New Clinical and Morphologic Aspects in Trigeminal Neuralgia

Levent Tanrikulu[1,2], Peter Hastreiter[2], Teresa Bassemir[2], Barbara Bischoff[2], Michael Buchfelder[2], Arnd Dörfler[3], Ramin Naraghi[2,4]

OBJECTIVE: **High-resolution magnetic resonance imaging can be used to delineate the morphology of neurovascular compression (NVC) in detail. This study focuses on essential morphologic parameters in relation to the clinical appearance of patients with trigeminal neuralgia (TN).**

METHODS: **A total of 180 patients with TN underwent magnetic resonance-constructive interference in steady state/time of flight. Parameters of the affected nerves (length) and causative vessels were examined: (1) the relationship between the NVC site (caudal/cranial/laterocaudal/mediocranial) and affected area (V1, V2, V3); (2) nerve deformity; (3) vascular loop; (4) existence of a "cerebrospinal fluid (CSF) sign" by a separation of trigeminal fascicles by a vessel; and (5) localization of the causative vessel.**

RESULTS: **A total of 10 patients with V1 affection showed 6 caudal, 0 cranial and laterocaudal, and 4 mediocranial NVC; 26 patients with V2 affection showed 17 caudal, 0 cranial, 1 laterocaudal, and 8 mediocranial NVC; 29 patients with V3 affection showed 23 caudal, 1 cranial, 3 laterocaudal, and 2 mediocranial NVC; 25 patients with V1 and V2 affection showed 17 caudal, 1 cranial, 0 laterocaudal, and 7 mediocranial NVC; 36 patients with V2 and V3 affection showed 30 caudal, 3 cranial, 1 laterocaudal, and 2 mediocranial NVC; and 6 patients with V1, V2, and V3 affection showed 4 caudal, 1 cranial, 0 laterocaudal, and 1 mediocranial NVC. A total of 63 patients (35%) showed nerval deformity by distorsion of the trigeminal fascicles from compressing vessel; 37 of 39 patients (95%) with right-sided deformity showed right-sided TN; and 21 of 22 patients (95%) with left-sided TN showed left-sided nerve deformation. Two patients with bilateral nerve deformity showed bilateral TN. Rostral superior cerebellar artery (SCA) loop compression was seen in 24 patients (17%), caudal SCA loop compression was seen in 10 patients (7%), and double SCA loop compression was seen in 33 patients (23%). Sandwich compression was seen in 18 (12%), and a CSF sign was seen in 24 patients. All 24 patients (100%) with a CSF sign had V1 affection.**

CONCLUSIONS: **The CSF sign is pathognomonic for V1 affection. Vascular loops from cranial on the nerve were the most frequent types of compression in all areas of pain, followed by mediocranial loops. This evaluation is reproducible and contributes to the role of magnetic resonance imaging and a classification of findings in the preoperative evaluation of NVC.**

INTRODUCTION

Trigeminal neuralgia (TN) often is caused by distinct vascular compression of the root entry zone of the trigeminal nerve (cranial nerve [CN] V) at the lateral pontine aspect of the brainstem.[1-3] The vascular compression caused by an arterial or venous loop might induce focal demyelinization at the junction between central and peripheral myelin sheath,[4] which

Key words
- Cranial nerve morphology
- CSF sign
- High-resolution MRI
- Trigeminal neuralgia

Abbreviations and Acronyms
AICA: Anterior inferior cerebellar artery
CN: Cranial nerve
CSF: Cerebrospinal fluid
MR: Magnetic resonance
MRI: Magnetic resonance imaging
MVD: Microvascular decompression
NVC: Neurovascular compression
SCA: Superior cerebellar artery
TN: Trigeminal neuralgia

[1]*From the Department of Neurosurgery, Hannover Nordstadt Hospital, Hannover; Departments of* [2]*Neurosurgery and* [3]*Neuroradiology, University of Erlangen-Nuremberg, Erlangen; and* [4]*Department of Neurosurgery, Bundeswehrkrankenhaus Ulm, Ulm, Germany*

To whom correspondence should be addressed: Levent Tanrikulu, Dr. Med. [E-mail: levent.tanrikulu@krh.eu]

Levent Tanrikulu and Peter Hastreiter are co–first authors.

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can lead to ectopic impulses and ephaptic transmission, so that a so-called "cross-talk" between sensible-epicritic and protopathic-nociceptive afferences are explained for the triggered facial pain attacks.[5] The exact etiology still is unclear; as a result, idiopathic TN is accepted to be caused by neurovascular compression (NVC).[6] The causal treatment of TN is microvascular decompression (MVD), as described by Jannetta to maintain functional nerve integrity.[5,7-10]

Diagnosis is obtained by clinical history and symptoms. Magnetic resonance imaging (MRI) is performed to rule out symptomatic reasons for TN, such as tumors or primary demyelinizing conditions. The MRI-based analysis of NVC shows a relatively low specifity of approximately 40%.[11,12] High-resolution MRI shows asymptomatic NVC of the trigeminal nerve in 40% of healthy persons. This study examines more specific imaging parameters for a better evaluation of the underlying pathologic neurovascular patterns. This study aims to present a detailed analysis of high-resolution MRI data of patients with classical TN to enable a comparative categorization of the morphology and the localization of the underlying NVC with the clinical manifestation and the postoperative outcome.

