Comparison of posterior fossa exploration and stereotactic radiosurgery in patients with previously nonsurgically treated idiopathic trigeminal neuralgia

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Object. Stereotactic radiosurgery (SRS) is commonly performed in patients with trigeminal neuralgia, and numerous investigators have found that facial pain outcomes after this procedure are better for patients in whom prior surgery did not fail. Researchers in some centers claim that the results of SRS are equivalent to posterior fossa exploration (PFE). The goal in this study was to verify that claim.

Methods. Information was retrieved from a prospectively maintained database of patients less than 70 years old with idiopathic trigeminal neuralgia who underwent PFE (55 patients) or SRS (28 patients) as their initial surgery between 1999 and 2004. Of the two groups, patients who underwent radiosurgery were older (60.5 compared with 50.7 years, $p < 0.001$). Microvascular decompression was performed in 49 patients (89%) and partial nerve section was performed in six (11%) in the PFE group. The mean maximum dose for SRS was 89.1 Gy. At a mean follow-up duration of 25.5 months, patients who had undergone PFE were more commonly pain free without medications (75% at 1 year, 72% at 3 years) compared with the patients treated with SRS (59% at 1 and 3 years; $p = 0.01$). Additional surgery was performed in 10 patients (18%) after PFE, compared with eight patients (29%) after SRS ($p = 0.4$). Eight patients (15%) had either new facial numbness (six cases) or dysesthesias (two cases) after PFE, whereas 12 (43%) had either new facial numbness (eight cases) or dysesthesias (four cases) after SRS. No correlation was noted between the development of facial numbness and facial pain outcome after PFE ($p = 0.37$), whereas patients in whom trigeminal dysfunction developed after radiosurgery were more frequently free of pain ($p = 0.02$).

Conclusions. The results support PFE as a more effective primary surgery than SRS in patients with idiopathic trigeminal neuralgia. Moreover, injury to the trigeminal nerve during PFE is not required to achieve excellent facial pain outcomes.

KEY WORDS • trigeminal neuralgia • microvascular decompression • stereotactic radiosurgery

Trigeminal neuralgia (tic douloureux) is the most common facial pain syndrome, diagnosed in approximately 15,000 new patients each year in the US.¹³ Although this condition can be secondary to tumors or multiple sclerosis, it is believed that the majority of patients experience TN due to vascular compression and focal demyelination of the trigeminal nerve root.^{9,10} Medical therapy eliminates or significantly reduces the pain for approximately 75% of patients and is considered the treatment of choice for new-onset TN.

Unfortunately, the relief provided by medical therapy generally diminishes over time.³¹ A variety of operations have been used to treat patients with medically unresponsive TN, including PFE^{2,6,8,26,28,29} and SRS.^{5,17,18,22,23,27} The decision concerning which surgery to perform is based on a variety of factors, including the patient's age, medical conditions, and the pain's severity. Generally, MVD is consid-

ered to be the best operation for medically fit patients with TN.^{1,15,29} Less invasive procedures are commonly performed in patients with TN if they are elderly, suffer from significant medical comorbidities, or have recurrent facial pain after previous surgery.¹⁶ More recently, patient preference has emerged as an important deciding factor, and a large number of patients choose SRS as the least invasive procedure for TN based on information obtained from the Internet. To determine whether this is the best choice, in this study I have compared the relative effectiveness of PFE and SRS for patients with previously nonsurgically treated idiopathic TN.

CLINICAL MATERIAL AND METHODS

Patient Population

Between July 1999 and June 2004, I performed 345 operations in patients with idiopathic TN. The most frequent procedure was SRS (124 operations, 36%), followed by

Abbreviations used in this paper: MVD = microvascular decompression; PFE = posterior fossa exploration; SRS = stereotactic radiosurgery, TN = trigeminal neuralgia.

