

Received: 2021.06.13

Accepted: 2021.10.05

Available online: 2021.11.05

Published: 2021.12.13

# Use of High-Resolution Magnetic Resonance Imaging (MRI) for Radiological Diagnosis of Neurovascular Conflict: A Case Report

Authors' Contribution:  
Study Design A  
Data Collection B  
Statistical Analysis C  
Data Interpretation D  
Manuscript Preparation E  
Literature Search F  
Funds Collection G

ABCDEF 1,2

BCD 3

BCDEF 3

DE 4,5

**Arturs Balodis**  
**Raimonds Mikijanskis**  
**Linda Helēna Saulkalne**  
**Ramona Valante**

1 Institute of Diagnostic Radiology, Pauls Stradins Clinical University Hospital, Riga, Latvia

2 Department of Radiology, Riga Stradins University, Riga, Latvia

3 Department of Neurosurgery, Pauls Stradins Clinical University Hospital, Riga, Latvia

4 Department of Neurology, Pauls Stradins Clinical University Hospital, Riga, Latvia

5 Department of Neurology, Riga Stradins University, Riga, Latvia

**Corresponding Author:** Arturs Balodis, e-mail: [arturs.balodis7@gmail.com](mailto:arturs.balodis7@gmail.com)**Financial support:** None declared**Conflict of interest:** None declared**Case series****Patients:** Male, 77-year-old • Female, 58-year-old**Final Diagnosis:** Neurovascular conflict**Symptoms:** Trigeminal neuralgia**Medication:** Carbamazepine**Clinical Procedure:** Magnetic resonance imaging (MRI) • retrosigmoid craniotomy and microvascular decompression**Specialty:** Radiology • Neurosurgery**Objective:** Rare disease

**Background:** Neurovascular conflict (NVC) or neurovascular compression syndrome is a pathoanatomical phenomenon that puts the vessel and the cranial nerve in direct contact, resulting in mechanical irritation to the nerve. Several clinical syndromes in which abnormal activity spreads in the nerve innervation zone are known to be associated with neurovascular compression syndrome. Radiological examination and precise diagnostic measures are the cornerstones for successful diagnosis, but a precise diagnosis of NVC is not always easily achievable. Apart from routine radiological examination, additional diagnostic tools should be used, including high-resolution, three-dimensional (3D), T2-weighted (T2W) magnetic resonance imaging (MRI), magnetic resonance angiography (MRA), and precise diagnostic radiological criteria.

**Case Reports:** We present the cases of 2 patients diagnosed with trigeminal neuralgia V2/3 and severe facial pain for more than 5 years for whom treatment with medication was unsuccessful. Their primary MRI scans did not show specific signs of possible NVC. For clarification, additional high-resolution, T2W MRI scans were performed. Radiological evidence of NVC was found. During neurosurgery, an NVC was confirmed among the trigeminal nerve, the roots of the cerebellum, and the petrosal vein. The procedure was successful in both patients.

**Conclusions:** High-resolution, T2W MRI sequences together with 3D MRA (TOF-MRA) are the most sensitive tools available for detection of cranial nerve root entrance area vascular compression. The best way that radiologists can increase the accuracy of diagnosis of NVC is to take a systematic approach to evaluation and to apply the recommended criteria to images from patients suspected of having the condition.

**Keywords:** Magnetic Resonance Angiography • Neurosurgery • Neurovascular Conflict • Trigeminal NeuralgiaFull-text PDF: <https://www.amjcaserep.com/abstract/index/idArt/933566>

## Background

Neurovascular conflict (NVC) or neurovascular compression syndrome is a pathoanatomical phenomenon that puts the vessel and the cranial nerve in direct contact, resulting in mechanical irritation of the nerve. Chronic pressure on the nerve from the vessel leads to demyelination and axonal ischemia [1].

