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Percutaneous Stereotactic Differential Radiofrequency Thermal Rhizotomy for the Treatment of Trigeminal Neuralgia

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Purpose: The purpose of this study was to evaluate the effectiveness of radiofrequency thermal rhizotomy (RTR) for trigeminal neuralgia, after failure of pharmacological management.

Patients and Methods: Two hundred fifteen patients underwent RTR from 1991 to 1996 and were prospectively evaluated. These patients were characterized by age, sex, side of the face, and division(s) involved. Patients were evaluated for pain relief, recurrence requiring or not requiring reoperation, and the type and rate of complications. They were followed-up by serial clinical evaluation and telephone interview. Patients were categorized into groups: 1) Successful result: excellent, good pain relief; and 2) Unsuccessful result: fair, poor, or no pain relief. The RTR group was compared with historical controls. Follow-up ranged from 9 to 68 months (mean, 32 months) and results were evaluated at early and long-term follow-up.

Results: At early follow-up (defined as immediately postoperatively to 6 months), pain relief of excellent or good quality (successful result) occurred in 198 of 215 patients (92%). Fair or poor or no pain relief (unsuccessful result) occurred in 17 (8%) patients. At long-term follow-up (>6 months to 68 months), recurrence of pain that required reoperation occurred in 24 patients (11%) and recurrence of pain that did not require reoperation (medically managed) occurred in 34 patients (16%). Dysesthesia developed in 18 patients (8%); seven patients (3%) had dysesthesia alone (medically managed) and 11 patients (5%) had dysesthesia with recurrence of pain (medically or surgically managed). "Anesthesia/analgesia dolorosa" developed in four patients (1.8%) and was medically managed. At long-term follow-up, 83% of patients had good to excellent pain relief (successful result). There were no mortalities, no significant morbidity, and a low rate of minor complications.

Conclusion: With the use of this specific diagnostic approach and management algorithm, patients with trigeminal neuralgia can be successfully managed.

Trigeminal neuralgia (TN), often called "tic douloureux," is one of the most painful and debilitating craniofacial pain disorders. It is characterized by paroxysms of severe, lancinating, "electric-like" bouts of pain. TN is either idiopathic (primary) or due to a structural lesion involving the trigeminal system or associated with some other neurological process (secondary). Idiopathic (primary) TN is the most common cephalic neuralgia in people over 50 years of age, with a mean annual incidence of 4 per 100,000 population.[1] TN is predominately unilateral, has tactile "trigger" areas, does not produce a neurosensory or motor deficit, and is restricted to the distribution of the trigeminal nerve.[2,3] Pain attacks occur spontaneously, as well as being triggered by a sensory stimulus to the skin, intraoral mucosa surrounding the teeth, or tongue. Each attack usually lasts only seconds, but may be repetitive at short intervals, so that individual attacks can overlap and may be described as a linger-

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ing, painful sensation. Pain during the night that interrupt sleeps is rare. TN usually has an exacerbating and remitting course, with shorter periods of remission with increasing age. It is more common on the right side of the face, in those older than age 40, and in females.[4] The second and third divisions are most commonly affected, with isolated ophthalmic division involvement being rare.[5] Idiopathic TN is frequently difficult to manage because the cause remains unknown, and there is no universally accepted medical and surgical management protocol.

Medical management consists of pharmacologic and nonpharmacologic approaches, whereas surgical management consists of numerous peripheral and intracranial procedures. The first-line treatment is usually medical therapy with drugs such as carbamazepine (Tegretol; Basel Pharmaceuticals, Ciba-Geigy Co, Summit, NJ), baclofen (Lioresal, Geigy Pharmaceuticals, Ciba-Geigy Co, Ardsley, NJ), gabapentin (Neurontin; Parke-Davis, Warner-Lambert Co, Morris Plains, NJ), phenytoin (Dilantin; Parke-Davis) or clonazepam (Klonopin; Roche Laboratories, Hoffman-LaRoche, Inc, Nutley, NJ) in single or combination regimens. Pharmacologic therapy is effective for many patients; however, for some, these medications do not relieve the pain or they produce intolerable side effects with significant medical and functional morbidity. If medical therapy is unsuccessful or not tolerated, surgical treatment should be considered.

