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Surgical Management Options for Trigeminal Neuralgia

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Trigeminal neuralgia is a condition associated with severe episodic lancinating facial pain subject to remissions and relapses. Trigeminal neuralgia is often associated with blood vessel cross compression of the root entry zone or more rarely with demyelinating diseases and occasionally with direct compression by neoplasms of the posterior fossa. If initial medical management fails to control pain or is associated with unacceptable side effects, a variety of surgical procedures offer the hope for long-lasting pain relief or even cure. For patients who are healthy without significant medical co-morbidities, direct microsurgical vascular decompression (MVD) offers treatment that is often definitive. Other surgical options are effective for elderly patients not suitable for MVD. Percutaneous retrogasserian glycerol rhizotomy is a minimally invasive technique that is based on anatomic definition of the trigeminal cistern followed by injection of anhydrous glycerol to produce a weak neurolytic effect on the post-ganglionic fibers. Other percutaneous management strategies include radiofrequency rhizotomy and balloon compression. More recently, stereotactic radiosurgery has been used as a truly minimally invasive strategy. It also is anatomically based using high resolution MRI to define the retrogasserian target. Radiosurgery provides effective symptomatic relief in the vast majority of patients, especially those who have never had prior surgical procedures. For younger patients, we recommend microvascular decompression. For patients with severe exacerbations of their pain and who need rapid response to treatment, we suggest glycerol rhizotomy. For other patients, gamma knife radiosurgery represents an effective management strategy with excellent preservation of existing facial sensation.

KEY WORDS : Microvascular decompression · Trigeminal neuralgia · Gamma knife radiosurgery · Glycerol rhizotomy.

Introduction

Trigeminal neuralgia, also known as tic douloureux, is a potentially severe facial pain syndrome recognizable from the patient's history[19]. Pain typically is in the distribution of the maxillary (V2) or mandibular (V3)divisions of the nerve, with ophthalmic division of pain alone occurring in less than 5% of patients. The pain is unilateral in more than 95% of patients, and is described as sharp, lancinating, lightening bolt, and intermittent. In response to medication, the length of the pain, classically occurring in seconds, may transition to a more lingering type of unilateral pain. This may be particularly common after usage of agents such as Carbamazepine, the use of which is frequently diagnostic, since the vast majority of patients respond to this as an initial management strategy. The physical findings are typically normal, although mild light touch or pin perception loss has been described in central areas of the face. When detected, this is more suggestive that a mass lesion may be cause of the trigeminal neuralgia rather than neurovascular compression. The initial management of trigeminal neuralgia is medical. When patients become refractory to or intolerant of medical management, surgical options should be offered. Surgery has a high success rate, and can sufficiently ameliorate pain in most patients so that they will be able to discontinue medical management.

Pathophysiology

The mechanism of trigeminal pain production remains somewhat controversial[11]. One theory suggests that disease of the post-ganglionic trigeminal nerve results in ephaptic transmission between unmyelinated or partially demyelinated axons and normal heavily myelinated but damaged axons[6]. It is for this reason, for example, that patients typically can exacerbate their pain by sensations mediated through light touch or pressure (brushing their teeth, wind) but almost