PFE (112, 33%), percutaneous retrogasserian glycerol rhizotomy (107, 31%), and balloon microcompression (two, 1%). Adult patients less than 70 years old in whom I performed primary surgery for idiopathic TN between July 1999 and March 2004 were eligible for enrollment in this study. Every patient had persistent pain despite medical therapy, and each one suffered episodic shocklike pain within the trigeminal distribution. Patients were informed that PFE was the surgery most likely to relieve their pain without causing facial numbness. Despite this information, 28 patients opted for SRS, whereas 55 underwent PFE; the patient characteristics are outlined in Table 1. Patients who underwent SRS were older than the ones in the PFE group (60.5 compared with 50.7 years, $p < 0.001$). The groups were otherwise similar with regard to sex, pain duration, pain location, and presence of constant pain.

Specific operative details for the two procedures are as previously described.^{19,23} During PFE, the superior cerebellar artery compressed the trigeminal nerve alone or in conjunction with other vessels in 44 cases (80%), the anterior inferior cerebellar artery in two cases (4%), and the basilar artery in one case (2%). Venous compression was noted in four cases (7%). In six patients (11%), partial nerve section was performed either alone (four cases) or in conjunction with MVD (two cases). Of note, three (38%) of eight patients with some degree of constant facial pain underwent partial nerve section compared with three (6%) of 47 patients who described no constant face pain before surgery ($p = 0.03$). The mean hospital duration of stay was 3.1 days. Stereotactic radiosurgery was performed using the Gamma Knife unit (Elekta Instruments, Norcross, GA). All patients were treated with a single 4-mm isocenter of radiation directed at the root entry zone. The mean maximum radiation dose delivered to the trigeminal nerve was 89.1 Gy (range 85–97.9 Gy; doses corrected to an output factor of 0.87 Gy). All patients who underwent SRS were discharged on the day of the procedure.

Preoperative, surgical, and postoperative follow-up information was entered into a prospectively maintained database. Patients were contacted 3 months postsurgery, and then yearly thereafter to assess their facial pain outcome. Facial pain outcomes were classified as excellent (absence of lancinating facial pain without medications for TN),

good (complete pain relief but still requiring a low dose of medications), fair (continued facial pain but reduced $> 50\%$ compared with before surgery), and poor. Patient follow-up data were censored at last contact (65 patients), time of subsequent surgery (17), or death (one). The mean follow-up duration was 25.5 months.

Kaplan–Meier curves were calculated to determine the percentage of patients achieving and maintaining an excellent facial pain outcome after surgery.¹² Differences in facial pain outcomes between the surgical groups were tested by log-rank methods. Univariate comparisons of continuous variables were compared using the Student t-test; proportional differences were compared by the Fisher exact test.

RESULTS

Initial pain results after PFE were excellent in 49 patients (89%), and good, fair, and poor in two patients each (4%). In 12 patients (22%) recurrent pain developed at a median interval of 3 months postsurgery. At the last follow-up visit, 39 patients (71%) were pain free without medications. Excellent facial pain outcomes were achieved and maintained in 75 and 72% of patients at 1- and 3-year intervals, respectively, after PFE.

Initial pain results after SRS were excellent in 16 patients (57%), good in five (18%), fair in three (11%), and poor in four (14%). Three patients (11%) had pain recurrence at a median of 4 months postsurgery. At the last follow-up visit, 15 patients (54%) were free of pain without medications. Excellent facial pain outcomes were achieved and maintained in 59% of patients at 1- and 3-year intervals after SRS. These results show that patients who underwent PFE were more likely to achieve and maintain an excellent facial pain outcome compared with the stereotactically treated group ($p = 0.01$; Fig. 1). There was no significant difference in the number of patients who underwent additional surgery after PFE (10 patients) and SRS (eight) (18% compared with 29%, $p = 0.4$).

Complications after PFE included cerebrospinal fluid leakage that required repair (two patients), wound infection (one), and symptomatic transverse sinus thrombosis requir-

TABLE 1
Characteristics of 83 patients who
underwent treatment for idiopathic trigeminal neuralgia*

Factor	PFE (%)	SRS (%)	p Value
no. of patients	55	28	
M/F	21/34	12/16	0.81
mean age (yrs)	50.7	60.5	<0.001
pain duration (yrs)	4.8	6.7	0.11
rt/lt	34/22	14/14	0.48
pain location			
single division	20 (36)	13 (46)	0.48
multiple divisions	35 (64)	15 (54)	
any V ₁ pain	17 (31)	5 (18)	0.29
facial numbness	4 (7)	3 (11)	0.68
constant pain	8 (15)	3 (11)	0.74

* V₁ = first division of the trigeminal nerve.