Of the surgical procedures, percutaneous stereotactic differential radiofrequency thermal rhizotomy (RTR) is a well-recognized treatment.[6,7] At the Massachusetts General Hospital, RTR is the procedure of choice for patients undergoing initial surgical management. RTR is a technique of controlled thermal ablation of nerve fibers in the trigeminal ganglion or nerve root, producing loss of pain with relative preservation of touch and more complex facial sensations.[8-10] The radiofrequency generator and micro-electrodes allow for precise localization with nerve stimulation testing and provide a finite and restricted thermal nerve lesion.[6] RTR produces some sensory loss in the affected distribution, which is usually well tolerated. It does not affect facial nerve function and, therefore, facial muscle paresis is not a concern. Pain relief is generally immediate, complication rates and side effects are minimal and usually well tolerated, and patient satisfaction is high.[11]

The purpose of this study was to evaluate treatment outcome with RTR in patients who failed pharmacologic management.

Methods

PATIENT MANAGEMENT PROTOCOL

Patients who presented to the Massachusetts General Hospital Craniofacial Pain Center between 1991 and 1996 with a complaint of facial pain were considered for participation in this study. They were evaluated with a comprehensive interview, history, and physical examination. Physical examination of the head and neck consisted of evaluation of the cranial nerves with special attention to the neurosensory aspects of the trigeminal nerve.[12] Patients with the following five findings: 1) paroxysmal, lancinating, electric-like pain; 2) tactile trigger areas; 3) unilateral symptoms restricted to the distribution of the trigeminal nerve; and 4) no neurosensory deficit were given the clinical diagnosis of TN. These patients were entered into the management algorithm (Fig 1).

All patients with TN are evaluated by magnetic resonance imaging (MRI) of the brain and brainstem, with attention to the posterior cranial fossa and trigeminal system for evidence of tumor, vascular abnormality, or demyelination. Patients with a clinical diagnosis of TN and a normal MRI are started on pharmacologic therapy (Fig 1B). Those patients who do not conform to the clinical diagnosis of TN, or who have abnormal MRI findings, are further evaluated, and appropriate consultations and further diagnostic studies are ordered (Fig 1A). These patients were not included in this study.

Patients were prescribed pharmacologic regimens based on drug history and responsiveness to specific pharmacologic agents. Pharmacologic therapy was continued and adjusted based on pain relief and patient tolerance. If pharmacologic therapy was effective in providing adequate pain relief, it was continued, and the patients were monitored closely for 4 to 6 weeks. The dosage(s) of medications were slowly tapered in a stepwise fashion (one medication at a time over 2 to 4 weeks), monitoring for return of pain (Fig 1E). With a decreasing dose of medications, if there was recurrence of pain, the prior drug regimen was reinstituted. Patients who remained pain free were tapered off all medications. However, some patients were maintained on low-dose, prophylactic pharmacologic programs because of intermittent spontaneous or triggered bouts of pain (Fig 1F). Patients for whom pharmacologic therapy was either not effective in providing adequate pain relief or was not well tolerated were considered for surgical treatment with RTR (Fig 1C); this was 39% of the total study group.

RTR PROTOCOL

All patients considered appropriate candidates for RTR were interviewed and counseled. The procedure was thoroughly explained and the risks and benefits outlined and discussed. The potential complications and side effects were described and explained in terms that the patients could fully understand. All patients were given a written description of the procedure to review. Additionally, patients were ad-

