TRIGEMINAL NEURALGIA

Cranial nerve (CN) disorders comprise a group of maladies that result from "malfunction" of individual or groups of nerves that innervate the face, scalp, ear and throat. The responsible nerves may yield abnormal sensations or abnormal movements which are painful and/or debilitating. The cause for these different diseases remains unknown but most research indicates that the common thread is an injury to the nerve's internal insulating properties. This leads to abnormal communication between individual nerve fibers that as a group comprise the cranial nerve itself. The most common etiology for this injury is chronic compression of the nerve by arteries or veins that cause damage by pulsing against the nerve with each heartbeat. These repeated pulsations are thought to physically damage the nerve's electrical insulation (aka: myelin). Other causes include illnesses that directly damage myelin (multiple sclerosis and its association with TN) and trauma. Treatments for the CN disorders include medications, radiation therapy, and surgical procedures.

This discussion will focus on the most common CN disorder, **Trigeminal Neuralgia** (TGN**).**

What is Trigeminal Neuralgia (TGN)?:

TGN, also known as *tic douloureux*, is a syndrome that affects 4/100,000 patients /year. Females are almost twice as likely as men to develop pain as are older individuals (due to vessel elongation and tortuosity which increases with age). TGN presents with severe unilateral facial pain described by patient as sudden in onset, severe and excruciating, 10/10 in intensity, "the worst pain of my life", "worse than child birth", "worse than being kicked in the testicles", and electrical/shock-like /lancinating in nature. Patients usually note that TGN is spontaneous in onset or may be "triggered" by certain events such as change in head position, light touch to the face, a kiss on the cheek, cool wind (air conditioning or fan) blowing on the face, chewing, tooth brushing, talking or emotional stress. Patients rarely get relief by touching their face in the painful region and if they do, alternative diagnoses should be considered. Many individuals have committed suicide in response to their discomfort. Patients **always** remember where they were and what they were doing when symptoms first presented and they live in fear that the pain will recur without warning.

In some instances, TGN pain can be near constant as opposed to intermittent. In such cases patients cannot move or touch their face, chew, drink or talk without experiencing severe discomfort. This condition is termed *status trigeminus* and it generally requires hospitalization for administration of intravenous medications and fluids.

What is the Trigeminal Nerve (aka: Fifth cranial nerve, CN 5, CN V)?:

CN 5 consists primarily of a collection of sensory nerve fibers that arise from the skin or mucosa of the face, mouth, and ear canal, cornea, covering of the brain (dura mater), and outer layer (adventitia) of cerebral arteries. These fibers converge to form a ganglion (collections of

neuronal cell bodies) which then send projections to a sensory nucleus located in the midbrain, pons and upper cervical spinal cord. Projections from the sensory nucleus ultimately communicate with the sensory segments of the brain where pain and touch are interpreted as a conscious sensation (Figure 1, 2, 3).