Fig. 1. Graph showing the percentage of patients with excellent facial pain outcomes (no pain, off medications) after PFE and SRS ($p = 0.01$). Times are given in months.

ing optic nerve fenestrations (one). Eight patients (15%) had either new facial numbness (six cases) or dysesthesias (two cases) postsurgery. Excluding the six patients who underwent partial nerve section, the chance of new numbness after MVD was 4%. No treatment-related complications occurred after SRS, although 12 patients (43%) had either new facial numbness (nine cases) or dysesthesias (three cases) after radiosurgery. The incidence of new trigeminal deficits by maximum radiation dose was two (50%) of four for 85 Gy, six (33%) of 18 for 87 Gy, and four (67%) of six for 97.9 Gy. No correlation was found between trigeminal deficits after PFE and excellent facial pain outcomes ($p = 0.37$), whereas new trigeminal deficits did correlate with excellent facial pain outcomes after SRS ($p = 0.02$).

DISCUSSION

The goal of surgery for TN is to eliminate the patient’s facial pain with minimal morbidity. In this series, PFE provided a significantly higher cure rate than SRS in patients with previously nonsurgically treated idiopathic TN. This is noteworthy because the patients in the radiosurgery group would be predicted to do better than those in published reports on radiosurgery for TN (Table 2) for several reasons. First, patients in this comparison had not undergone prior surgeries for their facial pain. In several reports investigators have shown that patients who experience recurrent pain after their initial surgeries have worse results after SRS than patients who have not undergone prior surgical treatment.^{17,23} Second, the mean radiation dose used over this time frame was rather high (89.1 Gy). At radiation doses below 80 Gy, the chance of remaining pain free without medications 3 years after SRS is 40% or less.^{5,17} Conversely, at radiation doses above 85 Gy, approximately 55 to 60% of patients are pain free without medications 3 years after treatment.^{18,22} Most centers, however, have gradually reduced the radiation dose to minimize the chance of bothersome facial numbness after SRS.²² Therefore, the results of this study contradict the claim by some radiosurgery centers that SRS provides equivalent facial pain outcomes compared with PFE and should be considered the primary surgical option for patients with medically unresponsive TN.

TABLE 2
*Literature review of reported outcomes
after radiosurgery for trigeminal neuralgia**

Authors & Year	No. of Patients	Radiation Dose (Gy)	% Pain Free	% w/ Facial Numbness
Maesawa, et al., 2001	220	80	57 at 3 yrs (+/- meds)	10 at 2 yrs
Pollock, et al., 2002	117	87	55 at 3 yrs (off meds)	37 (crude)
Smith, et al., 2003 (LINAC)	41	90	45 at 3 yrs (off meds)	25 (crude)
Massager, et al., 2004	47	90	59 at 3 yrs (off meds)	38 (crude)
Brisman, 2004	293	76.8	10 at 3 yrs (off meds)	NS

* LINAC = linear accelerator; meds = medications; NS = not stated.

The majority (89%) of patients in whom a PFE was performed underwent MVD. This procedure is nondestructive and removes the neurovascular compression believed to be the origin of facial pain for the majority of patients with TN. Unlike ablative techniques, pain relief after MVD is independent of postoperative facial sensory disturbances.^{3,4} Moreover, the pain relief after MVD has also been determined to be quite durable. In the large series by Barker, et al.,³ on 1185 patients, 70% of patients were free of pain without medications for TN 10 years postoperatively. Likewise, Tronnier, et al.,²⁹ found excellent outcomes in 65% of patients 10 years after MVD. Thus, if the goals of TN surgery are elimination of facial pain without medications and preservation of trigeminal function, then MVD is the best available operation.

