classical trigeminal neuralgia as follows: (1) Paroxysmal attacks of pain lasting from a fraction of a second to two minutes, affecting one or more divisions of the trigeminal nerve; (2) Pain has at least one of



Figure 2

Bausch (National Library of Medicine)



Figure 3

Locke (National Library of Medicine)

the following characteristics: intense, sharp, superficial or stabbing; precipitated from trigger areas or by trigger factors; and (3) Attacks are stereotyped in the individual patients. Additionally, there can be no clinically evident neurological deficit, and the symptoms must not be attributed to another disorder. In contrast, atypical trigeminal neuralgia refers to symptoms that are not paroxysmal, have associated chronic pain, and/or a dysaesthetic quality.

More recently, Burchiel and colleagues² developed a simplified framework for defining and classifying trigeminal neuralgia (Table 1). Importantly, trigeminal neuralgia traditionally referred to as classical-type is redefined as TN1, while idiopathic facial pain that is aching, throbbing, or burning for more than 50% of the time (constant pain) is termed TN2. This distinction between shock-like (TN1) and constant (TN2) pain is the most significant predictor of long-term success after treatment.³

Preoperative MRI is useful to rule out any other potential pathological etiologies such as tumor or demyelinating disease. More advanced MR imaging can identify the presence of vascular compression at the root entry zone, which can aid pre-operative planning. Nevertheless,

the diagnosis and the decision for potential surgical exploration remains a purely clinical diagnosis irrespective of MRI presence of vascular compression.

HISTORICAL CONTEXT

The earliest reported case of trigeminal neuralgia was Johannes Laurentis Bausch (1605-1665), physician and president of the Imperial Leopoldian Academy of Natural Sciences. Bausch himself suffered from severe trigeminal neuralgia, and the course of his illness was detailed in his eulogy, which was published posthumously by the Academy.⁴

Next, John Locke (1632-1704), physician and famed philosopher, was summoned to visit the Countess of Northumberland (wife of an English Ambassador), who suffered from crippling trigeminal neuralgia. Locke recorded the case.⁴

The French term for trigeminal neuralgia, *tic douloureux*, was coined by surgeon Nicolaus Andre (born 1704), who reported a case series of five “tic” patients and, amazingly, practiced trigeminal nerve ablation by applying caustic substances through infraorbital foramina.⁴

John Hunter (1728-1793), an English anatomist and physician, further narrowed in on the neurological basis for trigeminal neuralgia, stating that:

There is one disease of the jaw which seems in reality to have no connection with the teeth, but of which the teeth are generally suspected to be

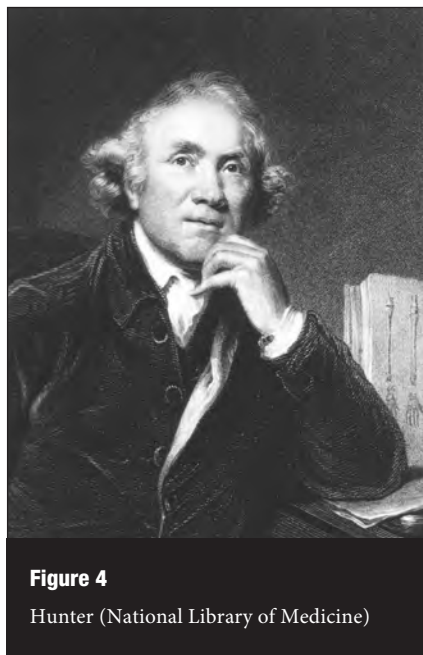


Figure 4

Hunter (National Library of Medicine)



Figure 5

Bell (National Library of Medicine)

*the cause...I have known cases of this kind where all the teeth of the affected side of the jaw have been drawn out, and the pain has continued in the jaw...Hence it should appear that the pain in question does not arise from any disease in the part, but it is entirely a nervous affection.*⁴

Sir Charles Bell (1774-1842), famed Scottish neuroanatomist, characterized the separate functions of the trigeminal (V) and facial (VII) nerves. Bell was the first to localize trigeminal neuralgia to the trigeminal (V) nerve.¹

Armed with this neuroanatomical knowledge, surgeons began to explore how they might treat this disorder. Harvey Cushing (1869-1939) pioneered a temporal fossa approach beneath the middle meningeal artery, aiming to completely extirpate the trigeminal ganglion. Cushing later shifted to isolated sensory root avulsion to spare motor function.⁵ Walter Dandy (1886-1946) performed trigeminal root neurotomies via a posterior fossa approach and noted that “The [trigeminal nerve] sensory root is frequently indented, lifted up, or bent at an angle by the artery...This I believe is the cause of *tic douloureux*.”⁶