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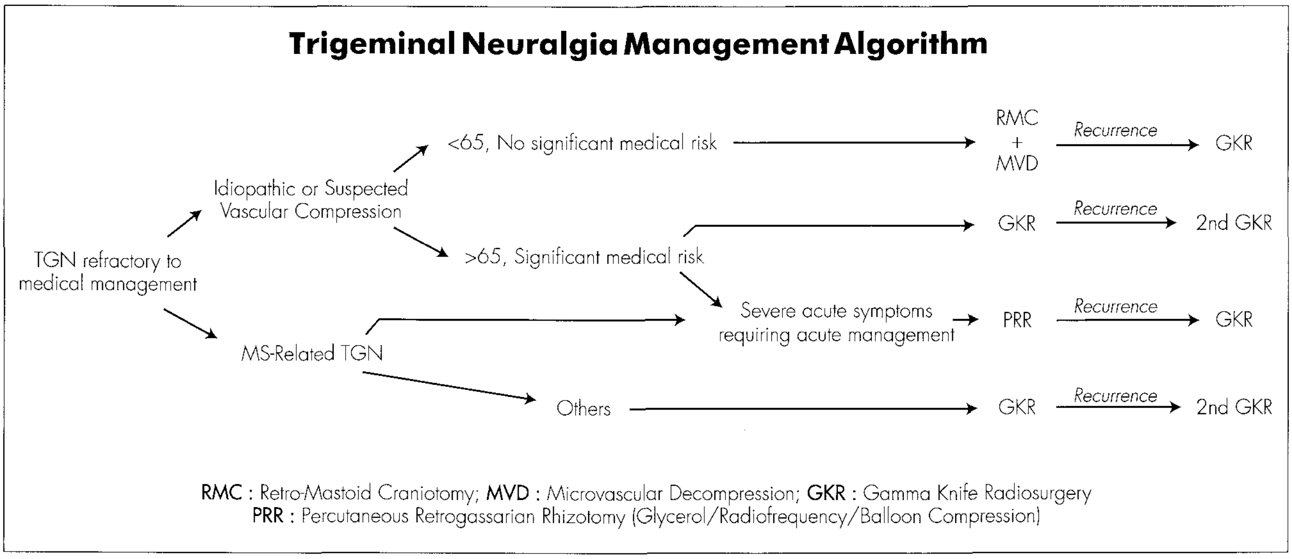

Fig. 1. Suggested surgical management algorithm for medically refractory trigeminal neuralgia.

never reproduce their pain by activation of pain receptors. Failure of sensory inhibitory mechanisms of pain control may also be involved. It is thought that pain occurs when receptive neurons in the trigeminal nucleus involve thalamic relay neurons as well.

Various etiologies have been associated with the development of trigeminal neuralgia. In many patients the pain is clearly due to vascular cross compression of the trigeminal nerve root entry zone, first described by Dandy[29], noted by Gardner[8], and confirmed by Jannetta[1,10,30]. Other published etiologies include aneurysms, meningeal inflammation, tumors (e.g. schwann cell tumors, meningiomas, or epidermoid tumors) or craniovertebral junction anomalies that affect the post-ganglionic trigeminal nerve. Trigeminal neuralgia, both unilateral and rarely bilateral has occurred in the context of demyelinating syndromes such as multiple sclerosis[4]. In such patients, no vascular lesion usually can be identified. The development of trigeminal neuralgia in a young person less than 45 years of age should suggest the possibility of multiple sclerosis, and requires further investigation. Other conditions may mimic trigeminal neuralgia, including paranasal sinus disease and temporomandibular joint disorders. The male to female ratio of trigeminal neuralgia in most series is approximately 2:3. The average age of pain onset in idiopathic trigeminal neuralgia typically is the sixth decade of life, and occur more often in the elderly, although it has been reported even in very young patients.

The evaluation of patients with trigeminal neuraglia

Patients with a characteristic history and normal neurological examination should be evaluated by high resolution neurodiagnostic imaging, preferably MRI scans of the skull base. Using high resolution imaging sequences such as narrow slice volume acquisition or T2 weighted imaging, vascular etiologies are recognized. These include vascular cross compression, dolicoectatic basilar arteries, vascular malformations (rarely), or other associated bony skull base structural anomalies which should be detected in advance. In addition, the rare finding of an ipsilateral developmental venous anomaly (DVA) should give pause to surgeons contemplating microvascular decompression. Failure to understand the venous drainage pattern surrounding the trigeminal nerve can lead to a inadvertent catastrophic neurologic event following coagulation of the critical venous outflow in patients with a DVA.