Trigeminal neuralgia is the most common type of neurovascular conflict (incidence 4 to 20/100 000) [2,3]. Patients with the condition present clinically with repeated neuropathic pain in the V1, V2 innervation zone. Medical treatment with anti-epileptic drugs is possible, but the results are not always satisfactory. Thus, microvascular decompression performed surgically often is the treatment of choice, and 80% of patients are symptom-free 1 year after the procedure [4,5].

To successfully diagnose NVC and achieve the best results for patients suspected to have it, radiological examination is of utmost importance but it is not always easy to achieve. Standard magnetic resonance imaging (MRI) sequences usually are insufficient for accurate evaluation. Several diagnostic tools should be used to make a precise radiological diagnosis, including high-resolution, three-dimensional (3D), T2-weighted (T2W) MRI (also known by other names, such as constructive interference in steady-state, Balance, and FIESTA, depending on the manufacturer), magnetic resonance angiography (MRA), and precise diagnostic radiological criteria [6]. Use of these tools enables accurate visualization of vascular structures and nerves and helps identify their precise anatomical relationships. Because of its high sensitivity and specificity, MRI is considered the most well-known and precise option for diagnosing a suspected NVC [7,8].

In the present article, we describe the cases of 2 patients diagnosed with trigeminal neuralgia V2/3 who had severe facial pain for more than 5 years. Their initial diagnoses were imprecise and treatment with medications had been unsuccessful. In both patients, primary MRI scans showed no signs of possible neurovascular conflict. To clarify the diagnosis, additional high-resolution, T2-weighted MRI scans were performed. In one patient, there was strong radiological evidence of a neurovascular conflict. In the other patient, however, the additional sequences did not provide the strong evidence needed to make a definitive diagnosis. In both patients, a neurovascular conflict was confirmed during surgery and the procedures were successful. These cases illustrate the path for diagnosing neurovascular conflict, difficulties in arriving at that conclusion, and radiological features in patients with the condition.

