# MRI EVALUATION OF TRIGEMINAL NEURALGIA

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**ABSTRACT**

**BACKGROUND**

Neuralgia is the set of symptoms associated with nerve dysfunction. The most common of these symptoms is pain, which can occur intermittently in one area of the body or can radiate along the length of a damaged nerve. The most common type of neuralgia is trigeminal neuralgia. This study focuses on the effectiveness of MRI in visualising the entire course of trigeminal nerve and to diagnose the exact location, aetiology responsible for trigeminal neuralgia and possible pretreatment evaluation.

**MATERIALS AND METHODS**

Clinical records and imaging studies of 30 patients between the ages of 18-60 years who presented to the Department of Radiodiagnosis, KIMS, for brain magnetic resonance imaging with (Philips 1.5T machine) during June 2015 to December 2016 were analysed retrospectively.

**RESULTS**

- The entire course of trigeminal nerve is evaluated in these patients.
- There are different causes of trigeminal neuralgia, but in our study, most frequent cause is mechanical irritation of nerve is due to neurovascular contact (24 cases). The other causes identified are cerebellopontine angle lesions, brainstem tumours, demyelinating disease involving brainstem.
- The cisternal portion of the nerve is the most common site of involvement.

**CONCLUSION**

Trigeminal nerve is the largest cranial nerve. MRI is unique as it produces images of entire course of the nerve. Of the many causes of trigeminal neuralgia, neurovascular conflict is the most common cause. The exact location and degree of neurovascular compression is graded on MRI.

**KEYWORDS**

Trigeminal Neuralgia, 3D CISS, Neurovascular Compression, Superior Cerebellar Artery, MRI Evaluation.

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## BACKGROUND

Trigeminal neuralgia is the most common facial neuralgia characterised by episodes of paroxysmal sharp and shooting electric shock like pain, which usually lasts for few seconds to few minutes more often involving the maxillary and mandibular branch of the trigeminal nerve. Neurovascular compression is a major cause of TN, which is defined as an "abnormal" contact between an artery and the root entry zone of a cranial nerve. The root entry zone is the transition zone of the central to the peripheral myelin.

Neurovascular compression syndrome is defined as a direct contact with mechanical irritation of cranial nerves by blood vessels.

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Neurovascular compression is a pathophysiologic phenomenon, which is implicated in several cranial neuropathies. The most common one is trigeminal neuralgia. Neurovascular compression may be asymptomatic or symptomatic caused by arteries and veins. Arteries more likely cause symptoms due to their pulsatility and high pressure anatomical location of neurovascular contact also plays key role in symptomatology.

Trigeminal nerve is most commonly involved in neurovascular compression syndrome.

Neuropathy of the trigeminal nerve can involve its full course from its nuclei in the brain stem to its peripheral branches-

- It is often diagnosed clinically based on the patient's complete history of pain (severity, duration, episodes, and trigger factors).
- MR imaging protocol is essentially based on two sequences.
- A 3D steady state sequence and an angiographic sequence.

## MATERIALS AND METHODS

### Inclusion Criteria

- Patients with clinical symptoms of trigeminal neuralgia lasting at least 6 months in duration before presenting for the imaging study.
- Age group- 18-60 years.

### Exclusion Criteria

Patients with contraindication to magnetic resonance imaging- claustrophobia, cochlear implant, pacemaker, etc. were excluded from the study-

Study Period - Between June 2015 to December 2016.
Study Design - Prospective cross-sectional descriptive study.
Sample Size - 30 patients.
Study Equipment - 1.5 Tesla Philips MR machine.

### Protocol for MRI

- Routine sequences applied include T1, T2 and FLAIR axial sequences, coronal T2, sagittal T1/FLAIR and diffusion weighted sequence.
- A 3-dimensional constructive interference in steady state (3D CISS) sequence was acquired. Reconstruction in coronal and sagittal planes was done for interpretation of 3D CISS images.
- Patients with space occupying lesions also underwent a 3D contrast-enhanced fat suppressed T1-weighted imaging sequence.

