Factors Determining the Outcome in Trigeminal Neuralgia Treated With Percutaneous Balloon Compression

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■ OBJECTIVE: **To analyze 3T magnetic resonance imaging (MRI) findings and clinical features of patients with trigeminal neuralgia (TN) who underwent percutaneous balloon compression and to determine whether these findings had an impact on prognosis of TN.**

■ METHODS: **A retrospective review of patients with TN who underwent percutaneous balloon compression in the Neurosurgery Department at Istanbul Faculty of Medicine between January 1, 2007, and January 1, 2016, was undertaken. Of 105 patients who underwent percutaneous balloon compression, 27 patients who received surgical treatment for the first time for typical TN were included in the study. Follow-up data, clinical features, and 3T MRI findings were analyzed retrospectively. MRI findings and clinical features of patients with and without recurrence of TN were compared. The correlation between fractional anisotropy (FA) values and recurrence was investigated.**

■ RESULTS: **During follow-up, 9 (33%) patients had recurrence. The patients with recurrence had longer duration of symptoms ($P = 0.032$), higher FA difference ($P = 0.042$), and higher FA difference rate ($P = 0.023$). A trend toward early recurrence was found in patients with higher FA difference rate, although this was not significant ($P = 0.051$, $R = 0.319$).**

■ CONCLUSIONS: **Symptom duration was longer and microstructural changes were more apparent in patients with recurrence. In addition to age, comorbidities, and other clinical and radiographic features, symptom duration and FA values obtained with 3T MRI might be valuable information in surgical decision making.**

INTRODUCTION

Contemporary surgical treatment options for trigeminal neuralgia (TN) are microvascular decompression (MVD), percutaneous procedures (glycerol rhizotomy, radiofrequency thermocoagulation, balloon compression), and radiosurgery (Gamma Knife [Elekta AB, Stockholm, Sweden], Cyberknife [Accuray Inc., Sunnyvale, California, USA]).[1,2] Age and comorbidities, the presence of neurovascular compression (NVC) on magnetic resonance imaging (MRI), effectiveness of medical treatment, and patient preference are factors considered in treatment selection. With the introduction of 3T MRI devices, NVC can be detected with high sensitivity.[3-5] Diffusion tensor imaging (DTI) sequences help to determine microstructural changes in the trigeminal nerve root entry zone (REZ).[6-8] Leal et al.[5] found a correlation between effectiveness of MVD treatment and NVC determined with MRI.[5] Prognosis was found to be better in patients with significant NVC and trigeminal atrophy. The effect

Key words
- Fractional anisotropy
- Magnetic resonance imaging
- Outcome
- Percutaneous balloon compression
- Trigeminal neuralgia

Abbreviations and Acronyms
ΔADC: Apparent diffusion coefficient difference
ΔFA: Fractional anisotropy difference
ΔV: Volume difference
ADC: Apparent diffusion coefficient
DTI: Diffusion tensor imaging
FA: Fractional anisotropy
MRI: Magnetic resonance imaging
MVD: Microvascular decompression
NVC: Neurovascular compression
PBC: Percutaneous balloon compression
p̂FA: Fractional anisotropy difference rate
p̂V: Volume difference rate
REZ: Root entry zone
TN: Trigeminal neuralgia
V: Volume

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of degree of NVC and microstructural changes in trigeminal REZ on the prognosis of percutaneous procedures has yet to be investigated.

MATERIALS AND METHODS

Patient Selection

We retrospectively reviewed the clinical data of patients with TN who were treated with percutaneous balloon compression (PBC) in the Neurosurgery Department at Istanbul Faculty of Medicine between January 1, 2007, and January 1, 2016. Of 105 patients reviewed, 27 were selected for the study using the following criteria: typical TN (type I TN with paroxysmal, recurring, shock-like pain on 1 side of the face) without multiple sclerosis and PBC performed as the first surgical procedure with preoperative or follow-up MRI available. All patients included in the study were interviewed about their postoperative and present conditions.

Clinical Data

The following data were obtained from hospital records and interviews: age, sex, duration from the start of the pain, side and dermatome, severity of pain (preoperative and postoperative Barrow Neurological Institute scores), follow-up duration, and time of recurrence if present. The difference of preoperative and early postoperative Barrow Neurological Institute facial pain scores was calculated to demonstrate the first benefit from PBC.