Medical management

The goal of pharmacological therapy is to control the pain with a low risk of side effects[39]. Over time the effectiveness of medical management tends to wane. Carbamazepine is widely regarded as the most effective initial treatment, and has a relatively low risk ratio. A few patients will develop symptomatic hyponatremia or reversible leucopenia. Carbamazipine is generally tolerated in doses in the range of 600-800 mg/day except in the elderly patients. Management usually starts at approximately 100 mg., twice a day. The dose is gradually increased until pain control is obtained or until the patient develops sedating, ataxic or other toxic symptomatology. Recently, oxcarbazepine has been used as well with relatively few side effects, but perhaps with not quite the same level of efficacy as Carbamazepine. Other agents that have been used in selective patients include Baclofen, Phenytoin, Gabapentin, Clonazepam, and more recently Lamictal. If a patient is no longer helped by these medications, experiences significant break through pain, or suffers undesirable cognitive, incoordination or other side effects, a referable for neurosurgical management is clearly indicated.

Surgical options

In general, surgical options vary with patients related to their age, physical findings, and neurodiagnostic imaging[3,20]. Fig. 1. shows a potential surgical algorithm for decision-making relative to therapeutic options in the management of trigeminal neuralgia. The selection of a treatment option involves a thorough discussion between patient and the responsible surgeon relative to the risks and benefits of the surgical strategies. There are some general principles. The best outcome from surgery is complete pain relief with no postoperative sensory dysfunction and no new neurological deficits. In addition, the results should be longlasting, and still allow additional treatment options in the future if a relapse occurs. Prevention of the complication of severe deafferentiation facial pain (anesthesia dolorosa) is paramount. Trigeminal neuralgia, regardless of whether newly diagnosed or recurrent, always has management options available, both medical and surgical. Anesthesia dolorosa, in contrast, responds to neither medical or surgical management. The current armamentarium of trigeminal neuralgia in management has been extraordinarily effective at reducing the risks of post-surgical deafferentation pain.

The selection of a treatment option also must reflect the general medical condition and the age of a patient. For younger healthy patients with trigeminal neuralgia, a definitive surgical procedure which goes after the root cause of the disorder (microvascular compression of the trigeminal root entry zone) is intuitive[44]. This option is bolstered by long term treatment outcome reports which confirm that approximately 70% of patients remain pain free at ten years[1]. Unfortunately, microvascular decompression by retrosigmoid craniotomy is not appropriate for all patients especially since trigeminal neuralgia occurs more often in the elderly. Microsurgical risks are higher in elderly patients who are more likely to have concomitant medical illnesses.

Minimally invasive treatment options should be selected for such patients. Gamma knife radiosurgery has proven to be an extremely effective management strategy with a very low risk of postoperative sensory dysfunction and a high success rate, especially in those patients who have never had failed prior surgical management. The latency until pain relief is longer after radiosurgery, with an average of two weeks. Some patients may not have satisfactory pain relief for a number of months. Therefore, gamma knife radiosurgery as a primary management is not appropriate for patients who are having severe pain poorly controlled by medication, poor current quality of life or inability to eat or to gain nourishment. Such patients need a procedure which leads to early pain relief, but at the same time has a reasonably low risk of causing significant sensory dysfunction. Over the years, our triage techniques have basically used these criteria in the selection of treatment options, and have led us to avoid percutaneous retrogasserian radiofrequency rhizotomy, a procedure that while effective, is designed to cause sensory dysfunction in the face. Radiofrequency rhizotomy also has an incremental increase in sensory dysfunction if it is performed on the same patient again. The risks of radiofrequency rhizotomy, although rare, include significant sensory dysfunction, extraocular movement deficits, optic nerve injury, temporal lobe seizures, and meningitis[43,45]. For experienced neurosurgeons, those risks are low, so that the outcomes of a radiofrequency rhizotomy are satisfactory in many patients[41,42]. Other percutaneous management options such as balloon compression have advocates but we prefer procedures with less risk of untoward facial sensory loss[2].