## RESULTS

- The entire course of trigeminal nerve is evaluated in these patients.
- There are different causes of trigeminal neuralgia, but in our study, most frequent cause is mechanical irritation of nerve due to neurovascular compression (24 cases).
- The other causes identified are cerebellopontine angle and brainstem tumours, demyelinating disease involving brainstem.
- The cisternal portion of the nerve is the most common site of involvement.

| No. | Age | Sex | Location | Cause |
|---|---|---|---|---|
| 1. | 71 | F | Cisternal portion | NVC- Superior cerebellar artery |
| 2. | 64 | M | Cisternal portion | NVC- Superior cerebellar artery |
| 3. | 46 | F | Cerebellopontine angle | Vestibular schwannoma |
| 4. | 34 | F | Brainstem | Multiple sclerosis |
| 5. | 58 | M | Cisternal portion | NVC- Superior cerebellar artery |
| 6. | 62 | M | Cisternal portion | NVC- Superior cerebellar artery |
| 7. | 67 | M | Brainstem | NVC- Superior cerebellar artery |
| 8. | 70 | M | Cisternal portion | NVC- Anterior inferior cerebellar artery |
| 9. | 82 | M | Brainstem | NVC- Superior cerebellar artery |
| 10. | 54 | F | Cisternal portion | NVC- Anterior inferior cerebellar artery |
| 11. | 73 | M | Brainstem | Glioma |
| 12. | 55 | M | Cisternal portion | NVC- Superior cerebellar artery |
| 13. | 42 | F | Cisternal portion | NVC- Superior cerebellar artery |
| 14. | 65 | F | Cisternal portion | NVC- Superior cerebellar artery |
| 15. | 39 | M | Cerebellopontine angle | Arachnoid cyst |
| 16. | 58 | M | Cerebellopontine angle | Vestibular schwannoma |
| 17. | 40 | M | Cisternal portion | NVC- Superior cerebellar artery |
| 18. | 46 | M | Cisternal portion | NVC- Superior cerebellar artery |
| 19. | 32 | M | Cisternal portion | NVC- Superior cerebellar artery |
| 20. | 47 | F | Cisternal portion | NVC- Superior cerebellar artery |
| 21. | 52 | M | Cisternal portion | NVC- Superior cerebellar artery |
| 22. | 60 | F | Cisternal portion | NVC- Superior cerebellar artery |
| 23. | 51 | M | Cisternal portion | NVC- Superior cerebellar artery |
| 24. | 68 | M | Cisternal portion | NVC- Superior cerebellar artery |
| 25. | 49 | M | Cisternal portion | NVC- Superior cerebellar artery |
| 26. | 52 | M | Brainstem | NVC-Vertebrobasilar arterydolichoectasia |
| 27. | 67 | M | Brainstem | NVC- Superior cerebellar artery |
| 28. | 60 | M | Meckel's cave | Trigeminal schwannoma |
| 29. | 70 | F | Cisternal portion | NVC- Superior cerebellar artery |
| 30. | 76 | M | Cisternal portion | NVC- Superior cerebellar artery |

- Out of 30 patients, 21 were men (70%) and 9 were women (30%). It has a peak around 50 to 70 years.
- Patients with neurovascular contact formed an overwhelming majority of the cases. 24 (80%) out of 30 patients had a neurovascular contact demonstrable on the 3D CISS sequence. Neurovascular contact was not demonstrable in other routine noncontrast sequences due to the limited spatial and contrast resolution. Few of the cases of neurovascular contact were also identifiable on contrast-enhanced isotropic 3D gradient fat suppressed T1-weighted images.
- 21 out of 24 patients (87.5%) had superior cerebellar artery as the vessel in contact with the trigeminal nerve. 2 out of 24 patients (8.3%) had anterior inferior cerebellar artery as the cause of neurovascular contact and one case of vertebrobasilar-dolichoectasia (4.2%).
- Cerebellopontine angle lesions constituted (15%) of the cases with the demonstrated lesions being vestibular schwannoma (2 cases) and one case of arachnoid cyst.
- One out of 30 patients (3.33%) with brainstem glioma presented clinically with trigeminal neuralgia.
- One out of 30 patients (3.33%) known case of multiple sclerosis had developed symptoms of trigeminal neuralgia. No vascular loop was demonstrated. However, a demyelinating plaque was seen in the ipsilateral hemipons in this patient and was assumed to be the cause of patients' symptoms.
- The limitations of the above study include- small sample size and no postsurgical correlation.

