

To be or not to be a neurovascular conflict: importance of the preoperative identification of the neurovascular conflict in the trigeminal neuralgia

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Abstract: The trigeminal neuralgia caused by neurovascular compression is a neurosurgical pathology requiring the preoperative identification as exact as possible of the neurovascular conflict. In this case, neuroimaging is very useful, as it allows not only the determination of the neurovascular conflict of the trigeminal nerve, but also the correct indication of an adequate surgical approach.

Key words: trigeminal neuralgia, neurovascular compression syndrome, trigeminal nerve

Introduction

Described since the second century A.D. in the writings of Aretaeus of Cappadocia (18), the trigeminal neuralgia (TN) is the “worst pain humans have been afflicted with” (15), known as “suicide disease” because of the significant numbers of people taking their own lives before effective treatments were discovered. In 1994, the Association for the Study of Pain describes the trigeminal neuralgia as “a sudden, usually unilateral, severe, brief, stabbing, recurrent pain in the distribution of one or more branches of the fifth cranial nerve” (36).

The most frequent cause of the TN is the focal compression of the trigeminal nerve root at the place of entry into the pons (root entry zone) produced by an artery, most of the times,

or by a vein (31).

The concept of neurovascular compression and the cause of the TN have been proposed for the first time in 1934 by Walter Dandy (16), his hypothesis being supported in 1962 by James W. Gardner (20). Only 5 years later, in 1967, the American neurosurgeon Peter Joseph Jannetta confirmed this hypothesis and promoted in neurosurgery the microvascular decompression as a treatment method of the TN due to neurovascular compression (23).

Pathogenesis

In the TN, the prevailing model is the neurovascular compression theory, where a redundant or aberrant looping of intracranial vessels results in neurovascular conflict (41). Even though any intracranial anatomic (artery, vein, etc) or subsequently developed

(tumor) structure can compress the trigeminal nerve (V nerve) at its exit from the brainstem, the studies show that the superior cerebellar artery and the anterior inferior cerebellar artery are the most frequently involved (1, 31, 52, 53) (Figure 1, Figure 2). The most frequently, the compression is at the level of the transition zone of the V nerve, which represents a point of transition from the central myelin (derived from the oligodendroglia) to the peripheral myelin (derived from Schwann cells) (31, 33).

Diagnostic

Clinically, the TN is characterized as a facial pain syndrome with intense lancinating pain episodes, located within the sensory area of the V nerve.

The nature of the pain in the TN is typical: paroxysmal, lancinating, electric-like, unilateral, extremely severe, episodic, lasting a few seconds with remissions and recurrences, often exacerbated by cutaneous stimuli such as cold air, shaving, tooth brushing, chewing or the simple tactile touch (37). The neurological examination is usually normal and one can rarely detect a subtle trigeminal sensory deficit (13). Usually, up to the imaging identification of a neurovascular conflict at the level of the V nerve, the patients are treated with Carbamazepine or Gabapentin, which diminish pain, but for short periods.

Imaging

The election imaging examination in the neurovascular compression syndrome (NVCS) is represented by the high-spatial resolution magnetic resonance (MR) (33) which is performed so as to detect first of all the neurovascular contact (Figure 1) and secondly so as to exclude other causes of TN,

such as the posterior fossa tumors or the multiple sclerosis lesions (32, 39).

Among the MR sequences, the most important are the high-spatial-resolution performed with T2-weighted sequences (3D TOF, 3D FIESTA) and, of course, the MR angiography so as to visualize the artery which compresses the V nerve (17, 30, 56).

Imagistically (MR), the neurovascular conflict can be classified in three grades: grade I: simple contact between the nerve and the vessel, grade II: artery distorting/displacing the nerve and grade III: artery indents the nerve root, producing the thinning of the nerve (21) (Figure 2).

One of the MR limits is that the neurovascular contacts can also be found in asymptomatic persons and, as a consequence, this imaging method is not very specific for the NVCS (1, 33). Moreover, in the MR imaging, in a study, 30% of the healthy subjects had neurovascular contact grade I and 2% - grade II, so that the imaging diagnostic must be very well judged in the clinical context (21). Precisely in order to try an approximation as good as possible of the diagnostic, it is recommended to perform three high-resolution sequences, in association, because of their complementariness (29, 50):

1. 3D T2 high-resolution sequences: allow the visualization of the nerve root, its trajectory, its diameter and indentations. Moreover, these sequences allow the visualization of the cerebellopontine angle and the cerebrospinal fluid cisterns. A limitation of this exploration would be the absence of the differentiation between nerves and vessels.