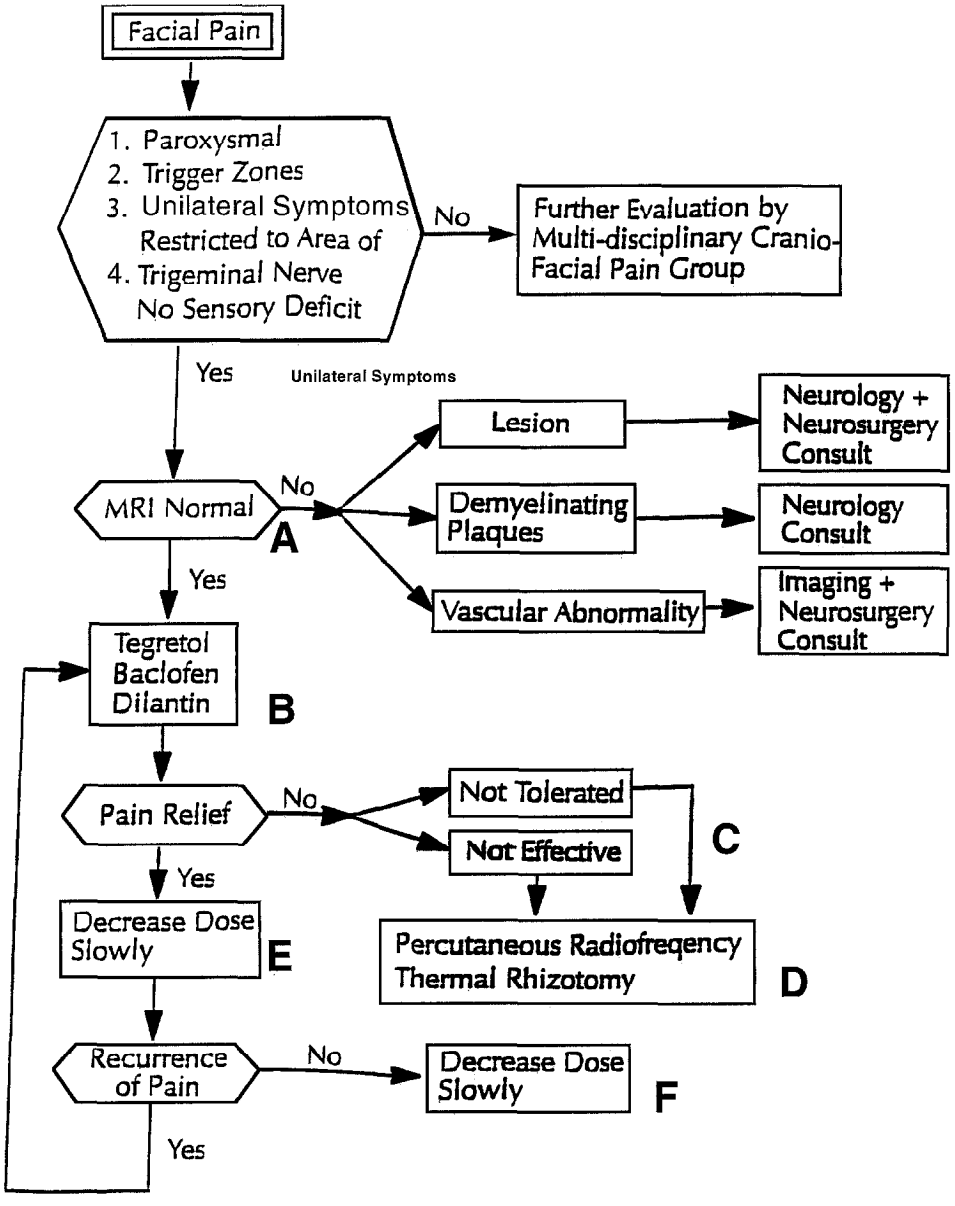

FIGURE 1. Management algorithm. *A*, MRI of the brain, brainstem, and base of skull is obtained on all patients. Further evaluations and diagnostic studies are only performed when physical examination or MRI findings are abnormal. *B*, Medication is prescribed in a progressive and stepwise fashion. EXAMPLE: 1) Carbamazepine (tegretol): 300-1,200 mg/d; or 2) Baclofen (lioresal) 20-80 mg/d or 3) Gabapentin (neurontin) 300-1,200 mg/d or 4) phenytoin (Dilantin) 300-1,200 mg/d or 5) Tegretol + baclofen; or 6) Neurontin + baclofenDoses of Medications are Titrated to pain relief and patient side effects. Clonazepam (Klonopin) 0.5-1.0 mg/d is often also added to the above regimens. *C*, Drug allergy or idiosyncratic reaction; Laboratory abnormalities (CBC, liver function, drug levels); Significant side effects; Patient preference. *D*, Before radiofrequency thermal rhizotomy, local anesthetic blocks are performed in some patients as part of a further diagnostic evaluation. This can evaluate the level of pain relief with local anesthesia of the individual nerve divisions as well as have the patient experience the feeling of altered sensation. *E*, Doses of medications are decreased slowly in a stepwise fashion, depending on the prior regimen that was providing pain relief. After the patient has been pain free for 4-6 weeks, medication can be gradually tapered and hopefully eliminated. *F*, Further decrease in dosage of medication is predicated on the pain history of the patient. Many patients are maintained on pharmacologic therapy.

vised of the surgical alternatives to RTR, namely, glycerol rhyzolysis, percutaneous balloon compression of the trigeminal ganglion, and posterior fossa exploration/microvascular decompression. The risks and benefits of these procedures, and similarities to and differences from RTR were explained and discussed. Any patient who wished further surgical consultation was referred to the appropriate individuals. Patients who consented to undergo RTR were included in this study. The procedures were performed in the Surgical Suite of the Department of Interventional Radiology.