## Case Reports

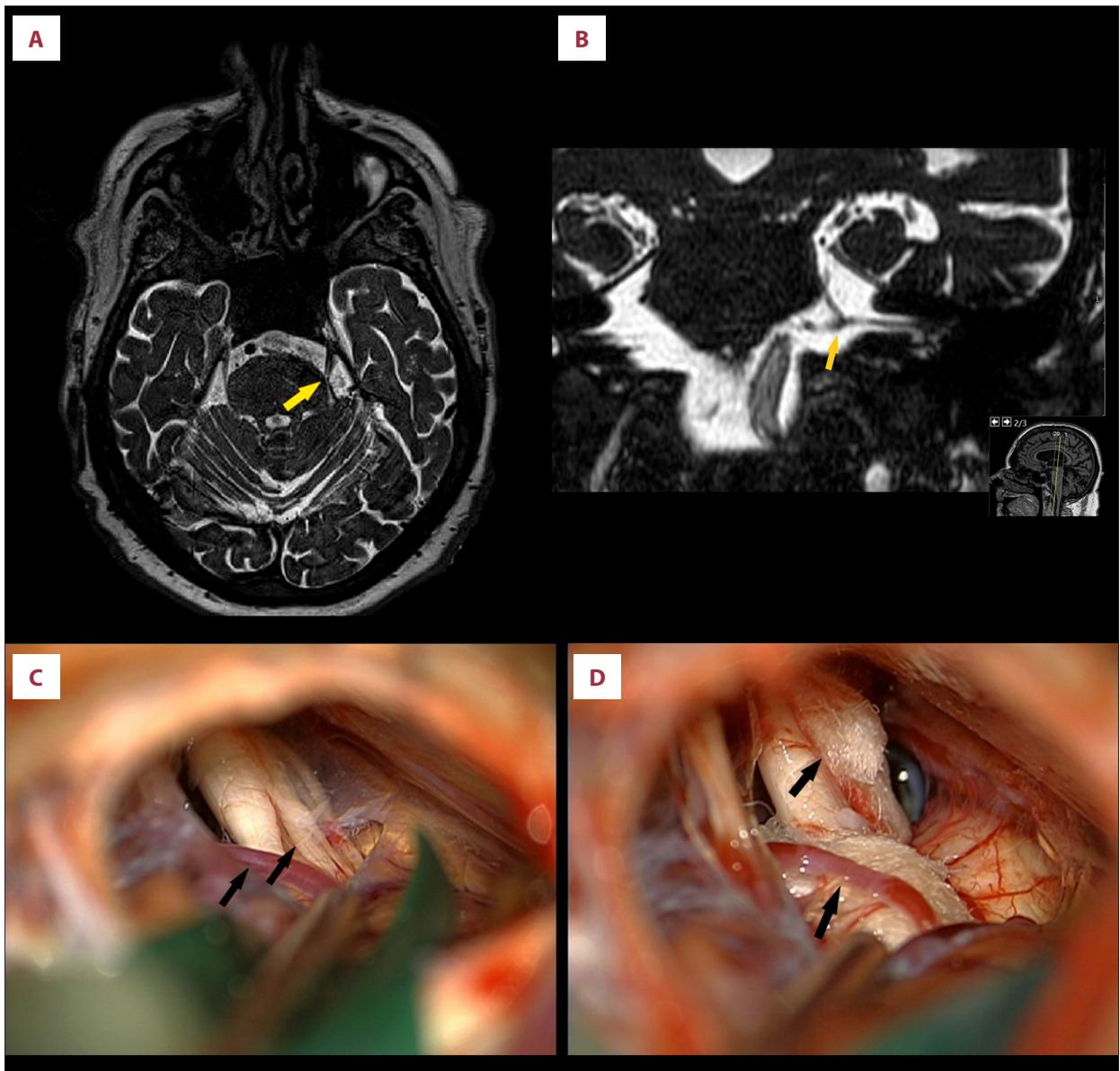
To underscore the importance of a precise radiological examination as an initial tool for correct diagnosis of NVC, we have chosen to present and compare the cases of Patients A and B.

Patient A was a 77-year-old man who had been diagnosed previously with neuralgia in the second and third branches of the trigeminal nerve on his left side. His current symptoms were severe electric-like pain in his left upper and lower jaws and left cheek. Treatment with medication provided no relief from the symptoms, which were refractory to multiple drugs.

**Figure 1A** shows the initial head MRI scan that was performed (thin-slice 3D, T1-weighted [T1W] reconstruction of axial, sagittal, coronal, T2W, fluid-attenuated inversion recovery [FLAIR], and MR diffusion images with an apparent diffusion coefficient map, susceptibility-weighted [SWI] series, and thin-slice 3D images of the T2 axial cranial nerve). The vascular structures that are visible most likely are the left root of the trigeminal nerve, but there are no data to suggest significant deformation of the trigeminal nerve roots. Because MRA was not performed, it was not possible to accurately assess the relationship between the nerve and blood vessels, and particularly the arteries.

Patient A then underwent a gasserian ganglion block, after which his symptoms were in remission for approximately 6 months. Repeated blockade was performed, with no significant clinical effect. Four years later, a second head MRI scan was performed (**Figure 1B**). It included additional high-resolution sequences (T2W axial turbo spin echo images, FLAIR long-repetition-time axial images; T1W, 3D isotropic sequences with multiplanar reconstruction [MPR]; diffusion-weighted axial images; venography blood oxygen level-dependent axial imaging; multiple high-resolution, 3D MR angiograms with MPR; balanced fast field echo; and MRA). Because the images showed a vessel near the proximal part of the left trigeminal nerve, a NVC could not be ruled out. There was reasonably strong suspicion that an NVC was present between the left trigeminal nerve and left inferior cerebral artery. Given the patient's ongoing clinical presentation and his lack of response to previous treatments, he was seen by a neurosurgeon in the hospital. When a second head MRI provided more precise radiological findings, the patient was admitted to the Neurosurgery Department for surgery.