Nevertheless, in some patients no neurovascular compression is found at surgery. The ability to perform a partial nerve section provides another means to provide pain relief, but most patients will experience a degree of facial numbness if the nerve is cut or intentionally manipulated.^{14,24} The obvious drawback of PFE is the potential risk associated with this operation. Nonetheless, the chance of major morbidity or death after PFE is low. In my series, only one patient (2%) suffered a new neurological deficit other than facial numbness.

Despite these considerations, PFE may not be the best operation for all patients. Negative predictive factors after MVD include female sex, long pain duration, prior MVD, and atypical pain features.^{2,28,30} Of note, in this series 15% of the patients who underwent a PFE described a component of constant facial pain in addition to intermittent shocklike pains. A neurovascular conflict was frequently not detected at surgery in patients with constant facial pain, and these individuals more frequently underwent a partial nerve section rather than an MVD. Although it is likely that these patients have Type 2 TN based on Burchiel’s⁷ recent facial pain classification scheme, I avoided using this terminology because it would disrupt the prospective nature of the TN patient database.

Importantly, age has not been correlated with worse outcomes after MVD for TN. Investigators in several papers have concluded that outcomes for MVD in patients older than 65 years were similar to those in younger patients, with no increase in the risk of serious morbidity or death.^{11,20,25} Thus, MVD appears to be safe and effective even for older patients with TN if their general medical condition is stable and the aim of treatment is complete pain relief without medications. Finally, PFE is predicted to be a more cost-effective option than SRS, despite higher procedural costs, because of its increased efficacy and the less frequent need for later surgeries.²¹ At our center, the cost of a quality-adjusted pain-free year after PFE was \$8174 compared with \$8269 for SRS.

References

1. Apfelbaum RI: Neurovascular decompression: the procedure of choice? *Clin Neurosurg* 46:473–498, 2000
2. Barker FG, Jannetta PJ, Bissonette DJ, et al: The long-term outcome of microvascular decompression for trigeminal neuralgia. *New Engl J Med* 334:1077–1083, 1996
3. Barker FG II, Jannetta PJ, Bissonette DJ, et al: Trigeminal numb-