Microvascular decompression

A retrosigmoid craniotomy followed by microvascular decompression (MVD) of offending arterial or occasionally venous vessels of the root entry zone is a definitive treatment with high success rates[23]. It should be performed by surgeons with extensive experience in posterior fossa surgery. The recognition of a vascular loop as an etiology, proposed by Dandy, confirmed by Gardner, and popularized by Jannetta, is an effective strategy with long term improvement in outcomes. At ten years, approximately 70% of patients can remain pain free after a single procedure, perhaps the best long term results of any currently available surgical procedures. MVD is designed to attack the cause of trigeminal neuralgia in many patients. A retrosigmoid craniotomy is also performed in those patients with mass lesions that distort the trigeminal root entry zone. Pain may be related to direct tumor compression of the nerve, or as suggested by Jannetta, may be related to impact of a tumor displacing a blood vessel such as the superior cerebellar artery (SCA) into the root entry zone of the nerve. It is likely that recovery from trigeminal neuralgia after microvascular decompression is dependent upon healing or re-myelination of the fibers partially damaged by the neurovascular compression syndrome. Surprisingly, however, most patients get pain relief relatively early after microvascular decompression, especially when there is obvious SCA or other arterial compression of the root entry zone. The SCA loop typically comes from above, compressing the V2, V3 post-ganglionic fibers, and is usually strategically nestled into the axilla of the nerve superiorly. Primarily, V1 pain may be occasionally caused by inferior neurovascular compression sometimes by an aberrant loop of the anterior inferior cerebellar artery.

MVD technique

Microvascular decompression is done usually in the lateral position, or more rarely in the semi-sitting position, depending on a surgeon's choice. After opening the dura, gentle superior-medial retraction of the cerebellum facilitatesevacuation of CSF. After being careful to recognize the seventh and eighth cranial nerve complex, the trigeminal nerve is inspected. An SCA loop can be gently lifted out, and decompressed by placing a small amount of Teflon padding between the root entry zone and the blood vessel. Occasionally, venous compression is recognized. Small veins can be safely bi-polared, providing that the surgeon knows that the outflow is not in fact part of a developmental venous anomaly. Larger veins can be decompressed.

Currently, the risks of hearing dysfunction, related to direct injury or retraction of the cerebellum, should be seen in less than 1 or 2% of patients. This event can be reduced further by using brainstem evoked response monitoring during the procedure. Feedback during the procedure from a clinical neurophysiologist often allows the surgeon to avoid compression using retractors (which may not be needed in many patients, especially in the elderly), and to rapidly decompress the fifth nerve region. The surgeon must be careful to wax any bone edges through mastoid air cells, to avoid the risk of a postoperative CSF leak. The dura should be closed in a water tight fashion. Some centers prefer craniotomy and others craniectomy. A titanium mesh patch over the craniectomy site may reduce the risk of some postoperative long term headache.

As noted above, this procedure is ideal for the patient who is generally younger than 70 years of age, who is in good medical health, and who wishes to have a definitive procedure designed to go after the etiology.

Percutaneous Retrogasserian Glycerol Rhizotomy (PRGR)

Glycerol rhizotomy, first discovered serendipitously by Hakannson working at the Karolinska Hospital in Stockholm, has become a popular and important management strategy using minimally invasive percutaneous techniques. Working with the intellectual giant, Lars Leksell, who developed the gamma knife, Hakannson devised a procedure to percutaneously inject glycerol mixed with tantalum dust into the retrogasserian nerve. The procedure was designed to leave a permanent marker of the trigeminal target in order to facilitate subsequent gamma knife radiosurgery. To their surprise, the glycerol injection alone resulted in pain relief in the vast majority of patients. In his Ph.D. thesis, Hakannson thoroughly worked out the potential mechanism and technique. A weakly neurolytic alcohol (99% anhydrous glycerol) was the agent. Following the pioneering efforts of Hakannson, various other centers across the world began to adopt this procedure including our group in Pittsburgh. Since 1981, Lunsford and colleagues have performed more than 1,000 glycerol procedures for trigeminal neuralgia, some for newly diagnosed patients and some for those who have recurrent pain despite prior surgery. The procedure is anatomically based, and does not require intraoperative sensory examination or reporting by the patients. It is especially ideal for older patients since it allows thorough sedation during the procedure.