2. 3D TOF MRA: visualizes only the high-flow vessels (arteries).

3. 3D T1 sequence with gadolinium: visualizes all vessels, both arteries and veins.

More recently, among the MR sequences, the diffusion-tensor imaging with tractography can allow the analysis of white matter integrity from the V nerve by measuring in vivo the molecular diffusivity (9, 22, 28, 33). This sequence practically assesses the damage and degeneration of white matter tracts appearing as a consequence of the loss of myelin and axonal membranes at the level of the neurons composing the V nerve (7, 38).

Another imaging exploration which must be carried out in the TN, but rather for the differential diagnosis is the computer-tomography which can evaluate the bony anatomy of the posterior cranial fossa and the bone lesions which may cause bone destruction (skull base osteomyelitis, external otitis, Langerhans' cell histiocytosis), proliferation (fibrous dysplasia, chondrosarcoma) or remodeling (meningiomas, schwannomas) (8, 43).

In other words, the preoperative imaging is very important in recognizing the neurovascular conflict and in establishing a correct surgical approach. For instance, in case of the TN compression by a transverse pontine vein, a conventional sub occipital approach can be insufficient in the visualization (21), a lateral suboccipital approach being preferable so as to visualize Meckel's cave (49).

Treatment

From the initial description in 1932 of the NVCS by Walter Dandy and to date, several treatment methods in the TN have been proposed: the medical therapy, the stereotactic radiosurgery, the glycerol rhizotomy, the radiofrequency thermal rhizotomy and the

balloon microcompression (5). Unfortunately, these alternative treatments are associated with poorer long-term pain control and higher incidence of recurrences varying between 17-46% (44, 45, 57).

Even though the initial treatment is the medical one, with antiepileptic drugs, the neurovascular decompression represents the election treatment in the NVCS, being the most efficient treatment to achieve initial and long-term pain control for TN (2, 25, 55), with a success rate of 63%-94% (3, 5, 11, 26, 35, 51) and a complications rate of almost 1-5% (3, 5, 6). Moreover, in 91-97% of the cases, pain relief appears immediately after the surgery (19).

The surgical treatment (microvascular decompression) is indicated in the patients with debilitating pain refractory in at least three medicines, including Carbamazepine (14).

The surgery indication must be correctly made, because in the reported cases, the absence of the intraoperative neurovascular compression varied between 4 and 89%, with an average of 7.5% (27). Even in the cases where inntraoperative there was no vascular compression, certain studies suggest that the manipulation with minimal trauma had a favorable therapeutic effect in the patients with TN (4, 34, 57), even though in these cases, most of the operators prefer a partial sensory rhizotomy when they are not persuaded of the existence of the neurovascular conflict (45).

The surgery consists in microvascular decompression of the V nerve and the positioning of Teflon pledgets to separates offending vessels from the V nerve. Teflon is the most popular material used in NVCS even

though it also presents complications, of which the most frequent is the inflammatory foreign body reaction, with an incidence of 5% (12, 42). Chen et al have issued in their study a hypothesis according to which Teflon induces an inflammatory giant-cell foreign body reaction when it comes into contact with the dura mater or with the tentorium (12).

Pain prognostic factors

The most important prognostic factors are: the immediately postoperative pain relief (54), the age of the patient, the medical comorbidities (15) and the nature of the compressive vessel (venous compression representing a poor prognostic factor) (27). Among them, the most important prognostic factor is pain relief (54).

Complications

The most frequent complications are represented by:

1. cerebrospinal fluid leak, the most frequent complication of the NVCS with an incidence of 0.9-12% (40)

2. meningitis

3. cerebellar injury. This complication type can be avoided by realizing an optimized petrotentorial corridor, by the retraction of the cerebellum in a direction that is infero-lateral rather than directly lateral (tangential to the course of the VIII nerve) (10)

4. post-operative hemorrhage, including the subdural hematoma (15)

5. cranial nerve palsies: facial palsy by the injury of the VII nerve and hearing loss by the injury of the VIII nerve which appears as a consequence of the excessive retraction of the cerebellum while trying to expose the trigeminal cistern, direct trauma on the nerve or its vascular supply. Once with the intraoperative

introduction of the brain stem auditory evoked potential monitoring, this complication was reduced from 19 to 2% (11, 55).