- ness and tic relief after microvascular decompression for typical trigeminal neuralgia. **Neurosurgery** 40:39–45, 1997
4. Bergenheim AT, Shamsgovara P, Ridderheim PA: Microvascular decompression for trigeminal neuralgia: no relation between sensory disturbance and outcome. **Stereotact Funct Neurosurg** 68:200–206, 1997
 5. Brisman R: Gamma knife surgery with a dose of 75 to 76.8 Gray for trigeminal neuralgia. **J Neurosurg** 100:848–854, 2004
 6. Broggi G, Ferroli P, Franzini A, et al: Microvascular decompression for trigeminal neuralgia: comments on a series of 250 cases, including 10 patients with multiple sclerosis. **J Neurol Neurosurg Psychiatry** 68:59–64, 2000
 7. Burchiel KJ: A new classification for facial pain. **Neurosurgery** 53:1164–1167, 2003
 8. Burchiel KJ, Clarke H, Haglund M, et al: Long-term efficacy of microvascular decompression in trigeminal neuralgia. **J Neurosurg** 69:35–38, 1988
 9. Dandy WE: Concerning the cause of trigeminal neuralgia. **Am J Surg** 24:447–455, 1934
 10. Jannetta PJ: Arterial compression of the trigeminal nerve at the pons in patients with trigeminal neuralgia. **J Neurosurg** 26 (Suppl):159–162, 1967
 11. Jodtke A, Winking M, Deinsberger W, et al: Microvascular decompression as treatment for trigeminal neuralgia in the elderly patient. **Minim Invasive Neurosurg** 42:92–96, 1999
 12. Kaplan EL, Meier P: Nonparametric estimation from incomplete observations. **J Am Stat Assoc** 53:457–481, 1958
 13. Katusic S, Beard CM, Bergstralh E, et al: Incidence and clinical features of trigeminal neuralgia, Rochester, Minnesota, 1945–1984. **Ann Neurol** 27:89–95, 1990
 14. Kureshi SA, Wilkens RH: Posterior fossa reexploration for persistent or recurrent trigeminal neuralgia of hemifacial spasm: surgical findings and therapeutic implications. **Neurosurgery** 43:1111–1117, 1998
 15. Lee KH, Chang JW, Park YG, et al: Microvascular decompression and percutaneous rhizotomy in trigeminal neuralgia. **Stereotact Funct Neurosurg** 68:196–199, 1997
 16. Lopez BC, Hamlyn PJ, Zakrzewska JM: Systematic review of ablative neurosurgical techniques for the treatment of trigeminal neuralgia. **Neurosurgery** 54:973–983, 2004
 17. Maesawa S, Salame C, Flickinger JC, et al: Clinical outcomes after stereotactic radiosurgery for idiopathic trigeminal neuralgia. **J Neurosurg** 94:14–20, 2001
 18. Massager N, Lorenzoni J, Devriendt D, et al: Gamma knife surgery for idiopathic trigeminal neuralgia performed using a far-anterior cisternal target and a high dose of radiation. **J Neurosurg** 100:597–605, 2004
 19. McLaughlin MR, Jannetta PJ, Clyde BL, et al: Microvascular decompression of cranial nerves: lessons learned after 4400 operations. **J Neurosurg** 91:1–8, 1999
 20. Ogungbo BI, Kelly P, Kane PJ, et al: Microvascular decompression for trigeminal neuralgia: report of outcome in patients over 65 years of age. **Br J Neurosurg** 14:23–27, 2000
 21. Pollock BE, Ecker RD: A prospective cost-effectiveness study of trigeminal neuralgia surgery. **Clin J Pain** (In press)
 22. Pollock BE, Phuong LK, Foote RL, et al: High-dose trigeminal neuralgia radiosurgery associated with increased risk of trigeminal dysfunction. **Neurosurgery** 49:58–64, 2001
 23. Pollock BE, Phuong LK, Gorman DA, et al: Stereotactic radiosurgery for idiopathic trigeminal neuralgia. **J Neurosurg** 97:347–353, 2002
 24. Rath SA, Klein HJ, Richter HP: Findings and long-term results of subsequent operations after failed microvascular decompression for trigeminal neuralgia. **Neurosurgery** 39:933–940, 1996
 25. Ryu H, Yamamoto S, Sugiyama K, et al: Neurovascular decompression for trigeminal neuralgia in elderly patients. **Neurol Med Chir** 39:226–230, 1999
 26. Sindou M, Howeydi T, Acevedo G: Anatomical observations during microvascular decompression for idiopathic trigeminal neuralgia (with correlations between topography of pain and site of the neurovascular conflict). Prospective study in a series of 579 patients. **Acta Neurochir** 144:1–13, 2002
 27. Smith Z, De Salles AA, Frighetto L, et al: Dedicated linear accelerator radiosurgery for the treatment of trigeminal neuralgia. **J Neurosurg** 99:511–516, 2003
 28. Theodosopoulos PV, Marco E, Applebury C, et al: Predictive model for pain recurrence after posterior fossa surgery for trigeminal neuralgia. **Arch Neurol** 59:1297–1302, 2002
 29. Tronnier VM, Rasche D, Hamer J, et al: Treatment of idiopathic trigeminal neuralgia: comparison of long-term outcome after radiofrequency rhizotomy and microvascular decompression. **Neurosurgery** 48:1261–1268, 2001
 30. Tyler-Kabara EC, Kassam AB, Horowitz MH, et al: Predictors of outcome in surgically managed patients with typical and atypical trigeminal neuralgia: comparison of results after microvascular decompression. **J Neurosurg** 96:527–531, 2002
 31. Zakrzewska JM, Patsalos PN: Long-term cohort study comparing medical (oxcarbazepine) and surgical management of intractable trigeminal neuralgia. **Pain** 95:259–266, 2002

Manuscript received March 3, 2005.

Accepted in final form April 8, 2005.

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