RTR is a surgical procedure on the trigeminal (Gasserian) ganglion performed by a percutaneous approach under local anesthesia, intravenous sedation, and intermittent general anesthesia administered by a senior neuroanesthesiologist. The surgical approach uses specific anatomic landmarks and radiologic guidance. The surgical instruments and electrodes (22- to 25-gauge) enter the skin 2.5 to 3.0 cm lateral to, and just below (0.5 cm), the labial commissure (Fig 2).[6,7,13] The direction of the instruments is determined by two planes: a lateral plane directed at a point one-third of the distance from the external auditory meatus to the lateral canthus of the eye, and a medial plane from the puncture site to the medial aspect of the pupil. Using biplanar videofluoroscopy, the surgical instruments are placed through the pterygomandibular and infratemporal spaces toward the base of the skull and directed through foramen ovale into the ganglion. Placement is confirmed by a nonpainful, square wave current of low voltage (0.2 to 0.3 V), pulsed at 50 cycles per second for 1 millisecond, delivered through the microelectrode, with the pa-

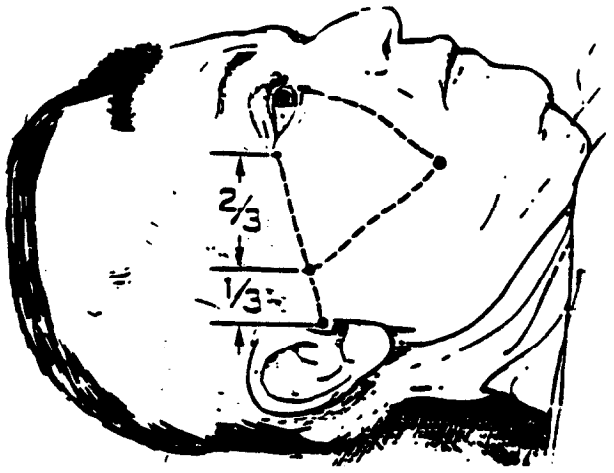

FIGURE 2. Percutaneous surgical approach.

tient awake and alert. The patient identifies the location of the stimulus on the face, and the anatomic distribution is recorded. Using this technique, precise and accurate placement of the microelectrode can be accomplished in the distribution(s) of the pain. After the appropriate location(s) are identified, the radiofrequency thermal lesioning begins.

Thermal lesioning is carried out in cycles of 45 to 90 seconds at temperatures of 65° to 90°C, with the patient under general anesthesia. After each thermal lesioning, the patient is awakened, and sensory stimulation testing and physical examination are performed. Depending on the results of testing, additional thermal lesioning may be performed. To achieve effective pain relief and preservation of tactile functional sensation, the goal of thermal lesioning is to produce hypalgesia and not anesthesia. Once this is achieved, the procedure is complete. Patients are allowed to adequately recover and usually are discharged home with a companion later that day. If any complications were encountered during or after the procedure, patients were admitted to the hospital for further observation.

Patients were followed-up in person, or by telephone interview, at 1 week, 1 month, 6 months, and then yearly. Patients were questioned about, and examined for, facial hypesthesia/hypalgesia, dysesthesia, side effects, and complications. All patients were asked to give a satisfaction rating for the management of their pain after RTR using the published "description of early results" criteria: excellent, good, fair, poor, and failure (Table 1).[7] Excellent or good results are considered successful, with no tic pain and no or only minor dysesthesia. Fair and poor results, with some tic pain and moderate to major dysesthesia, were considered unsuccessful. Patients with a recurrence of pain were re-examined and re-entered into the management algorithm on their prior pharmacologic regimen. Patients with recurrence of pain that did not respond to additional pharmacologic therapy were considered for reoperation.