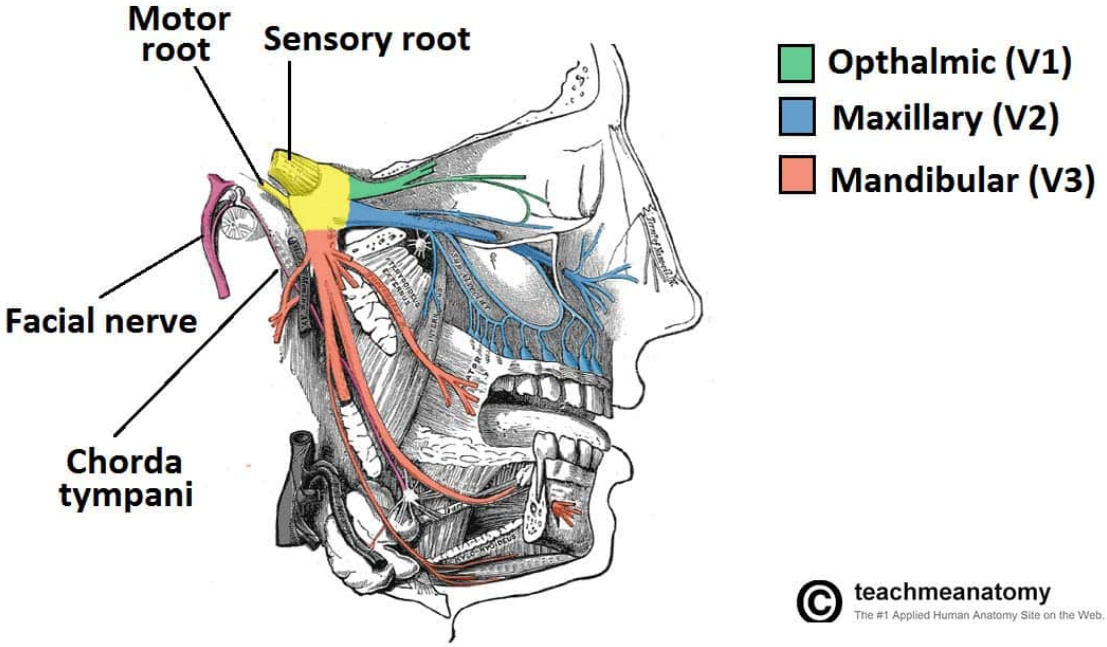

FIGURE 1: Anatomic representation of CN 5 innervation of the face and head.

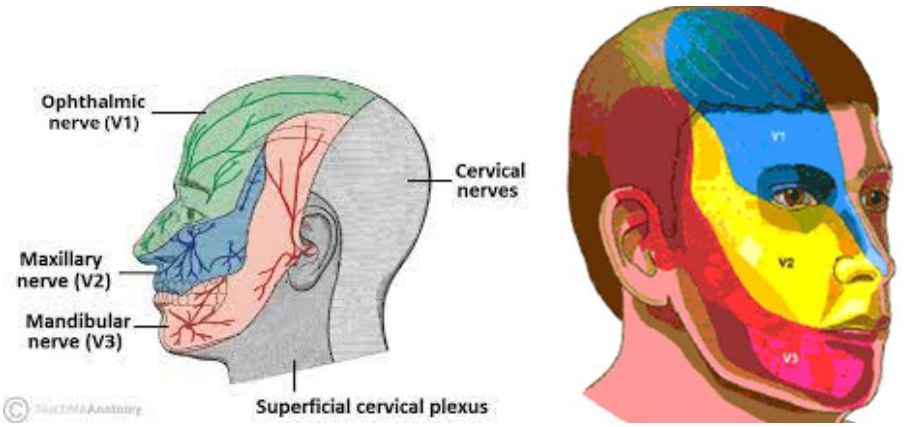

FIGURE 2: Areas (dermatomes) of the head and face that give sensory input to CN 5