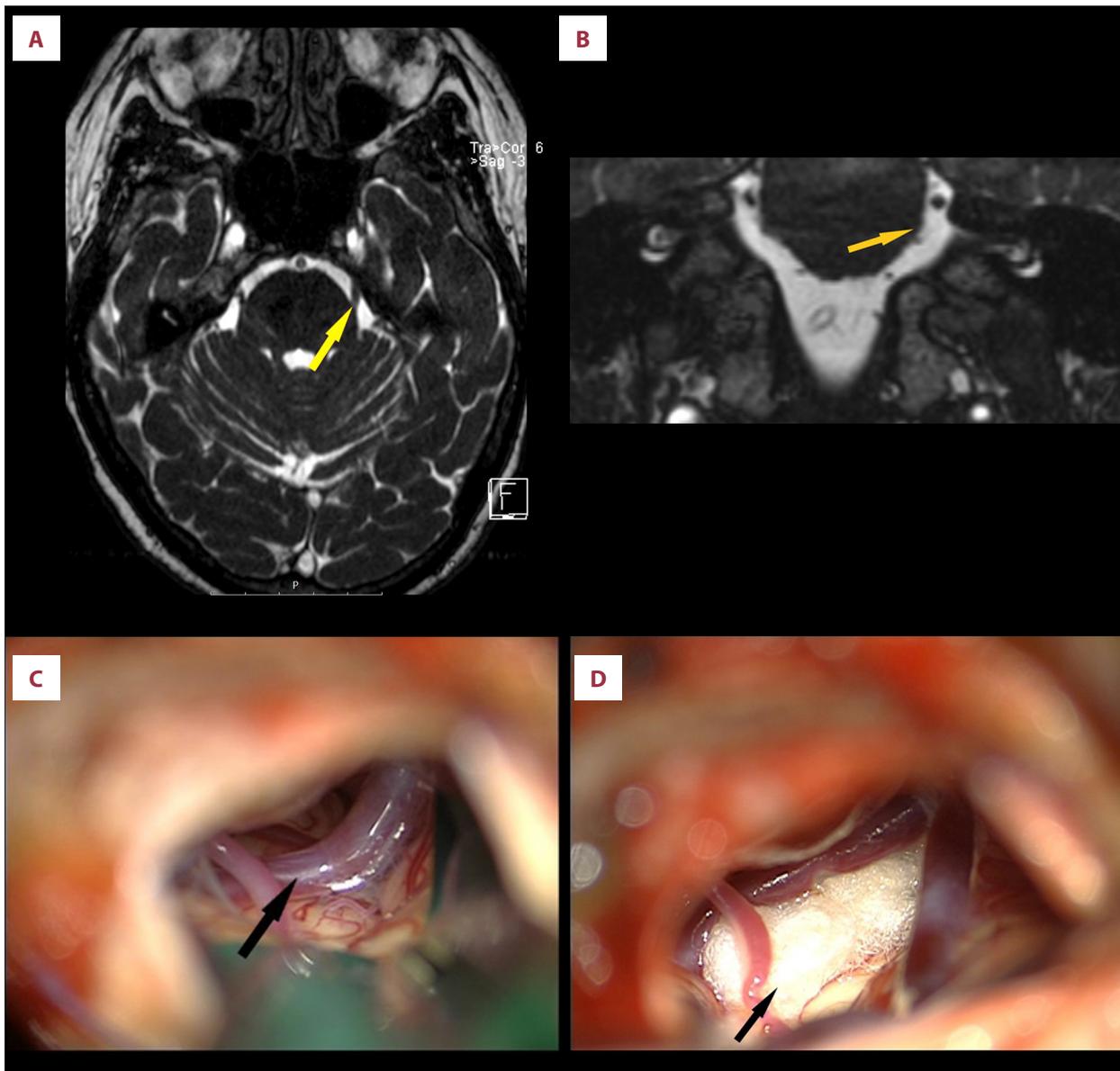
A retrosigmoid craniotomy and microvascular decompression of the left trigeminal nerve were performed (**Figure 1C, 1D**). During the procedure, a primary NVC between the left trigeminal nerve and the left anterior cerebral artery was observed.