MATERIALS AND METHODS

Clinical Data

A total of 211 patients were admitted from 2001 to 2008 to the neurosurgical outpatient clinics for NVC syndromes at the University Hospital of Erlangen. A total of 31 of 211 patients were excluded from the study because of movemental artifacts on the MRI ($n = 7$) or patients who had a previous history of MVD ($n = 24$). The resulting 180 patients with classical TN were included to this study (for demographics and clinical parameters of the examined patients, see **Table 2**).

Detailed MRI

All 180 patients underwent high-resolution MRI at the Department of Neuroradiology at the University of Erlangen: 165 patients (92%) underwent 1.5-Tesla MRI (Sonata, Siemens, Erlangen, Germany) and 15 patients (8%) underwent 3-Tesla MRI (Siemens Trio). According to an institutional protocol for imaging of patients with NVC syndromes, a magnetic resonance (MR) fluid-attenuated inversion recovery sequence was performed to rule out tumorous, infectious, or hemorrhagic lesions as a potential cause for TN. As a second step, an MR-constructive interference in steady state and MR-time of flight sequence were performed, which consist of 96 equidistant slices (**Table 1**).

The MRI data were loaded to a special visualization tool (Medalyvis, Institute for Computer Graphics and Neurocenter, Department of Neurological Surgery, University of Erlangen). For anatomical analysis the axial (transversal), sagittal, and coronal slices were applied. After the patient data were loaded, the quality of the scan was evaluated for movement and pulsational artifacts. After exploration of the CN V, the corresponding vessels were observed, whereas arteries were followed along their original course to the basilar artery and veins usually were localized as lateral conglomerations, which coursed to the tentorium and drained into the petrosal veins.

Table 1. MRI Protocol for MR-CISS and MR-TOF

MRI Parameter	MR-CISS	MR-TOF
Time of repetition, TR	12.2 ms	40 ms
Time of echo, TE	5.9 ms	7.15 ms
Slice thickness	0.4 mm	0.4 mm
Amount of slices	96	96
Field of view	200 mm	230 mm
Flip angle	70°	45°
Acquisition time, minutes	5	5.48
Matrix, voxels	512 × 512	512 × 512
Size of voxels, mm	0.4 × 0.4 × 0.4	0.4 × 0.4 × 0.4

MRI, magnetic resonance imaging; CISS, constructive interference in steady state; TOF, time of flight.

Anatomical Parameters of the Trigeminal Nerve

Measurement of the Nerve. The distance from the exit of the pons to the apex at the entrance to the Meckel cave was analyzed. This was carried out in the sagittal slices (**Figure 1**).

Localization of NVC. NVC was defined as a cisternal space where no cerebrospinal fluid (CSF) signal was detected between the CN V and the causative vessel over at least 2 sagittal slices. The distance

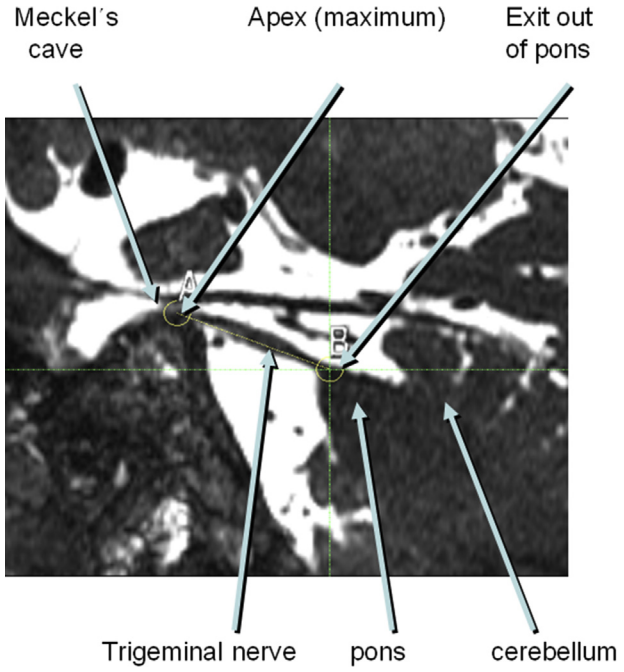

Figure 1. Measurement of the nerve length on the sagittal magnetic resonance-constructive interference in steady state slices.