6. trigemino-cardiac reflex is a complication which may occur because of the stimulation of any of the sensory branches of the V nerve (47). The physiopathological mechanism consists in the decrease of the mean arterial blood pressure and heart rate by more than 20% and appears once with V nerve manipulation. This reflex is characterized by arterial hypotension, bradycardia, apnea and gastric hypermotility (46, 47, 48). After the cessation of the surgical manipulation, the mean arterial blood pressure and heart rate come back to normal and because of that is very important to perform the gentle manipulation of the vascular-nervous structures during the surgery.

7. anesthesia "dolorosa" is a continuous, dysesthetic pain, with burning character, which appears because of the trigeminal deafferentation (13)

8. recurrence. The factors which proved to be predictable in the recurrence are: symptomatology lasting for more than eight years, V nerve compression by a vein, absence of the immediate postoperative pain relief, female gender, minimizing nerve trauma by careful manipulation (6, 25), age younger than 53 years, symptoms duration of more than 10 years and pain localization on the left in men (55)

9. death: the mortality associated with this intervention is of 0.1% in Jannetta series (24).

Conclusions

The TN caused by the neurovascular conflict represents a neurosurgical pathology which can be safely solved in the current

context. So as to issue a correct surgical indication in case of a NVCS, the neuroimaging is very important because it establishes the neurovascular contact, the surgical approach, but also the exclusion of other causes of the TN.

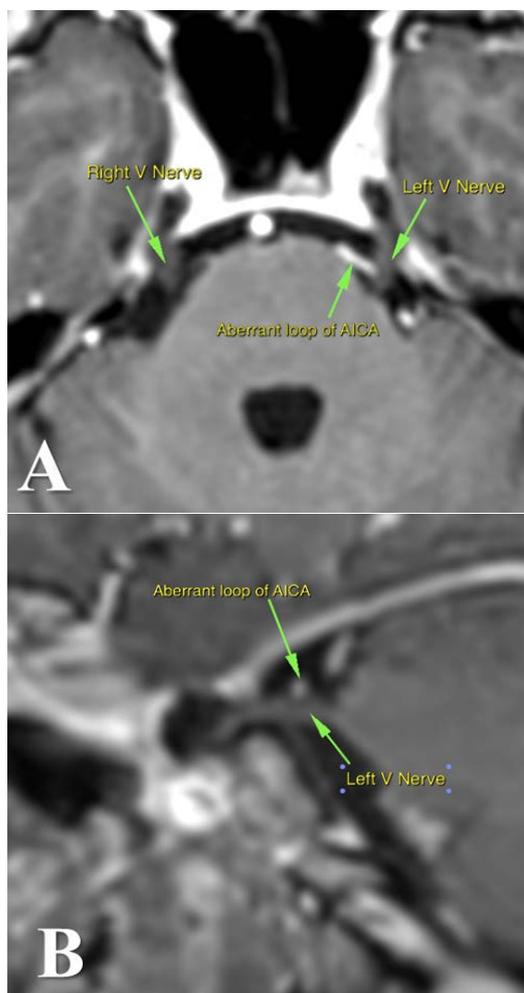


Figure 1 - MRI 3DT1 axial (A) and sagittal (B) sections showing left trigeminal nerve, compressed by an aberrant loop of anterior inferior cerebellar artery (AICA); the right trigeminal nerve is normal (Dr. B. Dobrovat's personal collection)

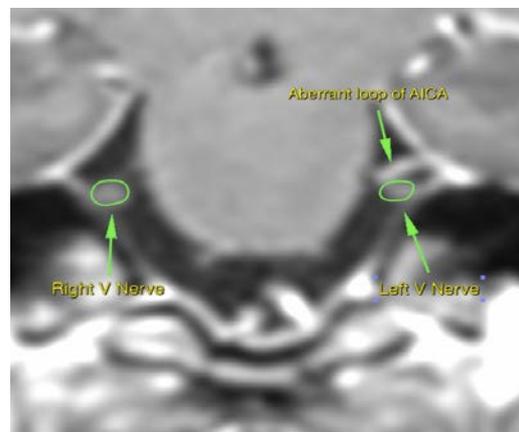


Figure 2 - MRI 3DT1 coronal section showing left trigeminal nerve, compressed by an aberrant loop of AICA, with a reduced caliber in the contact site, compared with the normal caliber of the right trigeminal nerve (Dr. B. Dobrovat's personal collection)

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