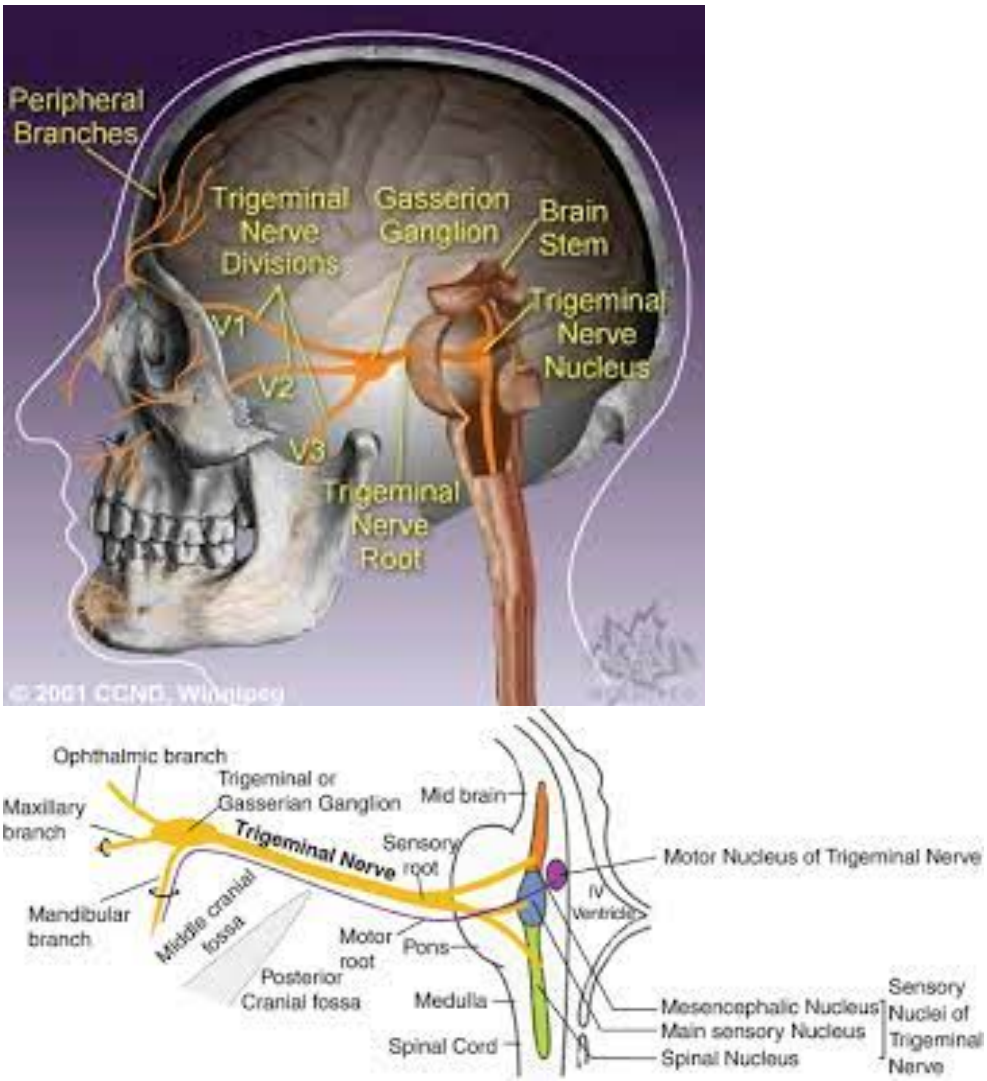

FIGURE 3: Anatomic drawings showing the V 1,2,3 segments of CN 5 traveling from the face and head to merge and form the Gasserian Ganglion which in turn sends a fiber bundle to the Trigeminal Nucleus in the midbrain, pons and upper cervical spinal cord. This Nucleus then projects to sensory and motor regions of the cerebral cortex for further processing.

CN 5 receives sensory information from three regions (dermatomes V1, 2, 3) of the face via three nerves that converge to form the sensory ganglion (Gasserian ganglion) in the skull. A single bundle (Trigeminal Nerve) exits the sensory ganglion and enters the pons where it in turn terminates in the Trigeminal Nucleus which ultimately sends projections to the sensory cortex for interpretation. Abnormal signals due to Trigeminal Nerve injury cause innocuous sensations like touch to be misinterpreted as pain. Figure 1, 2 and 3 show where the dermatomes of the

face are located, what portions of the trigeminal nerve innervate each region, and how the nerve pathways connect to the brainstem.

CN 5 also provides separate motor fibers (aka: *portio minor)* that innervate those muscles of the head that move the jaw. These muscles aid in chewing and are termed "muscles of mastication". TN does not involve these motor fibers making it a disease solely of abnormal sensation.

Where is TGN pain located?:

Because CN 5 receives sensory information primarily from the face and mouth and because the three facial dermatomes are innervated by V1, 2 and 3 (Figure 2) the pain described by patients with TN most commonly is located on the right or left side of the face and may involve a single or multiple dermatomes. V2 is most commonly involved followed by V3 and then V1. The most common presentation is pain in both V2 and V3 while pain in V1, 2 and 3 is 5% or less. Fewer than 1% of patient have bilateral discomfort.

What other conditions can cause facial pain?:

When pain is constant, burning, bilateral or involves areas outside V1, 2 or V3, the medical practitioner should consider facial pain syndromes or lesions that can cause facial pain other than TGN. These may include, but are not limited to:

Other cranial nerve pain syndromes (Geniculate neuralgia, Glossopharyngeal Neuralgia)
Occipital neuralgia
Dental disease (dental caries, gum disease)
Temporomandibular joint disease
Neoplasm
Sphenopalatine neuralgia
Post herpetic pain
Ocular/Orbital disease
Headache syndromes
Traumatic peripheral TN injury with secondary neuroma formation
Styloid body abnormalities
Sinusitis
Psychogenic pain
Post concussive pain
Temporal arteritis