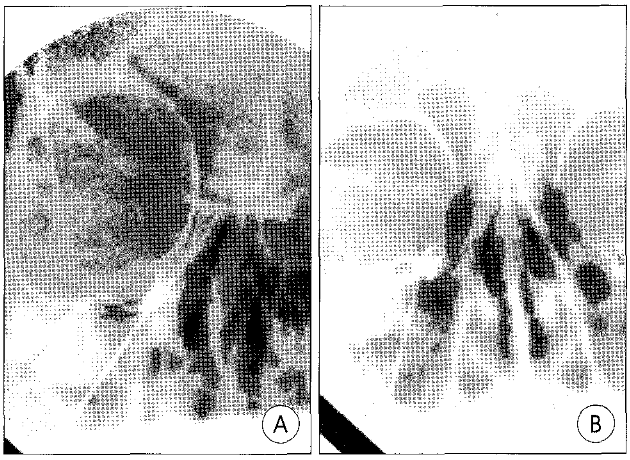

Fig. 2. Percutaneous trigeminal cisternography using nonionic water soluble contrast injected using a 22 gauge spinal needlepassed via the foramen ovale. If a true AP fluoroscopic image is not achieved (A) the cistern appears too medial. In a direct AP view (inferior orbital rim at the level of the petrous bone) the cistern is at medial inferior orbital rim junction (B).

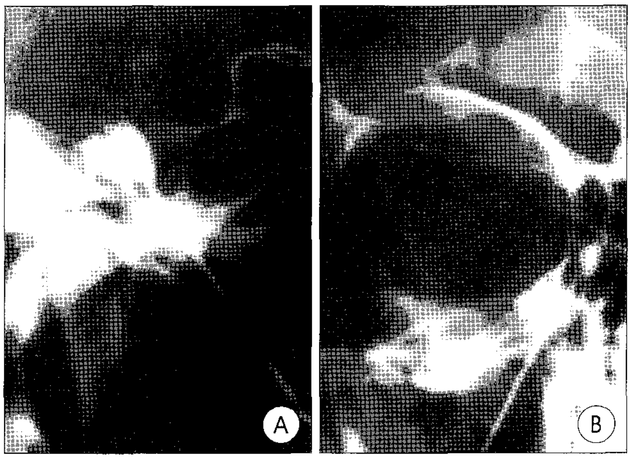

Fig. 3. Lateral (A) and AP (B) trigeminal cisternography prior to glycerol rhizotomy. The cistern size is estimated during cisternography (usually 0.2–0.4 ml).

PRGR technique

After proper selection of patients and an explanation of risks and benefits, the patient is placed supine upon a C-arm table. Most surgeons prefer to do this with the patient straight ahead on a cerebellar head rest, and with the C-arm fluoroscope in the antero-posterior (AP) position. The head is prepped with alcohol, and after local anesthesia is injected, a 22 gauge spinal needle is inserted 2.5 cm lateral to the corner of their mouth. The needle is angled medially and advanced through the foramen ovale. The foramen is usually well seen on the AP view when the petrous bone is placed at the level of the inferior orbital rim (Fig. 2). The needle needs to be placed through the medial aspect of the foramen ovale and directed to the retrogasserian nerve itself, which is actually a post-ganglionic CSF cistern that communicates with the posterior fossa subarachnoid space (Fig. 3). The cistern is located at the junction of the medial and inferior orbital rim. This defines the X coordinate of correct placement of the needle. The Y and Z coordinates are anatomic points 2.5 cm anterior to the external auditory canal. Laterally the cistern lies at a radiographic "V" formed by the shadows of the clivus (medially) and the petrous bone (laterally). The intersection of these three planes defines the target point (the foramen ovale) through which the needle must be placed in order to successfully enter the trigeminal cistern.

