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Stereotactic radio surgery and radio frequency rhizotomy for trigeminal neuralgia in multiple sclerosis: A single institution experience

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ABSTRACT

Objectives: For patients with medically unresponsive trigeminal neuralgia (TN), surgical options include micro vascular decompression (MVD), radiofrequency rhizotomy (RF), and stereotactic radio surgery (SRS). Multiple sclerosis (MS) is a demyelinating condition that can be associated with TN, but is not amenable to treatment with MVD. We sought to identify the outcome differences of patients with TN in MS undergoing SRS or RFR in an attempt to identify factors that may influence outcomes. We also evaluated cost outcomes, both initially and over time, based on the index procedure. We performed a retrospective review of our experience with 17 cases.

Patients and methods: A single institution retrospective chart review was performed. Since 1997, 17 patients with TN and MS have been treated at our institution. All patients underwent a preoperative MRI to rule out a compressive lesion. Patients either underwent SRS (n = 7) or RFR (n = 10) as their index procedure and were evaluated as a group based on this first procedure. Outcome measures included preoperative Expand Disability Status Score (EDSS) scores, pre- and postoperative facial pain and medication use, post-intervention facial numbness, need for subsequent procedures, and duration of follow-up. Charges for the index procedure, subsequent interventions, and total costs were tabulated and analyzed in 2017 US dollars, adjusting for inflation.

Results: The median age of patients at first operation in each group was 58.5 ± 10.9 and 63.5 ± 7.5 for SRS and RFR respectively. There were no significant differences in basic demographics. Overall, 71% of these patients had an excellent or good initial pain outcome. Over time, 60% of RFR and 29% of SRS patients required additional procedures to obtain satisfactory pain relief. The patients who underwent RFR as their index procedure required a significantly higher number of procedures to achieve adequate pain relief (RFR = 2.7 vs SRS = 2.0 [p = 0.04]). The average index procedure costs in US dollars were significantly different (SRS = 53,300 ± 5257 vs RFR = 12,315 ± 3387). The average subsequent costs (costs incurred following the initial intervention) (SRS = 8320 ± 17,842, RFR = 36,002 ± 46,767) and total costs (SRS = 61,620 ± 16,087, RFR = 48,317 ± 48,475) were not statistically significantly different.

Conclusion: TN in the setting of MS is highly difficult to treat medically with SRS and RFR being offered as options for these patients. Both can provide good initial pain relief. For patients who have RFR as their initial procedure, a larger number of procedures are required for relief compared to patients who initially underwent SRS. While there is a significant difference in the cost of the initial procedure, over time, with the cost of required subsequent interventions, there is no significant difference in total costs between the two groups.

1. Introduction

Idiopathic trigeminal neuralgia (TN) has an incidence rate in the general population of approximately 12 per 100,000 persons [1]. The risk of developing TN in the setting of multiple sclerosis (MS) can be up to 20 times higher than the general population [2]. TN is characterized by moments of lancinating facial pain that can be spontaneous or triggered by even the slightest sensory stimulus. The pain may occur for only a brief moment or last for chronic periods of time [1]. The classical description of the pathogenesis of idiopathic TN involves a compressive vessel at the trigeminal nerve root entry zone which causes damage to and dysfunction of the internal sensory network. On the other hand, TN

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in the setting of multiple sclerosis (MS) is hypothesized to be due to the development of a demyelinating plaque at the trigeminal nerve root entry zone [3,4]. Primary treatment of TN includes conservative management with medications such as carbamazepine, which has an overall effectiveness of 80% in idiopathic TN [5]. For patients with TN who do not respond to medications, surgical intervention via micro vascular decompression (MVD), radio frequency rhizotomy (RFR), or stereotactic radiosurgery (SRS) offers significant efficacy and are offered at our institution [6–18]. Additionally, percutaneous glycerol neurolysis and balloon compression are available and indicated interventional therapies [19]. Unfortunately, for patients with concurrent MS, TN is more difficult to treat both pharmacologically and surgically with significant recurrence rates [15,20–25]. Micro vascular decompression is not recommended for TN with MS, as the pathology is not vascular compression but a demyelinating plaque [7,26]. Prior studies have attempted to evaluate the costs and outcomes in TN patients [8,10,27,28]. In our study, we sought to present the outcomes, experience, and cost of treatment of TN with MS at our institution.

2. Patients and methods

This research study and its methodological approach were approved by our institution's Institutional Review Board (IRB# 201701755). Since 1997, 17 patients with concurrent MS and TN have been treated at our institution. Diagnosis and management of these patients were based on clinical presentation. The diagnosis of MS was established by the patient's primary neurologist with their signs and symptoms meeting the 2010 McDonald Criteria for Diagnosis of Multiple Sclerosis prior to presentation to the neurosurgery clinic [29]. All patients had intractable TN pain despite multiple appropriate medical therapies and were currently taking or had previously failed treatment with carbamazepine or oxycarbamazipine. Given this presentation, all were candidates for surgical intervention. All of the individual patients were interviewed, examined, and a discussion was conducted concerning the two indicated surgical options of RFR or SRS. Patients were additionally provided with a document outlining the risks, benefits, and further details concerning these procedures (See e-only Supplementary file). All patients had a preoperative MRI (T1, T2, Diffusion, and T1 post-contrast sequences) to rule out a compressive lesion as the underlying cause of the patient's symptoms. The risks, benefits, technique, and expected outcome for each option were discussed in detail. The ultimate recommendation and surgical decision was typically based on the patient's preference for quick relief or an intervention with minimal morbidity.