Radiologic Evaluation

Four high-resolution MRI sequences were obtained from the patients using a Philips Ingenia 3.0T (Philips Healthcare, Andover, Massachusetts, USA) MRI scanner to evaluate neurovascular conflicts and microstructural changes. The presence and degree of NVC were examined using driven equilibrium gradient recalled echo MRI, time-of-flight magnetic resonance angiography, and gadolinium-enhanced three-dimensional T1 sequences. The degree of NVC was split into 4 categories using the MRI classification of Leal et al. (Table 1).[9]

The volume (V) of the affected trigeminal nerve was calculated using open source Medical Image Processing, Analysis and Visualization software (a free download available on the website http://mipav.cit.nih.gov/) with the driven equilibrium gradient recalled echo sequence. Trigeminal nerve borders were delineated from the exit from the pons to the entrance of Meckel cave (Figure 1). The volume difference (ΔV) between the affected and unaffected side was calculated. Proportion of ΔV to nonaffected nerve volume was used (volume difference rate [p̂V]) to determine the degree of atrophy.

Table 1. Classification of Neurovascular Compression Degree

0	No contact with vessel
1	Simple contact with vessel
2	Contact and indentation of nerve
3	Contact and distortion of nerve

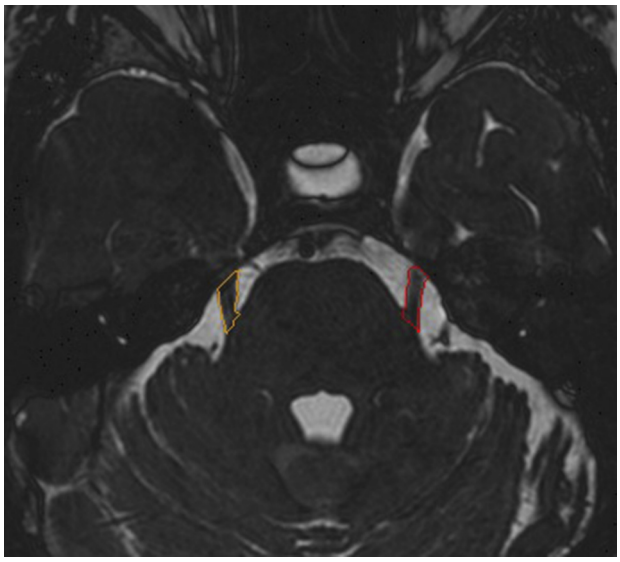

Figure 1. Calculation of trigeminal nerve volume with Medical Image Processing, Analysis and Visualization software.

A DTI sequence was used to detect microstructural changes. DTI measures water proton diffusion within tissues. The derived fractional anisotropy (FA) value shows directionality of the diffusion and provides information about white matter pathologies affecting water diffusion.[10] FA and apparent diffusion coefficient (ADC) of the affected REZs were calculated using a Philips Achieva (Philips Healthcare) workstation. The difference between the affected and unaffected sides was calculated (ΔFA, ΔADC) (Figure 2). In addition, the FA difference rate (p̂FA) (ΔFA/nonaffected FA) was calculated for statistical analysis.

Statistical Analysis

In patients with and without recurrence, variables including age, symptom duration, first benefit, V, ΔV, p̂V, FA, ΔFA, p̂FA, ADC, and ΔADC were compared using Student *t* test. The χ^2 test was used for sex comparison. Diffusion parameters (FA, ΔFA, p̂FA, ADC, ΔADC) of NVC and non-NVC groups were compared using Mann-Whitney U test. Kendall tau-b correlation was performed with the symptom duration and recurrence time of patients after the significant difference in the recurrence and nonrecurrence groups was determined. MRI variables (V, FA, and ADC) of the affected and nonaffected nerves were compared using Student *t* test.

RESULTS

The mean age of the 27 patients included in the study was 59.07 years ± 13.49 (range, 34–82 years). The mean follow-up time was 37.3 months ± 21.08 (range, 12–68 months). Recurrence of pain was seen in 9 patients (33%) during the follow-up period. Six (22%) the patients had no NVC on MRI (Table 2). Pain was on the right side in 19 patients. One third of the patients had pain on V3 (Table 2). No patients had major complications such as anesthesia