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Case study

Outcome of Gamma Knife radiosurgery for trigeminal neuralgia associated with neurovascular compression

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ABSTRACT

We reviewed 130 patients from 1999 to 2012 to evaluate whether neurovascular compression (NVC) has prognostic value for pain relief in idiopathic trigeminal neuralgia (TN) treated by Gamma Knife radiosurgery (GKRS). Patients were assigned to one of the following groups based on NVC identified by MRI: no NVC, small vessel NVC, and large vessel (defined as part of the vertebrobasilar arterial system) NVC. Follow-up ranged from 4 to 14 years. Primary outcome was pain graded by the Barrow Neurological Institute (BNI) pain scale. Successful pain control was defined as a score within Grade I-IIIb. Among the 130 patients, 53 had no neurovascular compression (group 1), 60 had a small vessel NVC (group 2), and 17 had a large vessel NVC (group 3). Successful pain control was 85% in group 1, 75% in group 2, and 88% in group 3 ($X^2 = 2.480$, $p = .289$). Secondary outcome was new onset facial numbness which was 21% in group 1, 28% in group 2, and 35% in group 3 ($X^2 = 1.683$, $p = .431$). NVC did not affect pain outcome for TN patients treated by GKRS. The lack of poorer response with large vessel NVC that has been reported in literature may be explained by treatment of multiple 4 mm shots (as opposed to a single shot in 11/17 patients) to cover a larger compression area of the nerve root by a tortuous vessel.

1. Introduction

It is now well accepted that neurovascular compression (NVC) near the root entry zone of the trigeminal nerve is an important offending agent of most idiopathic trigeminal neuralgia (TN). Microvascular decompression (MVD) is a safe and effective treatment for the disease with a high rate of long-term success [1–3]. Some authors even advocate for MVD as first line treatment. On the other hand, radiosurgery (RS) has become increasingly popular for its simplicity and safety since 1996 when Kondziolka et al. published the first serial report on the early success of RS for TN [4]. Various prognostic factors have also been studied to predict better outcomes in TN patients. One of which is NVC identified by MRI. While some authors have reported that the presence of NVC leads to a favorable response to RS, [5,6] others have shown no significant differences in pain relief [7–10]. There has also been report that large vessel NVC is associated with worst outcomes [11]. We retrospectively reviewed the outcome of our idiopathic TN patients to evaluate whether the presence of NVC and type of vessel has prognostic value for pain relief in idiopathic TN treated by Gamma Knife radiosurgery (GKRS).

2. Materials and methods

2.1. Patient population

A total of 130 patients with idiopathic TN treated by GKRS from 1999 to 2012 were identified. Patients with tumors and multiple sclerosis or other causes of secondary TN were excluded from the study. All patients were followed for at least 4 years (range: 4–14 years). All 130 patients had undergone previous medical treatment, 25 (19.2%) had undergone MVD, and 9 (6.9%) had undergone pulsed radiofrequency (PRF). Forty-one patients (32%) still had intractable pain after their first GKRS and underwent repeat GKRS. Median time interval between first and repeat GKRS was 20 months (range: 1–96 months). Median age at time of GKRS was 63 years (range, 34–95 years). All patients gave informed con-

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sent before treatment and finished the clinical follow-up. We assigned each patient into 1 of 3 groups based on MRI findings: no NVC (group 1), small vessel NVC (group 2), and large vessel (defined as part of the vertebrobasilar arterial system) NVC (group 3). The characteristics of these 130 patients are summarized in Table 1.

2.2. Radiosurgical procedure

All patients were treated with the Model B Leksell Gamma Knife (Elekta Instruments, Atlanta, GA). Patients received local anesthesia to facilitate pain-free mounting of the stereotactic frame. Thin section (1 mm), non-contrast, T1 and T2-weighted images were obtained to delineate the trigeminal nerve and its relationship to the surrounding vasculature.

The designated target was the entry zone of the trigeminal nerve. During the first GKRS procedure, patients received a single isocenter dose between 60 and 90 Gy (mean: 78.7 Gy) to the 100% dose point using a 4-mm collimator. For patients with large vessel NVC (group 3), multiple shots were used to cover the larger compressed area in 11 patients (Fig. 1).

In repeat GKRS procedures, patients were treated with a maximum dose between 35 and 80 Gy (mean: 48 Gy), which encompassed the periphery of the designated treatment volume identical to the first target. In the early stages of the repeat treatments, we selected the same dose as the first procedure, but because facial numbness seemed relatively high, we reduced the dose to 35–50 Gy in an attempt to reduce the risk of facial numbness. All patients received an additive dose of 100–160 Gy (mean: 128 Gy).