Fig. 4. Percutaneous marking of the cistern by combining the glycerol with tantalum powder provides confirmation of the correct target.

Fig. 5. Axial contrast enhanced magnetic resonance image showing 50% isodose line (A) at Gamma Knife radiosurgery for left sided trigeminal neuralgia. A central dose of 80 Gy was delivered using a 4 mm collimator. Imaging follow-up at 6 months (B) shows contrast enhancement at the site of radiosurgery.

PRGR is performed under local anesthesia supplemented by mild intravenous sedation. In some patients, Propofol or a rapid acting barbiturate is delivered just prior to the final placement of the needle through the foramen ovale. Transdural placement results in pain commonly referred to the V1 region of the face. Such pain may lead to a brief bout of hypertension (more common in women), or occasionally activating a monosynaptic trigeminal cardiac reflex leading to profound bradycardia or even syncope (more common in males). This rare event occurs in less than 1% of patients. The appearance of CSF through the tip of the needle is an excellentbut an insufficient sign. Medial placement of the needle in the subarachnoid space beneath the temporal lobe can sometimes lead to CSF flow. Correct placement of the needle more medially in the trigeminal cistern facilitates the subsequent cisternogram. The patient is brought to the semi-sitting position, and up to 0.4 ml of sterile non-ionic iodine is injected to be able to confirm AP and lateral cistern appearance. Once this is identified, the cistern volume is calculated based on the amount of contrast injected before it begins to flow out of the cistern into the posterior fossa. Once the contrast is evacuated out, it is replaced by the appropriate volume of glycerol. We mix it with tantalum dust to leave a permanent marker of the cistern (Fig. 4). We can predict excellent results when patients have easy foramen ovale penetration, good CSF flow, a normal trigeminal cistern, excellent evacuation of the contrast agent, easy replacement with glycerol, and a concomitant neurophysiologic response (reddening of the face, or a brief hypertensive or hypotensive event). When all of these features are noted 95% of patients will have an excellent result with pain relief within a matter of a few days. Approximately 20-30% of patients will have a relatively mild outbreak of herpes simplex perioralis between three and 14 days postoperatively. Patients with a history of cold sores are placed on oral antiviral therapy for one week.

Comparative theories

In general, percutaneous techniques are advocated for elderly patients, those with multiple sclerosis, and those with recurrent, severe, active pain after microvascular decompression. In addition, the risk of impairment of contralateral hearing should be considered in the pre-treatment discussions, as there is virtually no risk of such a complication after percutaneous management or radiosurgical procedures. In a comparative study of three techniques, Lee et al. noted initial success rates in 96.5, 92 and 83% after either microvascular decompression, radiofrequency trigeminal electrocoagulation or glycerol rhizotomy respectively[20]. Facial deafferentation sequelae (dysesthesiae) were reported for 6.3, 5 and 3% of patients respectively. In a review of different procedures, Lovely and Jannetta reported excellent or good pain control for 78, 74, and 56% of patients using microvascular decompression, radiofrequency thermocoagulation or glycerol rhizotomy respectively[23]. It should be noted that the seemingly unsatisfactory results of glycerol rhizotomy report a disproportionate number of patients who have already failed prior procedures.