**Figure 1.** Patient A. (A) Initial head magnetic resonance imaging (MRI) without contrast (Philips Ingenia 1.5 T): T2-weighted, sampling perfection with application optimized contrasts, isotropic. No findings suggest significant deformation of the roots of the trigeminal nerve. The vascular structures are attached to the left root of the nerve and most likely are veins after passage. There is no convincing direct contact with arterial vessels. (B) A repeat head MRI scan (Philips Ingenia 1.5 T) showing the multiplanar reconstruction of the nerves in the coronal plane. A reasonably close passing vessel is visible in the proximal part of the left trigeminal nerve, which most likely is the left inferior cerebellar artery. According to diagnostic criteria for neurovascular conflict (NVC), the vessel must cross the nerve perpendicularly and there must be deformations and angulations in the nerve's course ("bending"). (C) An intraoperative image from Dr. R. Mikijanskis's archives. An NVC of the left anterior cerebellar artery is seen from behind and with the petrosal vein in the front. (D) An intraoperative image from Dr. R. Mikijanskis's archives. The Teflon material between the nerve and the artery ensures that they are not in contact. A similar separation can be done between a nerve and a vein.

Patient B, a 58-year-old woman, had been diagnosed 6 years before with neuralgia in left trigeminal nerves 2 and 3. She presented with severe shock-like pain on the left side of her face. Initially, she reported that the symptoms were more obvious in cold weather, so they were believed to be seasonal.

At first, treatment with carbamazepine (1000 mg/d) was effective. Subsequently, the patient's condition became refractory to antiepileptic drugs and her pain was uncontrollable.



**Figure 2.** Patient B. **(A)** The second head magnetic resonance imaging (MRI) scan (Siemens Magnetom Avanto 1.5 T). A high-resolution, T2-weighted multiplanar reconstruction (MPR) thin slice. The MRI scan shows no visible deformation in the left trigeminal nerve. **(B)** A second head MRI scan (Siemens Magnetom Avanto 1.5 T). A high-resolution, T2-weighted MPR thick image. The MRI scan shows more detailed vessel structure on the left side, near the outlet of the left trigeminal nerve, but the 2 structures are not closely attached. The image provided no convincing evidence of an NVC. **(C)** An intraoperative image from Dr. R. Mikijanskis's archives. A minimal effect is visible from the left superior cerebellar artery and the NVC with the left petrosa vein and its perpendicular detaching branch. **(D)** An intraoperative image from Dr. R. Mikijanskis's archives. Teflon material is inserted between the nerve and vessels.

No NVC was found when a head MRI scan with contrast was performed (axial T2W fast spin echo; axial T2W FLAIR; axial multiecho, multiplanar, T1W; axial diffusion-weighted 1000b; apparent diffusion coefficient (mm<sup>2</sup>/s); coronal T2W FSE plus post-contrast axial T1W spine echo; and post-contrast coronal and sagittal T1W spin echo). A month later, on a repeat head MRI scan (**Figure 2A, 2B**) with additional T2W

constructive interference in steady-stage axial and T1W spin echo sequences, no deformation was seen in the left trigeminal nerve. However, the vessel structure was more detailed on the left side near but not closely attached to the outlet of the left trigeminal nerve. It was hard to tell if the structure was venous or arterial. Therefore, there was still no convincing evidence of an NVC.