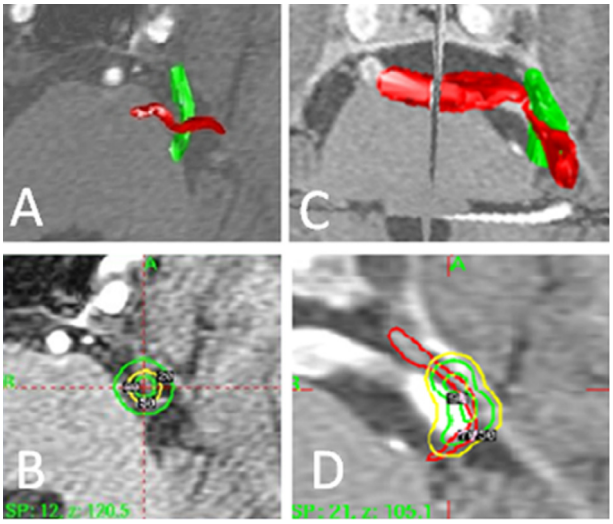

Fig. 1. Axial MR images showing small vessel compression of trigeminal nerve (A) and target localization of the entry zone of the trigeminal nerve with the 20% isodose line at the brainstem margin (B). A large blood vessel (vertebral or basilar artery) compressed the trigeminal nerve (C) and multiple 4-mm shots to cover the elongated trigeminal nerve (D).

Table 1
Summary of characteristics and clinical outcomes in 3 groups according to type of neurovascular compression.

Patient factors	No NVC (N = 53)	Small NVC (N = 60)	Large NVC (N = 17)	Total (N = 130)	X^2/F	p-Value
Laterality Rt: Lt	30:23	36:24	7:10	73:57	1.914[a]	.384
Gender M: F	25:28	27:33	12:5	64:66	3.622[a]	.163
Age (yrs)	63 (37–95)	63 (34–85)	66 (43–80)	63 (34–95)	.397[b]	.673
Pain duration (mos)	49 (6–156)	62 (2–240)	40 (4–120)	54 (2–240)	2.199[b]	.115
MVD/or RF before GKRS	18 (13/5)	14 (10/4)	2 (2/0)	34 (25/9)	.617[c]	1.000
No. of repeated GKRS	16 (30%)	21 (35%)	4 (24%)	41 (32%)	.883[a]	.643
First to repeated GKRS(mos)	20 (1–78)	19 (2–96)	28 (7–72)	20 (1–96)	.188[b]	.829
First GKRS dose	79.5 (60–90)	78.5 (60–90)	77.1 (60–85)	78.7 (60–90)	1.451[b]	.238
First and 2nd GKRS dose	123(100–145)	132(110–160)	126(110–140)	128(100–160)	.868[b]	.428
Follow-up period (yrs)	8.9 (4–14)	9.1 (4–14)	7.9 (4–13)	8.9 (4–14)	1.059[b]	.350
Location					2.783[c]	.857
Single branch (V1, V2 or V3)	14 (26%)	13 (22%)	4 (24%)	31 (24%)		
V1+2	5 (9%)	5 (8%)	1 (6%)	11 (9%)		
V2+3	33 (62%)	37 (62%)	11 (65%)	81 (62%)		
V1+2+3	1 (2%)	5 (8%)	1 (6%)	7 (5%)		
Final pain outcome						
Grade I	22 (42%)	29 (48%)	8 (47%)	59 (45%)		
Grade II	11 (21%)	5 (8%)	2 (12%)	18 (14%)		
Grade IIIa	9 (17%)	9 (15%)	4 (23%)	22 (17%)		
Grade IIIb	3 (6%)	2 (3%)	1 (6%)	6 (5%)		
Grade IV	1 (2%)	7 (12%)	1 (6%)	9 (7%)		
Grade V	7 (13%)	8 (13%)	1 (6%)	16 (12%)		
Final pain outcome					2.480[a]	.289
Grade I–IIIb	45 (85%)	45 (75%)	15 (88%)	105 (81%)		
Grade IV–V	8 (15%)	15 (25%)	2 (12%)	25 (19%)		
New facial numbness						
Grade I	42 (79%)	43 (72%)	11 (65%)	96 (74%)		
Grade II	11 (21%)	11 (18%)	4 (24%)	26 (20%)		
Grade III	0	5 (8%)	2 (12%)	7 (5%)		
Grade IV	0	1 (2%)	0	1 (1%)		
New facial numbness					1.683[a]	.431
Grade I	42 (79%)	43 (72%)	11 (65%)	96 (74%)		
Grade II-IV	11 (21%)	17 (28%)	6 (35%)	34 (26%)		
Further treatment						
MVD	4 (8%)	4 (7%)	1 (6%)	9 (7%)	0.188[c]	1.000
GKRS	4 (8%)	5 (8%)	1 (6%)	10 (8%)	0.148[c]	1.000

[a] Chi-Square Test.
[b] One-Way ANOVA Test.
[c] Fisher's Exact Test.

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