In our experience, the failure of a prior surgical procedure significantly impacts on the subsequent success of an additional procedure in patients with trigeminal neuralgia. MVD has been associated with a 0.5% mortality rate in a recent series and a 29% risk of facial sensory dysfunction. We should mention that there are certainly advocates of balloon microcompression management of trigeminal neuralgia. One report indicated that 65% of patients achieved excellent control, whereas 32% have developed recurrences at a median interval of 51 months[2]. Sensory dysesthesiae occurred in 3% and hearing impaired in 11% of patients who underwent balloon compression. It is the general consensus that successful MVD provides the longest potential for pain relief. In experienced hands, microvascular decompression can be performed with low risk, and is especially valuable in younger healthy patients with typical trigeminal neuralgia.

Stereotactic radiosurgery

Although the initial target for trigeminal rhizotomy is thought to be the gasserian ganglion, it became clear that a better target was the retrogasserian trigeminal nerve. This required high resolution imaging, first proposed with cisternography by Leksell, and subsequently replaced in recent years by a high resolution MRI scan. Stereotactic radiosurgery is the least invasive procedure for trigeminal neuralgia. It is an excellent option for elderly patients or those with medical co-morbidities, or pain refractory to prior surgical procedures[5,12-18,21,22,24-28,31-38,40,46,47]. A variety of sites have reported outcome data from stereotactic radiosurgery. Although the gamma knife has been used in most centers, more recently modified linear accelerators have been used to perform radiosurgery. At our center between December 1992 and May 2007, a total of 749 radiosurgical procedures for trigeminal neuralgia were performed at the University of Pittsburgh. We recently reported a long term outcome of 220 patients who were managed for idiopathic longstanding pain refractory to medical therapy[25]. One hundred and thirty-five patients (61%) had prior surgery including MVD, glycerol rhizotomy, radiofrequency lesion, balloon compression, peripheral neurectomy or ethanol injections (older procedures rarely done at the present time). Eighty-six patients (39%) had one 39 (17.5%), had two and ten (4.5%) had three or more or prior procedures. For 85 patients, radiosurgery was the first surgical procedure. The current maximum doses were categorized as 80 Gy in a single procedure using 4 mm collimator of the Leksell U, B or C gamma knife (Fig. 5).

Pain relief after radiosurgery

The outcome of pain relief has been categorized as excellent (complete pain relief without the use of analgesic medication), good (complete pain relief while still requiring some low dose medication, fair (partial pain relief, improvement > 50% compared to preoperative assessment), and poor (<50% pain relief). Most patients respond after radiosurgery atan average of two to four weeks after the procedure, maximizing at six months. In our experience, complete pain relief without medication was obtained in 48 % of patients, with excellent and good outcomes in 63% of patients. Greater than 50% pain relief (excellent, good and fair) were obtained in 82% of patients. The most important factors associated with a poor response was a history of atypical pain features, such as constant, dull or burning pain, or failure of a prior surgical procedure. Only 44% of patients with atypical pain features responded in six months, whereas 84% of patients with typical pain relief experienced pain relief. Regis et al. reported that 87% of their patients were initially pain free in a series of 57 patients receiving a single dose of 90 Gy[34]. The "French" post-ganglionic target is a more anterior site, closer to the gasserian ganglion. Nicol et al. noted that 74% of patients were pain free after radiosurgery in a series of 42 patients who had undergone using 90 Gy Radiosurgery. Using thin section MRI, Brisman et al. noted vascular contact with 59% of the patients undergoing trigeminal neuralgia radiosurgery. These authors reported a particularly good response to gamma knife radiosurgery with 56% having excellent outcomes and up to 90% or more of patients having good pain relief.

After radiosurgery, some patients have developed recurrence despite the initial response after radiosurgery as well other surgical procedures. In our experience, thirty (13.6%) patients experienced recurrence of pain after the initial pain relief with a mean duration of fifteen months. Greater than 50% pain relief was maintained in 76% at one year and 67% at three years. According to various literature sources, recurrence rates at last follow-up after radiosurgery vary from 3.3 to 21%[27,28]. Radiosurgery can be repeated[9].