Evaluation:

After obtaining a detailed medical and surgical history, certain specific questions should be asked to help determine the likelihood that a patient suffering with facial pain has TGN. These include the following:

Dermatomal pain location (V1, V2, V3, other dermatomes)
Pain description (Onset, duration, quality, intensity)
Areas of the face with decreased sensation (including the cornea)
Unilateral or bilateral location
Response to medications
Triggering events (touch, wind, AC, change in head position, anxiety, eating, drinking, talking)
Existence of comforting actions

All patients with suspected TGN should undergo a brain MRI with and without contrast. The purpose of this study is to determine if any structural abnormalities exist that could be causing the facial pain such as a tumor, stroke, or a lesion related to Multiple Sclerosis (see below). Some surgeons use the MRI to determine if any vessels are compressing CN 5. The presence or absence of vessels helps determine whether or not they will recommend microvascular decompression (see below). In the author's experience, while MRI may show evidence of vascular compression of CN 5 at the pons, if it does not, there may still be compression from small veins or arteries that can be remedied by a surgical procedure.

In addition to the above, patients should undergo a full dental exam, neurologic exam and in some cases an ENT exam to rule out the presence of other illnesses that can cause facial discomfort. These include, but are not limited to, sinusitis, malignancy, headache syndrome (migraine and cluster headache), tooth decay and gum disease.

Treatment of TGN:

TGN treatment can be categorized as:
- Medical treatment (oral medications)
- Surgical treatment

Medical Treatment:

Patient's suffering from TGN rarely get a significant response from narcotic or non-narcotic pain relief medications unless the agents are administered in dosages that reduce level of consciousness. It is for this reason that opiates or other similar agents are rarely utilized for acute and chronic management. Medications that do help eliminate or reduce facial discomfort are those that reduce anomalous communication between nerve fibers or reduce neural excitability. These include:

Carbamazepine (CBMZ): First line medication that can provide relief in approximately 70% of patients with TGN.

Baclofen: Second line therapy that may be given alone or in combination with CBMZ.

Gabapentin: Second line therapy that may be given alone or in combination with CBMZ.

Phenytoin (intravenous): Often effective for patients hospitalized with *status trigeminus* who fail to respond to other medications.

Clonazepam: Third line therapy with less than 30% efficacy.

Amitriptyline: Third line therapy.

Potential side effects of the above medications include liver injury, leukopenia (low white blood cell count), drowsiness confusion, and potential teratogenicity. Close monitoring is imperative.

In the author's personal clinical experience CMBZ is the most effective medication and provides the greatest opportunity for medical control of TGN symptoms. CBMZ response is reliable enough that I question the diagnosis of TGN in patients who report never having any relief at some point from CBMZ administration. A history of CBMZ relief also appears to positively predict which patients are more likely to respond to surgical procedures. Unfortunately, CBMZ may work initially and lose efficacy over time. Patient's may also ultimately require dosages as high as 1000 mg/day which increases the incidence of intolerance from somnolence, disequilibrium and cognitive difficulties. Monitoring of cell counts and liver function tests is imperative for all patient using CBMZ for pain control. Those patients that do not respond to CBMZ will likely not obtain satisfactory pain relief from second or third line medications although these medications should be offered prior to surgical intervention.

Surgical Treatment:

When patients do not tolerate or respond to medical therapy, more invasive procedures may be offered. These include:

1. Percutaneous Balloon Compression of the Gasserian Ganglion
2. Percutaneous Radiofrequency Rhizotomy of the Gasserian Ganglion
3. Percutaneous Glycerol Rhizotomy of the Gasserian Ganglion
4. Gamma Knife Radiosurgery
5. Retromastoid Craniotomy with partial sectioning of CN 5 at the pons
6. Retromastoid Craniotomy and Microvascular Decompression of CN 5 at the pons (aka: Jannetta Procedure; MVD)