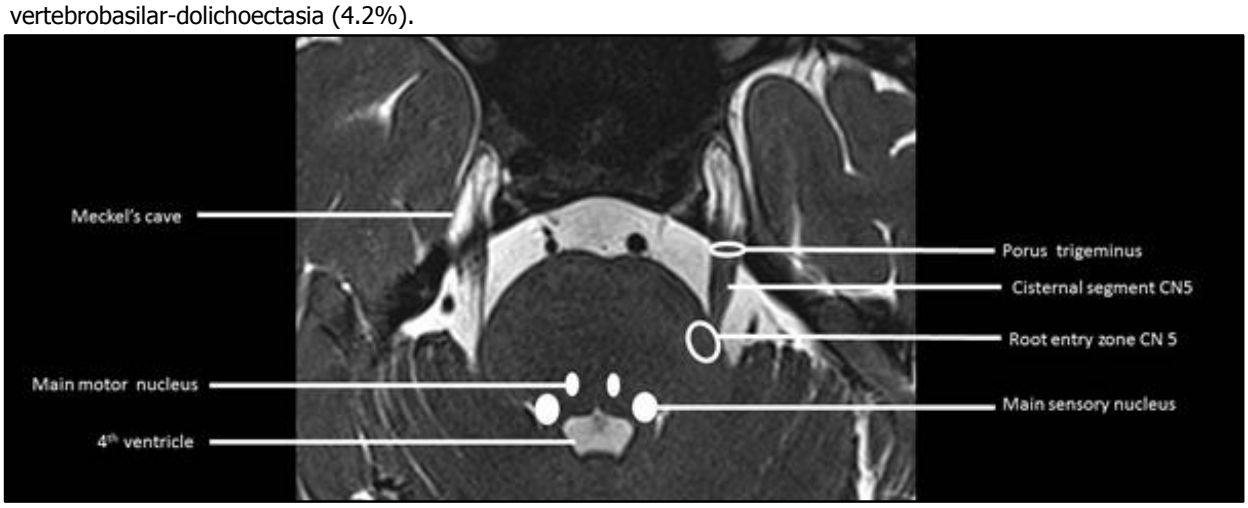


***Figure 1. Normal Appearance of Trigeminal Nerve on CISS Sequence[1]-Showing Root Entry Zone of the Nerve, Cisternal Segment and Meckel's Cave***

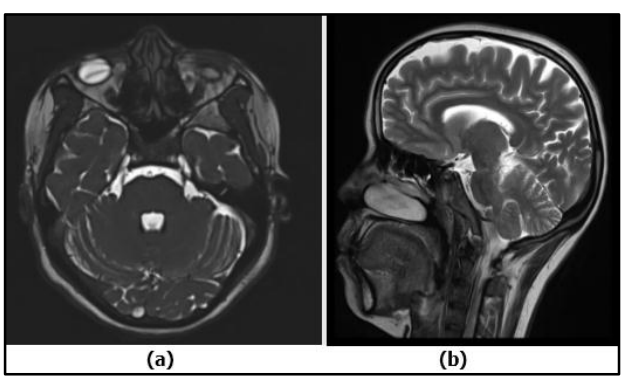


***Figure 2. Neurovascular Compression- 3D CISS Axial (a) and T2W1 Sagittal Images (b) Clearly showing the Right Superior Cerebellar Artery Indenting the Right Trigeminal Nerve at its Inferior Surface. Significant Discrepancy in Girth is seen between the Trigeminal Nerves on Either Sides.***

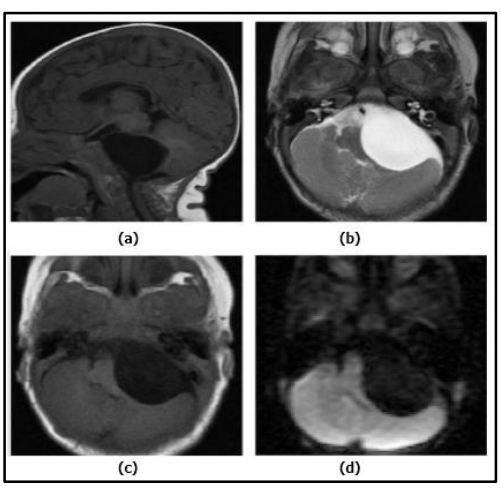


***Figure 3. Cerebellopontine Angle (CPA) Arachnoid Cyst.(a) Sagittal T1-Weighted and(b)Axial T2-Weighted Magnetic Resonance Images show a Smoothly Contoured Fluid-Intensity Left CPA Mass, which Suppresses Completely on Axial Fluid Attenuated Inversion Recovery (FLAIR)Imaging(c).(d)Axial Diffusion-Weighted Image shows Low-Signal Intensity (No Restricted Diffusion) Confirming the Cerebrospinal Fluid/Fluid Nature of this Mass. Despite Significant Local Mass Effect. There is no Obstructive Hydrocephalus in this Child who presented with Macrocrania and Head Tilt***