Table 1. DESCRIPTION OF EARLY RESULTS

Result	Description
Excellent	No tic pain, dysesthesia, or troublesome paresthesia
Good	No tic pain, monor dysesthesia/paresthesia
Fair	No tic pain, moderate dysesthesia/paresthesia
Poor	Tic pain, major dysesthesia/paresthesia
Failure	Immediate

Data from Tew and Taha.[7]

Results

Between 1991 and 1996, 215 patients (39%) with a diagnosis of TN underwent surgical treatment with RTR and were prospectively followed-up. The mean follow-up was 32 months (range, 9 to 68 months).

The patients were characterized by age, sex, side of the face, and division(s) involved. Comparison was made between this patient group and previously published historical controls (Table 2). The average age of patients in this study was 61 years. Females, the right side of the face, and the third division were most commonly affected. There were no patients with isolated first division involvement, and only 8% had the first division involved at all.

Postoperatively, patients were evaluated for early results (immediately postoperatively to 6 months) and long-term results (>6 months to 68 months). The grading scale, "description of early results" described in 1995 by Tew and Taha (Table 1),[7] was used for evaluation of outcomes. Patients also were evaluated for complications and side effects of the procedure.

Table 2. CHARACTERISTICS OF PATIENTS COMPARED WITH HISTORIC CONTROL OF PREVIOUSLY PUBLISHED STUDIES

	Present Study	Historic Control*
Average age	61.5 yr Range: 41-95	65 yr
Sex	69% Female	62% Female
Side of face	58% Right	60% Right
Division involved (%)		
V-1	0	1
V-2	13	16
V-3	38	15
V-1, V-2	8	15
V-2, V-3	33	40
V-1, V-2, V-3	4	13

*Data from Tew JM, van Loveren H, *in* Schmidek HH, Sweet WH (eds): Operative Neurosurgical Techniques: Indications, Methods and Results, vol 2. Philadelphia, PA, Saunders, 1988.

The complications were classified and compared with published combined series data (Table 3).[7]

Early pain relief (immediately postoperatively to 6 months), classified as excellent or good (successful), occurred in 198 of 215 patients (92%). Fair or poor pain relief (unsuccessful) occurred in 13 (6%) patients, and there were four (1.8%) initial failures. At long-term follow-up (>6 months to 68 months), tic pain recurred in 58 patients (27%). Of these recurrences, 24 patients (11.2%) required reoperation, whereas 34 patients (15.8%) did not require reoperation and were managed with medical therapy. Using pharmacologic therapy, surgical treatment, or no additional treatment, long-term excellent or good (successful) pain relief occurred in 179 of 215 patients (83%).

There were no mortalities and no major morbidity. Two patients developed postoperative symptoms that were considered consistent with aseptic (chemical) meningitis and were hospitalized and appropriately evaluated and treated. Both patients were blood culture negative, had normal cerebrospinal fluid analysis, and did not become septic. Both patient's symptoms resolved uneventfully and they were discharged from the hospital in 2 to 3 days.

Dysesthesia developed in 18 patients (8%). Corneal analgesia developed in five patients (2%), with two of these patients (0.01%) developing transient keratitis that needed ophthalmologic evaluation and treatment. "Anesthesia dolorosa" developed in four patients (1.8%). No patient developed ocular muscle paresis or visual loss. Approximately 29% of patients developed transient ipsilateral masticatory muscle weakness, but no patient developed motor branch involvement that resulted in masticatory muscle palsy or permanent functional impairment. No other cranial nerve deficits were encountered.

Table 3. COMPLICATIONS IN THE CURRENT STUDY COMPARED WITH HISTORIC CONTROL OF PREVIOUSLY PUBLISHED STUDIES

	Present Study	Historic Control* (%)
Masticatory muscle weakness	62 (28.8%)	23
Dysesthesia	18 (8.4%)	20
Anesthesia dolorosa	4 (1.8%)	1
Corneal analgesia	5 (2.3%)	7
Keratitis	2 (0.9%)	2
Aseptic (chemical) meningitis	2 (0.9%)	2
Bacterial meningitis	0	0.2
Carotid-cavernous fistula	0	0.1
Intracranial hemorrhage	0	0
Diplopia	0	1.2
Other cranial nerve deficits	0	0
Death	0	0

*Data from Tew and Taha.[7]

Discussion

Dental and medical specialists are both involved with the evaluation and treatment of patients with craniofacial pain disorders. It has been shown that many patients with these types of problems can go undiagnosed, be misdiagnosed, and have multiple diagnostic and therapeutic interventions before being given the correct diagnosis.[14-16] Although the diagnostic criteria for TN are quite specific, not all patients give a "classic" history, and often the physical examination gives information that can be confused with other neurogenic and non-neurogenic pain disorders of the head and neck. To avoid these problems and provide appropriate disease-specific treatment that is evidence-based and effective, an algorithm for the diagnosis and management of TN has been developed and is presented in this report. This study used the algorithm to correctly diagnose TN, which is a prerequisite for a successful outcome with RTR.