A detailed description of each of these procedures goes beyond the scope of this publication. In summary, however, procedures 1-5 provide pain relief through destructive means. Each method aims to injure CN 5 sufficiently to eliminate the symptoms of TGN while preserving some degree of normal sensation to the ipsilateral face and cornea. Procedure 6 (Microvascular Decompression) aims to preserve normal CN 5 function by surgically exposing the nerve as it enters the pons (Root Entry Zone) and moving arteries and veins that are compressing the nerve and injuring it by pulsing against it. These arteries and veins are surgically separated from the nerve at the point where it enters the pons and small "pillows" (Teflon or other relatively inert material) are placed between the nerve and vessel so that the vessel no longer contacts the nerve. In some instances, veins may be removed rather than decompressed however in no instance is an artery intentionally removed. To view personal narrated surgical videos showing and explaining the decompression procedure please refer to **michaelhorowitzmd.com**)

Which specific procedure is offered to a patient along with its risks, benefits, and outcomes often depends upon a patient and surgeon's personal preference, a surgeon's skill set and personal outcomes, patient age, patient co-morbidities, and patient ability to safely tolerate general anesthesia. It is best to discuss options with the surgeon involved in order to glean specifics.

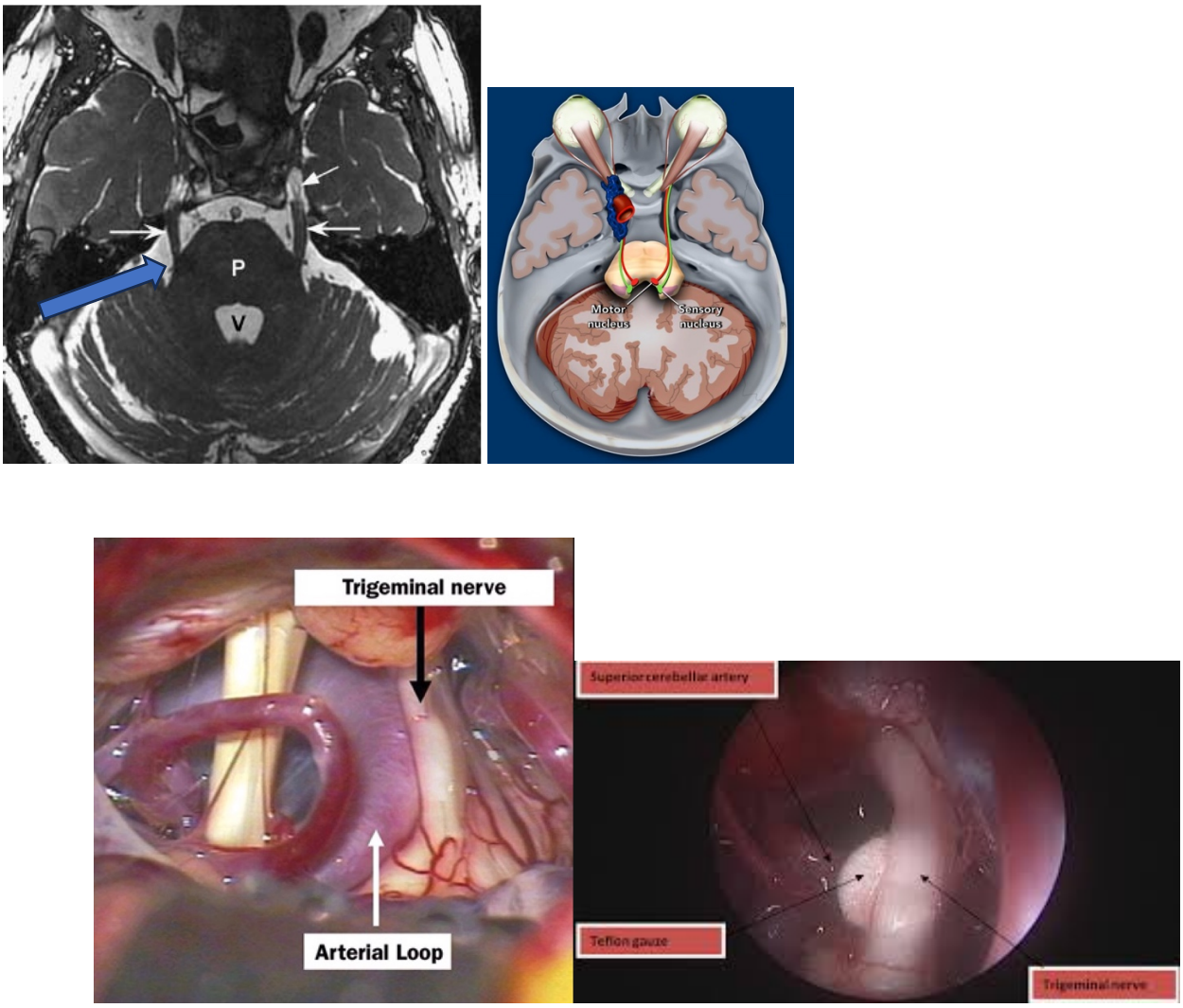

FIGURE 4: (Top left) Brain MRI showing the right and left CN 5 (white arrows) entering the pontine portion of the brainstem. Blue arrow shows location where microvascular decompression is performed. (Top right) Drawing showing right and left CN 5 entering the pons. (Bottom left) Surgical image showing TN compressed by an artery (Bottom right) Surgical image showing the blood vessel separated from the nerve by as "pillow" of Teflon.