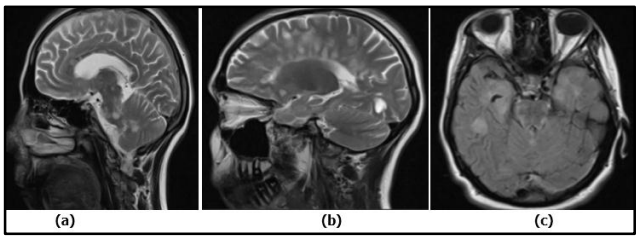


***Figure 4. Multiple Sclerosis- Sagittal T2-Weighted Image (a), (b)and Axial Flair(c) showing Circumscribed T2 Hyperintense Lesions at the Brainstem, Cerebellum, Periventricular Region, Callososeptal Interface. Some of them are Perpendicular to the Corpus Callosum Giving the Appearance of Dawson Fingers. The Remainder of the Brain is Within Normal Limits with No Intra or Extra-Axial Collection, Mass or Region of Abnormal Contrast Enhancement***

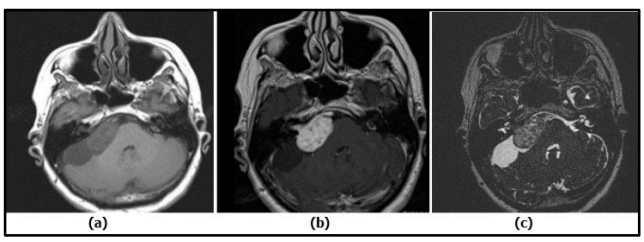


***Figure 5. MR Demonstrates Typical Ice Cream Cone Appearance of a Vestibular Schwannoma on Axial T1Image (a); Enhancing with Contrast (b). The Heterogeneously Hyperintense T2 Lesion is also seen on Axial CISS Sequence (C)***

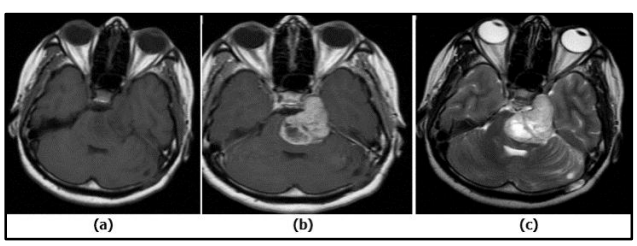


***Figure 6. Trigeminal Schwannoma-Well-Defined, Extra-Axial, Lobulated, Heterogenous Left Cerebellopontine Angle Lesion, which is Predominantly Isointense to Hypointense on T1W Image and Hyperintense on T2W Images. The Lesion is showing Prominent Heterogenous Enhancement on Contrast Administration. The Lesion is seen in the Course of the Left Trigeminal Nerve that is from the Origin at the Pons Extending into the Meckel's Cave. It is causing Compression of the Brainstem and Fourth Ventricle.***

## DISCUSSION

The trigeminal or fifth cranial nerve (V) is the largest cranial nerve and has both sensory and motor functions. The trigeminal nerve has four central brain stem nuclei)- the mesencephalic nucleus, which mediates proprioception; the main sensory nucleus, which mediates tactile sensation; the motor nucleus, which provides motor innervation; and the spinal nucleus, which mediates pain and temperature sensation.

The trigeminal nerve has three branches V1, V2, V3. V1 is the smallest division and purely sensory;V2 is also purely sensory and provides sensory innervation from the maxilla, palate, upper lip, cheek, nasal cavity, nose and nasopharynx; V3 is both motor and sensory and is the largest division; V3 supplies sensation to the chin, lower lip, floor of mouth, tongue, side of head and scalp and meninges. V1, V2 and V3 merge within the posterior aspect of the cavernous sinus to form the sensory trigeminal ganglion. The trigeminal ganglion is located in the anterior-inferior aspect of a dural pouch called the trigeminal cistern situated in a small depression in the petrous apex known as Meckel's cave. The trigeminal nerve fascicles enter the prepontine cistern through the porustrigeminus, an oval opening found beneath the free edge of the tentorium at the petrous apex. The fascicles reach the root entry zone of the trigeminal nerve (the most posterior centimetre of the nerve before it enters the pons) at the ventrolateral surface of the pons.[2,3] Neurovascular Compression Syndrome (NVCS) is defined as a direct contact with mechanical irritation of Cranial Nerves (CNs) by blood vessels.[4]