In the treatment algorithm used for this study, patients who fit the clinical diagnosis of TN had an MRI of the brain, brainstem, and cranial base. Reviews of TN by Sweet[3] and others have shown that a pathologic condition in any of these regions can produce signs and symptoms that could be confused with primary TN. Multiple sclerosis,[17-19] Chiari malformation,[20] pontine hemorrhages,[21] midbrain lesions,[22] cerebellopontine angle tumors,[23] other tumors,[24] and, most notably, vascular compression,[25-27] all have been implicated in causing TN. Although the purpose of this study was not to document pathologic conditions causing secondary TN, numerous patients in this study were found to have pathologic conditions thought to be the cause of their TN: meningiomas, schwannomas, multiple sclerosis plaques, ectatic basilar artery, pituitary tumor, and metastatic disease. Using this algorithm, these patients were able to be correctly diagnosed and referred for the most appropriate treatment.

In the current study, 39% of patients went on to surgical treatment with RTR, but most were managed with pharmacologic therapy. This is quite different from other reports of 60% to 75%, or greater, having surgical treatment.[7,28,29] We believe that aggressive pharmacologic trials are necessary and appropriate in treating TN. Regardless of the risks of drug therapy, many patients will benefit from such aggressive management. With newer agents that are less debilitating and potentially have fewer dangerous side effects, along with multiple drug regimens given as initial treatment, pharmacologic therapy can provide pain control, with remission being possible and probable. Additionally, although the results of this study show that RTR is very effective and has limited side effects, avoiding any surgical intervention should be a primary

consideration. Even the low rate of side effects found in this study can be significantly debilitating in some cases (dysesthesia, keratitis, and anesthesia dolorosa), medical therapy before surgical consideration is necessary and can be effective in many patients.

Of the patients in this study who underwent RTR, 92% had early, complete pain relief. When compared with other series (Table 4), our data have some similarities and differences. Our initial results are slightly less successful; 92% versus more than 97%. The reason for this difference is possibly related to philosophical and clinical consideration of patients for RTR. Although pain control is the ultimate goal, the relevant issues of the procedure and the decision-making process were throughly discussed with each person and their family individually. RTR is very effective and, therefore, it is often ethically difficult to withhold this treatment from patients. However, many patients with pain are desperate and will say initially that they understand and agree to the potential side effects of RTR in exchange for relief of pain. This frequently becomes a difficult challenge, especially when faced with a procedure that we believe in, perform regularly, and are studying. With RTR being a selective, neuroablative procedure, it can be performed in a differentially graded fashion. This can give pain relief without the more troublesome side effects. Our technique of performing RTR uses this concept to minimize side effects and provide complete pain relief. This may have an impact on our initial success rate.

Our recurrence rate (27%) was consistent with that of other series (23% to 30%), as was our rate of anesthesia dolorosa (1.8% vs 1% to 2%). Our rate of dysesthesia (8%) is significantly less than that in other series (15% to 24%). Pain recurrence after a successful RTR may not be related to the technique of the procedure but is more likely a property of the disease process. Once a successful thermal lesion is made, the long-term anatomic, histologic, and neurophysiologic changes that occur are not known. This most likely has some clinical relevance to long-term pain relief and recurrence rates, along with possibly altering the pathophysiologic process that is responsible for producing TN.

Anesthesia dolorosa, although an unfortunate complication of RTR as well as other neuroablative procedures, does not occur with a high frequency. The mechanism for loss of sensation with continued pain is not fully understood. It is thought that this represents a central process of abnormal modulation and processing of afferent signals and not solely the peripheral nerve damage.[30] Prevention of this problem after RTR probably lies in careful patient selection and not in the surgical technique.