2.1. Interventional technique

Radio frequency rhizotomy was performed in the radiology/angiography interventional suite. Under local anesthetic and monitored anesthesia care, the for a men ovale was engaged with a 5-mm exposed tip electrode. A Radionics radiofrequency generator (Radionics Model RFG-3CF, Radionics, Inc., Burlington, MA) was used to generate 50 Hz frequency stimulation with a 0–1 V current to confirm appropriate electrode location and pain area coverage. Once accurately placed, lesioning was performed in 10° C increments from 50 to 90° C for 50–90 s each. Between lesions, the electrode was intermittently adjusted to ensure lesioning covered the appropriate painful areas.

Stereotactic radio frequency ablation was performed using a linear accelerator with 5 arcs, single isocenter, and a 5-mm collimator with 90 Gy to the 100% isodose line directed at the root entry zone of the trigeminal nerve. The target was selected by fusing CT images obtained after application of the stereotactic ring, and a previously obtained thin cut MRI.

2.2. Follow-up evaluation

The patient's facial pain was evaluated before and at the 6 week post-intervention clinical appointment with visual analogue scores (VAS). Preoperative Expand Disability Status Score (EDSS) was determined based on clinical documentation and recorded [30]. Preoperative and postoperative medication use and facial numbness were also noted. An excellent outcome was defined as the patient being pain free with no need for supplementary medications. A good outcome was defined as decrease in pain or pain free with the use of supplementary medications. A poor outcome was defined as worsening pain or no improvement in pain at the patient's last recorded follow-up appointment. Patients were followed for the need of any additional procedures. Information regarding index, subsequent, and total charges was collected. Medication charges, lost productivity from inability to work, and other indirect costs were not included in our analysis given the high variability of medication charges by local pharmacies and patient disability level. Charges, rather than collections, were analyzed given the variability of collections based on insurance coverage. The raw charges were converted to 2017 US dollars using an inflation calculator. Where direct charges were not available for review based on the obtainable records, an estimated cost was derived as the average cost of the intervention in 2017 US dollars.

2.3. Statistical analysis

Microsoft Excel Version 14 for Windows was used for statistical analysis. A one-sided student's *T*-test was utilized for numerical data assessment. A "p" value of less than 0.05 was set as significance.

3. Results

3.1. Demographics

Since 1997, 17 patients with concurrent TN and MS have been treated at our institution. Ten underwent RFR as the index procedure, and 7 had SRS as their first intervention. The median age at first intervention in the SRS group was 58.5 ± 10.9 years, with 63.5 ± 7.5 years for the RFR group ($p = 0.46$). There were 3 males and 4 females in the SRS group and 5 each of males and females in the RFR group. The median EDSS for SRS was 2.0 ± 2.9 and for RFR was 4.25 ± 2.8 ($p = 0.28$). The median BMI was 34.5 ± 6.1 (range 17–34) for RFR and 26.5 ± 5.6 (range 23–38) for SRS ($p = 0.09$). In the SRS group, 3 patients (43%) had solely left-sided symptoms, while 4 (57%) had only right-sided symptoms. Among the RFR patients, 2 (20%) had left-sided symptoms alone, 6 (60%) had exclusively right-sided symptoms, and 2 (20%) had bilateral symptoms. Among the RFR patients, no patients had V1 involvement, 6 (60%) had V2 involvement and 2 patients (20%) experienced symptoms in V3. Within the SRS group, V1 symptoms were present in 1 patient (14%), 5 patients (71%) experienced V2 symptoms, and V3 involvement was present in 3 patients (43%). The median duration from diagnosis of MS to the date of the index procedure was 12.0 ± 6.9 and 17.0 ± 8.8 years for RFR and SRS ($p = 0.19$). Relief with RFR was achieved by the end of the procedure which was generally within an hour. Relief subsequent to SRS was achieved by 1–4 weeks. The median duration from the time of first operation to final follow-up appointment was 66.0 ± 58.8 and 10.4 ± 43.1 months for RFR and SRS respectively ($p = 0.067$). The median time from the most recent operation to final follow-up was 10.4 ± 16.0 and 66.0 ± 497.5 months for RFR and SRS ($p = 0.13$). Demographical features of these groups are summarized in Table 1.

3.2. Clinical outcomes

None of the patients achieved excellent relief. In our series, 71% (5/7) of SRS patients and 70% (7/10) of RFR patients achieved a good pain