More recently, Peter Jannetta, an American (and Pennsylvanian!) neurosurgeon, established open surgical microvascular decompression of the trigeminal nerve as an effective procedure for treating trigeminal neuralgia⁷ (discussed below). Lars Leksell (1907-1986), Swedish neurosurgeon and inventor, famous for stating that

Table 1. Burchiel definition and classification of trigeminal neuralgia (2)	
Diagnostic Classification	Defining Symptomatology
Idiopathic	
TN1	Sharp, shooting, electrical shock-like, episodic pain
TN2	Aching, throbbing, burning, >50% constant pain
Trigeminal Injury	
Neuropathic Pain	Unintentional (facial trauma; oral op; ear, nose, & throat op; skull base op; posterior fossa op; or stroke)
Deafferentation Pain	Intentional (neurectomy, gangliolysis, rhizotomy, nucleotomy, tractotomy, or other denervating procedure)
Symptomatic	Associated with multiple sclerosis
Postherpetic	Resulting from an outbreak of facial herpes zoster
Atypical Facial Pain	Somatoform pain disorder

“tools used by the surgeon must be adapted to the task and where the human brain is concerned, no tool can be too refined,” invented Gamma Knife Radiosurgery, which has since been used to introduce radiosurgical lesions of the trigeminal nerve to non-invasively treat trigeminal neuralgia (discussed below). Indeed, today’s multimodality armamentarium for treating trigeminal neuralgia is broad.

PATHOGENESIS

Our understanding of the pathogenesis of trigeminal neuralgia continues to evolve. The leading explanation involves trigeminal nerve root compression that causes demyelination. Multiple different anatomical variants (classically the superior cerebellar artery) may cause arterial and/or venous compression of the trigeminal nerve root, usually within a few millimeters of its entry into the brainstem.⁸ Pathological analyses demonstrate a focal zone of chronic demyelination immediately beneath the region of nerve indentation and limited to the immediate vicinity of the point of vascular indentation.⁹

In turn, this demyelination causes ectopic (erratic) impulses and ephaptic (indirect) cross-firing between nerve fibers. Experimental evidence from a model of purposefully demyelinated nerve fibers in cat dorsal spinal cord white matter demonstrates spontaneous, ectopic activity.¹⁰ Ephaptic coupling refers to the indirect firing that occurs between neural fibers through extracellular electrical fields,

as opposed to direct synaptic transmission. Ephaptic coupling has been experimentally demonstrated between immediately adjacent non-myelinated axons.¹¹

Abnormal ectopic and ephaptic electrical impulses may lead to the development of clinical pain hypersensitivity. Neuronal plasticity is believed to be the underlying cause of hypersensitivity phenomena including allodynia, hyperalgesia, and trigeminal neuralgia.¹²

Knowledge of pathogenesis can directly inform treatment approaches. Structural nerve root compression can be addressed with surgical decompression. Abnormal neuronal firing can be addressed with medications such as Carbamazepine, which stabilize neuronal ion channels, reducing neuronal excitability. Finally, hypersensitivity mediated by misdirected neuronal plasticity can be addressed with ablative techniques directed to the nerve itself.

TREATMENTS

Medical therapy for trigeminal neuralgia includes anticonvulsant drugs. In 1963 Carbamazepine’s efficacy in treating this disorder was first demonstrated by Sigfrid Blom.¹³ Carbamazepine stabilizes inactivated voltage-gated sodium channels, down-regulating cellular excitability. It remains the first-line drug of choice today. Alternative medications include Oxcarbazepine, Baclofen, Gabapentin, Lamotrigine, and Pimozide.

When medical therapy fails, surgical therapy may be indicated. Surgical therapy for trigeminal neuralgia consists of two broad categories, microvascular decompression, and ablative procedures. Microvascular decompression usually entails a retrosigmoid approach to the upper cerebellopontine angle and identification of the offending vessel causing nerve decompression. The most frequently identified culprit is a superior cerebellar artery loop which, once freed by sharp dissection, can be mobilized away from the nerve and kept separated from the nerve with a piece of shredded Teflon felt.¹⁴

Ablative procedures include rhizotomy (nerve obliteration) and radiosurgery. Rhizotomy is a percutaneous procedure, whereby a cannula is passed through the foramen ovale and the sensory component of the trigeminal nerve is destroyed by radiofrequency thermocoagulation, mechanical balloons (e.g., Fogarty catheter), or neurotoxic chemicals (e.g., glycerol). Radiosurgery utilizes Gamma Knife to stereotactically direct conformal, high-dose radiation to the cisternal portion of the trigeminal nerve. The procedure involves placement of a head frame, which allows for the acquisition of a stereotactic MRI scan to accurately identify the nerve and safely target the radiation dose.