Dysesthesia is a more common and problematic side effect of RTR. Our rate of dysesthesia (8%) is low compared with other series (15% to 24%). It has been shown that the level of sensory loss is correlated with the rate of dysesthesia and the length of time being pain free.[31] Mild hypalgesia was correlated with less dysesthesia but less time pain free, whereas analgesia was correlated with more dysesthesia but greater time pain free. This balance between pain relief, and the probability of producing dysesthesia after RTR, is difficult to predict and difficult to control. We postulate that our rate of dysesthesia is lower than that of other series because of careful patient evaluation, careful selection of patients for RTR and, most importantly, the production of small, precise lesions producing hypalgesia and not analgesia or anesthesia.

Our rates of additional complications (muscle weakness, corneal analgesia, keratitis, and aseptic meningitis) are consistent with those of other series. These problems, although not insignificant, do not produce major morbidity or functional deficits. Masticatory muscle weakness progressively improves spontaneously and can be helped additionally with physical therapy and passive mandibular motion exercises. Corneal analgesia is also usually transient and can be managed successfully with topical preparations and artificial tears. Our one case of keratitis was promptly diagnosed, and the patient was referred to an ophthalmologist, where treatment resulted in no corneal scarring or loss of visual acuity. Aseptic (chemical) meningitis is an inflammatory reaction that occurs in

Table 4. COMPARISON OF PUBLISHED DATA DIFFERENT SURGICAL PROCEDURES FOR THE TREATMENT OF TRIGEMINAL NEURALGIA

Technique	Immediate Pain Relief	Recurrence	Major Dysesthesia	Anesthesia Dolorosa	Trigeminal Motor Weakness	Permanent Cranial Nerve Deficit	Perioperative Morbidity	Mortality
Radiofrequency rhizotomy	98	23	10	1.5	24	0	1.2	0
Glycerol rhizotomy	91	54	55	1.8	1.7	0	1	0
Balloon compression	93	21	5	0.1	66	0	1.7	0
Posterior fossa exploration	95	17	0.4	0.1	0.1	3	10	0.6

some patients due to the intracranial manipulation with the procedure. Both patients in our series with postoperative symptoms consistent with meningitis were referred for prompt medical evaluation, were not found to have infectious meningitis, and were successfully managed on an outpatient basis without complications. Other more serious complications that have been reported in other series did not occur in our study group.

Several procedures are commonly used as surgical treatment for TN. These were recently compared, based on efficacy, side effects, and complications.[32] Of the percutaneous procedures, RTR has the best overall, long-term outcome data. The initial pain relief is equal to or better than with other procedures, the recurrence rate is less, and the side effects and complications are less frequent and less morbid. RTR has the ability to allow for pre-lesion testing for localization to produce a lesion in only the division(s) involved. RTR also affords the ability to clinically test after a lesion(s), to grade the level of hypalgesia/paresthesia, and possibly avoid side effects while still providing pain relief.

Glycerol rhyzolysis is not division specific, and has a very high recurrence rate (approximately 50%) and an equally high incidence of dysesthesia. Balloon compression of the ganglion is also not division specific, can produce significant bradycardia and hypotension during the procedure, has a very high incidence of masticatory motor dysfunction, can cause other cranial nerve abnormalities, and does not have long follow-up. Microvascular decompression (MVD) has long-term follow-up data, is very effective, and typically does not produce a sensory deficit, but has several significant disadvantages when compared with RTR. MVD requires a craniotomy with retraction of the cerebellum and brainstem. Certain potential complications are inherent in performing a craniotomy for any reason, especially in a non-life-threatening process. In addition to the risk of long general anesthesia and craniotomy, there is risk of cerebellar dysfunction, hearing loss, and facial palsy. Although these risks are statistically small, to the individual patient they are large and disastrous. Those who perform MVD routinely argue that the procedure is safe and effective.[33] The procedure is effective, yet it should not be considered "safe."

Recently, several reports have acknowledged gamma knife radiosurgery as essentially a noninvasive procedure having a very high rate of pain relief, with no facial numbness or side effects.[34,35] Although these results are encouraging, there only very short-term follow-up data are available, with numerous additional questions regarding the safety and justification for such treatment being recently reviewed.[36] There are potential risks and complications with any surgical procedure, but under no circumstance should the potential cure be worse than the disease.

Conclusion

Use of the management algorithm presented in this study is an effective way to evaluate, diagnose, and treat patients with TN. Surgical treatment with RTR is a safe and effective way to manage patients with TN in whom pharmacologic therapy is either ineffective or not tolerated. The side effects are low and are well tolerated. We believe that this should be the procedure of choice for initial surgical management or TN.

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