Because the patient continued to have symptoms and medical therapy was ineffective, she was admitted to the Neurosurgery Department for surgery. A retrosigmoid craniotomy and microvascular decompression of the left trigeminal nerve were performed (Figure 2C, 2D). During the procedure, an NVC between the left trigeminal nerve and the left petrosa vein and contact with the left superior cerebellar artery were confirmed. The compression primarily involved the vein rather than the artery.

In both cases, after surgery, the clinical symptoms of NVC diminished and the patients' quality of life greatly improved. Postsurgical computed tomography scans confirmed that the trigeminal nerve had been decompressed and the patients had no serious complications.

## Discussion

It has long been argued that arteries are more likely than veins to be the primary cause of NVC. Recent publications, however, document more and more cases in which veins are seen to be the primary cause of NVC, alone or in combination with arterial vasculature [9-11]. There is no question that arterial structures are the main cause of NVC, but newer studies are continuing to show that veins are increasingly important causative agents [12]. This is also underscored by the case of our Patient B, in whom the vein was the vascular structure primarily responsible for NVC, followed by the artery. Additional sequences on a preoperative MRI scan did not provide convincing evidence with which to differentiate the vascular structures. During surgery, the left petrosa vein was found to be the primary vascular structure involved in the NVC and the left superior cerebellar artery was a secondary cause.

Aside from recognizing that a vein can be the primary cause of NVC, imaging is crucial to confirming NVC in patients for whom there is clinical suspicion of the condition and who have related symptoms [9]. MRI is the most widely used and precise method of diagnosing a suspected NVC and studies show that it has high sensitivity and specificity [7,13]. The cases described in the present article confirm the benefits of using additional MRI sequences (high-resolution, T2W sequences together with MRA TOF) for more precise diagnosis in patients suspected of having NVC. In some studies, MRI has been shown to have a sensitivity of 97.4% and specificity of 100% for diagnosing NVC [8].

The crucial diagnostic marker for NVC is a vessel crossing the nerve perpendicular to the nerve root entrance area. To confirm, on MRI, that an NVC exists, at least 1 of the following nerve pathologies must be present: nerve deformations and angulations of the nerve's course (bending); nerve surface prints (penetration); or partial nerve pressure with an arterial loop, creating a deep indent on the nerve surface ("stretching") [9].

Recent studies indicate that MRI is the primary tool for diagnosing NVC because it is reliable, but it is also necessary for determining the degree of compression and hence the grade and severity of condition [14]. Findings on MRI are used to describe 5 grades, based on number of touch points, deformation, and atrophy of the nerve.

MRI does have limitations, and not only in its ability to show the degree of compression. Using it to differentiate between vascular structures also is challenging. MRI alone is not sufficient for that, even with additional high-resolution, T2-weighted sequences, as illustrated by the present case report. To help radiologically diagnose NVC, recent studies suggest using additional MRI sequences and also high-resolution 3D MRA (TOF-MRA) because with TOF-MRA, the precision of prediction of NVC is increased to up to 94.7% [11,13,15]. With TOF angiography, some experts argue, arterial and venous structures can be accurately differentiated [11,16]. In more than half of patients with NVC in one study, MRA correctly identified the vessel involved, with a sensitivity of 76% and specificity of 75% [15]. In another study, the technique's accuracy for identifying the correct vessel was up to 94.4% [16].

High-resolution, T2-weighted MRI sequences together with TOF-MRA are the most sensitive tools for detecting NVC radiologically [2,8,16]. Using additional diagnostic criteria is of great importance to ensure more precise diagnosis.

## Conclusions

NVC is a condition that can have a major impact on the quality of life of a patient and result in chronic, intractable pain. Therefore, proper clinical and diagnostic evaluation is essential. Diagnosis requires an in-depth understanding of the clinical aspects of neuroanatomy, neurophysiology, and cranial nerve dysfunction. High-resolution, T2-weighted MRI sequences together with 3D MRA (TOF-MRA) are the most sensitive tools available to radiologists today, allowing optimal detection of cranial nerve root entrance area vascular compression. To increase the accuracy of diagnosis of NVC, radiologists need to take a systematic approach to imaging and carefully apply the recommended criteria for the condition. With this approach, the incidence of false-negatives and false-positives during evaluation of patients suspected of having NVC will be reduced.

## Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

## References:

1. Baert AL, editor. Encyclopedia of diagnostic imaging. Neurovascular Conflict. Berlin, Heidelberg: Springer, 2008
2. Haller S, Etienne L, Kóvari E, et al. Imaging of neurovascular compression syndromes: Trigeminal neuralgia, hemifacial spasm, vestibular paroxysmia, and glossopharyngeal neuralgia. *Am J Neuroradiol*. 2016;37(8):1384-92
3. Manzoni GC, Torelli P. Epidemiology of typical and atypical craniofacial neuralgias. *Neurolog Sci*. 2005;26(Suppl. 2):s65-67
4. Obermann M. Treatment options in trigeminal neuralgia. *Ther Adv Neuro Disord*. 2010;3(2):107-15
5. Oesman C, Mooij JJ. Long-term follow-up of microvascular decompression for trigeminal neuralgia. *Skull Base*. 2011;21(5):313-22
6. Donahue JH, Orman DA, Mukherjee S. Imaging of vascular compression syndromes. *Radiol Clin North Am*. 2017;55(1):123-38
7. Zhou Q, Liu ZL, Qu CC, et al. Preoperative demonstration of neurovascular relationship in trigeminal neuralgia by using 3D FIESTA sequence. *Magn Reson Imaging*. 2012;30(5):666-71
8. Leal PRL, Hermier M, Souza MA, et al. Visualization of vascular compression of the trigeminal nerve with high-resolution 3T MRI: A Prospective Study Comparing Preoperative Imaging Analysis to Surgical Findings in 40 consecutive patients who underwent microvascular decompression for trigeminal neuralgia. *Neurosurgery*. 2011;69(1):15-26
9. Lozupone E, Lella G, Gaudino S, et al. Imaging neurovascular conflict: What a radiologist needs to know and to report? Poster. ECR 2012;C-1933: ID 57899487
10. Chen Gq, Wang Xs, Wang L, et al. Arterial compression of nerve is the primary cause of trigeminal neuralgia. *Neurol Sci*. 2013;35:61-66
11. Müller S, Khadhraoui E, Khanafer A, et al. Differentiation of arterial and venous neurovascular conflicts estimates the clinical outcome after microvascular decompression in trigeminal neuralgia. *BMC Neurol*. 2020;20:279
12. Brinzeu A, Landry D, Marc Sindou. Reliability of MRI for predicting characteristics of neurovascular conflicts in trigeminal neuralgia: Implications for surgical decision making. *J Neurosurg*. 2018;130:611-21
13. Vergani F, Panaretos P, Penalosa A, et al. Preoperative MRI/MRA for microvascular decompression in trigeminal neuralgia: Consecutive series of 67 patients. *Acta Neurochirurgica*. 2011;153:2377-82
14. Tucer B, Ekici MA, Demirel S, et al. Microvascular decompression for primary trigeminal neuralgia: Short-term follow-up results and prognostic factors. *J Korean Neurosurg Soc*. 2012;52(1):42-47
15. Anderson VC, Berryhill PC, Sandquist MA, et al. High-resolution three-dimensional magnetic resonance angiography and three-dimensional spoiled gradient-recalled imaging in the evaluation of neurovascular compression in patients with trigeminal neuralgia: a double-blind pilot study. *Neurosurgery*. 2006;58(4):666-73
16. Zeng QS, Zhou Q, Liu ZL, et al. Preoperative detection of the neurovascular relationship in trigeminal neuralgia using three-dimensional fast imaging employing steady-state acquisition (FIESTA) and magnetic resonance angiography (MRA). *J Clin Neurosci*. 2013;20(1):107-11