While medical therapy is generally accepted as the first-line treatment for trigeminal neuralgia, best surgical practice for patients refractory to medical therapy remains undefined. In a landmark 1996 New England Journal article, Barker and colleagues demonstrated that microvascular decompression is safe and effective, with a high rate of long-term success.¹⁵ More recently a review of ablative procedures found that radiofrequency thermocoagulation offers the highest rates of complete pain relief but also the highest rates of complications (e.g., masticatory weakness, corneal numbness, dysesthesia (impairment of sensitivity)), when compared with mechanical balloon, chemical injection, and radiosurgical ablation techniques.¹⁶ The sole prospective study of Gamma Knife Radiosurgery showed that radiosurgery is a safe and effective treatment, associated with delayed pain cessation but fewer complications than minimally-invasive ablative techniques.¹⁷

In practice, treatment decisions are centered around individual patient and treatment team characteristics and preferences. Young patients with TN1-type TN are often excellent candidates for open surgery, and microvascular decompression will typically achieve a complete

cure. Elderly patients with increased medical risks are often appropriate candidates for ablative therapies, which produce immediate relief. Finally, for elderly patients willing to wait a few weeks for symptoms to resolve, radiosurgery is an ideal choice because of its high efficacy and low complication profile.

REFERENCES

1. Prasad, S. & Galetta, S. Trigeminal neuralgia: historical notes and current concepts. *Neurologist* 15, 87-94 (2009).
2. Eller, J. L., Raslan, A. M. & Burchiel, K. J. Trigeminal neuralgia: definition and classification. *Neurosurg. Focus* 18, E3 (2005).
3. Miller, J. P., Acar, F. & Burchiel, K. J. Classification of trigeminal neuralgia: clinical, therapeutic, and prognostic implications in a series of 144 patients undergoing microvascular decompression. *J. Neurosurg.* 111, 1231-1234 (2009).
4. Eboli, P., Stone, J. L., Aydin, S. & Slavin, K. V. Historical characterization of trigeminal neuralgia. *Neurosurgery* 64, 1183-6; discussion 1186-7 (2009).
5. Adams, H. et al. Harvey Cushing's case series of trigeminal neuralgia at the Johns Hopkins Hospital: a surgeon's quest to advance the treatment of the 'suicide disease'. *Acta Neurochir. (Wien)* 153, 1043-1050 (2011).
6. Dandy, W. E. The Treatment of Trigeminal Neuralgia by the Cerebellar Route. *Ann. Surg.* 96, 787-795 (1932).
7. Jannetta, P. J. Arterial compression of the trigeminal nerve at the pons in patients with trigeminal neuralgia. *J. Neurosurg.* 26, Suppl:159-62 (1967).
8. Hardy, D. G. & Rhoton, A. L., Jr. Microsurgical relationships of the superior cerebellar artery and the trigeminal nerve. *J. Neurosurg.* 49, 669-678 (1978).
9. Love, S. & Coakham, H. B. Trigeminal neuralgia: pathology and pathogenesis. *Brain* 124, 2347-2360 (2001).
10. Smith, K. J. & McDonald, W. I. Spontaneous and evoked electrical discharges from a central demyelinating lesion. *J. Neurol. Sci.* 55, 39-47 (1982).
11. Ramon, F. & Moore, J. W. Ephaptic transmission in squid giant axons. *Am. J. Physiol.* 234, C162-9 (1978).
12. Woolf, C. J. & Salter, M. W. Neuronal plasticity: increasing the gain in pain. *Science* 288, 1765-1769 (2000).
13. Blom, S. Tic Douloureux Treated with New Anticonvulsant; Experiences with G 32883. *Arch. Neurol.* 9, 285-290 (1963).
14. McLaughlin, M. R. et al. Microvascular decompression of cranial nerves: lessons learned after 4400 operations. *J. Neurosurg.* 90, 1-8 (1999).
15. Barker, F. G., 2nd, Jannetta, P. J., Bissonette, D. J., Larkins, M. V. & Jho, H. D. The long-term outcome of microvascular decompression for trigeminal neuralgia. *N. Engl. J. Med.* 334, 1077-1083 (1996).
16. Lopez, B. C., Hamlyn, P. J. & Zakrzewska, J. M. Systematic review of ablative neurosurgical techniques for the treatment of trigeminal neuralgia. *Neurosurgery* 54, 973-82; discussion 982-3 (2004).
17. Regis, J. et al. Prospective controlled trial of gamma knife surgery for essential trigeminal neuralgia. *J. Neurosurg.* 104, 913-924 (2006).

Brain power



1-800-JEFF-NOW