Trigeminal Neuralgia in the setting of Multiple Sclerosis (MS):

Two percent (2%) of individuals with MS develop TGN due to myelin injury at the point where CN 5 enters the pons. MRI can frequently demonstrate MS plaques in this location (Figure 5). As a general rule, patients with TGN secondary to MS do not respond as well to medications or microvascular decompression as do patients with TGN unrelated to MS. MS patients more frequently respond to destructive treatments such as 1-4 listed in the above section on

treatment. In this author's clinical experience, however, when patients with MS fail to respond to medications or 1-4, or when they initially respond but then fail to obtain relief from repeat procedures, microvascular decompression with or without partial sensory root nerve sectioning may provide pain control or elimination. This is especially true in those individuals whose brain MRI fails to demonstrate a pontine plaque. MS patients undergoing MVD, however, should be counseled that the surgeon cannot predict the likelihood of pain relief and that the risk of facial and corneal sensory loss is higher than in patients without MS related pain. In view of the above, craniotomy for the treatment of TN in the setting of MS should be reserved as a procedure of last resort for individuals who have failed all other therapeutic options.

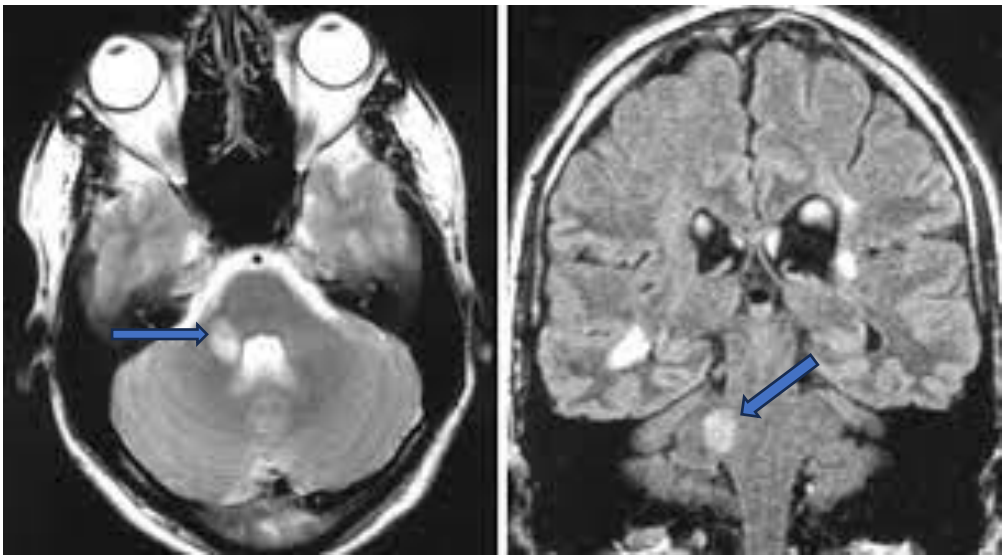

FIGURE 5: Brain MRI images showing an MS plaque in the pons near the CN 5 root entry zone (REZ) (blue arrows)

Summary:

TGN is a well described extremely severe facial pain syndrome that may drive some to suicide. Fortunately, effective medical and surgical therapies are available. Living with pain is generally not necessary.