The common basic aetiology in these vascular compression syndromes is the contact between the offending artery and the nerve. Therefore, it is logical that elimination of this contact would resolve the patient's symptoms. MRI is an essential element in the workup of these pathologies.[5]

The most common cause of trigeminal neuralgia is a compressing loop of artery most commonly the Superior Cerebellar Artery(SCA)) or vein pressing on the trigeminal nerve at the cerebellopontine angle seen in 95% of patients, although rare posterior fossa tumours can be another cause, most commonly vestibular schwannomas, meningiomas, arachnoid cyst or epidermoid cysts. Multiple sclerosis may also cause trigeminal neuralgia symptoms.[6]

The clinical findings do not permit accurate lesion localisation, radiologic examination must be used to visualise the fifth cranial nerve in its full course from its nuclei in the brain stem to its peripheral branches.

CT is limited in evaluating the brainstem and cisterns. MRI is the imaging modality of choice and should be considered the initial screening procedure in the assessment of patients with trigeminal neuralgia.[7]

In addition to T2-weighted images of the whole brain, high-resolution (3-mm thick sections) axial and coronal T1-weighted images of the skull base obtained both before and after intravenous administration of contrast material should he included. If the mandibular nerve is involved, axial T1-weighted images should extend from the skull base to the inferior mandible. Contrast-enhanced fat-suppressed images are valuable for evaluating perineural tumour spread. Oblique sagittal T1-weighted, three-dimensional gradient-echo MR images and MR angiograms are helpful for demonstrating neurovascular compression in cases of trigeminal neuralgia.[8,9]

In a comparative study between 3D CISS MR imaging and Magnetic Resonance (MR) angiography conducted by Norio Yoshino et al, they concluded that 3D CISS MR imaging with Multiplanar Reconstruction (MPR) is useful in the detection of NVC in patients with TN compared with MR angiography.[10] A 3D CISS imaging offers high spatial resolution and excellent contrast resolution and depicts both the artery and the vein responsible for the NVC. Furthermore, a close relationship was found between the region of neuralgic manifestation, distribution of the corresponding trigeminal branch fibres and the site of the vascular compression in the trigeminal nerve.[11]

Conventional MR angiography shows artery as high signal, nerve as intermediate and cerebrospinal fluid as low signal, but 3D CISS imaging show blood vessel and nerve appears as low signal, Cerebrospinal Fluid (CSF) as high-signal intensity, which shows that 3D CISS imaging has high-contrast resolution between these anatomic structures.[12]

Magnetic resonance imaging can help to characterise other lesions, which present with symptoms of neurovascular compression, the next common group being cerebellopontine angle lesions. In our study, we had two cases of vestibular schwannoma and one case each of trigeminal schwannoma, arachnoid cyst and pontine glioma. Schwannomas, also called neurilemmomas or neurinomas are benign tumours of neurogenic origin arising from perineural Schwann cells.[13,14]

Multiple sclerosis is the most common demyelinating disease and is a leading cause of nontraumatic neurologic disability. It is also a well-recognised cause of trigeminal neuralgia. About 1-5% of patients with multiple sclerosis develop trigeminal neuralgia. In our study, one patient with multiple sclerosis had symptoms of trigeminal neuralgia. The cause is a demyelinating lesion affecting the pontine trigeminal pathways.[15,16]

The use of high spatial resolution imaging allows the study of each of the portions of the trigeminal nerve seeking anatomical variants and/or pathological elements that could explain the clinical presentation of a relatively frequent syndrome such as the TN.[17,18]

This may occur not only with involvement of the nervous trunk or its distribution branches, but also of its intra-axial portions or those in the region of Meckel's space, thus making it necessary to identify them correctly.[10]

## CONCLUSION

- Magnetic resonance imaging with 3D CISS sequence is considered the first line of investigation in patients with trigeminal neuralgia.
- Other than neurovascular compression, MRI also has use in ruling out other causes of trigeminal neuropathy such as cerebellopontine angle and brainstem lesions.
- Thus, magnetic resonance imaging helps in determining patients who will benefit from surgical treatment.
- This will go a long way in helping to reduce the morbidity in patients with trigeminal neuralgia.

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