Complications after radiosurgery

Patients are discharged on the same day. The main complications after radiosurgery represent the risk of facial sensory dysfunction. Sensory loss is first detected at the initial visit.

Seventeen patients (7%) in our experience developed initial paresthesias or facial numbness that lasted longer than six months. Only one patient 0.4% developed any type of deafferentation sequellae. No patient developed any other neurological morbidities. The risk of trigeminal sensory dysfunction is higher when a dose of 90 Gy is used[9,25].

Radiosurgery technique

We believe that the gamma knife represents the most effective and efficient method to perform functional neurosurgery. Stereotactic head-frame application allows high-resolution neurodiagnostic MRI imaging. If a patient cannot have an MRI, we perform a CT constrast cisternogram to be able to define the nerve. Images of 1 mm slice-thickness allow clear-cut definition of the trigeminal nerve in the root entry zone. These are occasionally supplemented by T2 volume axial images which, facilitates target detection in patients who have had prior surgery. The ability to see the target is crucial. Once targeting is completed, dose delivery is completed by the U, B or C gamma knife. A single isocenter is used. Increasing the volume of nerve irradiated did not improve results but may increase the risk of sensory dysfunction involving the face[7]. We have no data to indicate that more sensory loss reduces delayed pain recurrence. One of the advantages of gamma knife is the preservation of trigeminal sensory function.

The dose rate is related to the age of the cobalt. A single 4 mm isocenter using a 201-source unit takes between 30 and 60 minutes depending upon the activity of the cobalt sources. The patient is discharged on the same day and is seen in follow-up in approximately six weeks. One other feature of note is that the very low risk of developing herpes simplex perioralis in gamma knife patients in comparison to those either undergoing MVD or percutaneous management.

The mechanism of efficacy of radiosurgery

While incompletely understood, histopathological studies performed in primates undergoing trigeminal gamma knife ablation show widespread myelinated and unmyelinated fiber disruption. The goal of the radiosurgery is to prevent cross-stalk of the partially demyelinated fibers while at the same time not causing extensive sensory loss. Imaging in most patients is not done routinely. However, in the case of recurrence, MRI will often show an area of contrast enhancement precisely confined to the nerve target area (Fig. 5). We have not seen patients who have developed temporal lobe or brainstem dysfunction, providing that we keep the lateral edge of the brainstem dose at 15 to 20% of the maximum dose. This relatively small volume seems to have a low risk of adverse radiation effects, and no patient has developed diplopia, ataxia, imbalance, or other signs or symptoms.

Summary

Neurosurgeons should be pleased that this interesting and occasionally troublesome condition responds both to medical management and ultimately to surgery if the patient becomes refractory or intolerant to medication. The surgical therapies that have been devised for treatment of trigeminal neuralgia constitute a long list. The recent goals of management include pain relief, facial sensory preservation, and the prevention and development of deafferentation pain sequelae. Microvascular decompression makes intuitive sense for appropriate candidates, going after the etiologyof trigeminal neuralgia in a significant number of patients. Well-trained microsurgeons can perform the procedure with low risk and long-term benefit. Unfortunately, many patients with trigeminal neuralgia are elderly or have associated other medical conditions which, makes them less satisfactory candidates for open microsurgical vascular decompression. Some have associated demyelinating disease. In such cases, we believe that gamma knife radiosurgery represents a primary additional treatment alternative. Today many patients who are young or otherwise eligible for microvascular decompression choose radiosurgery as a lesser invasive procedure. It clearly has less impact on their quality of life and allows rapid return to work. Although the latency of the pain relief is longer with radiosurgery, most patients are now controlled with one or more medications while waiting for the full effect to kick in. Therefore, they gradually taper their medicine. Radiosurgery canbe repeated if needed. We reserve percutaneous management strategies, noting their effectiveness, to those patients who have severe pain which interferes with quality of life, chewing and eating. In such cases, rapidly effective percutaneous management strategies become very important. We prefer glycerol rhizotomy in this context.

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