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Original Article

Frequency of trigeminal neurovascular contacts identified on 3D-fast imaging employing steady-state acquisition magnetic resonance imaging in asymptomatic adults

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Received: 30 November 2024
Accepted: 09 January 2025
Published: 31 January 2025

DOI
10.25259/SNI_1021_2024

Quick Response Code:

ABSTRACT

Background: Neurovascular conflict is considered one of the main causes of Trigeminal neuralgia, and 3D fast imaging employing steady-state acquisition magnetic resonance imaging (MRI) is the diagnostic imaging of choice. However, no tool is available to confirm imaging findings as the primary cause of trigeminal neuralgia because neurovascular contact is frequently found in asymptomatic individuals, according to some literature, although very little data is available till now. Therefore, we aim to determine the frequency of trigeminal neurovascular contact, involved nerve segment, culprit vessel, and characteristics of contacts in asymptomatic individuals. Knowledge about this is very crucial so that every patient may not be labeled as having neurovascular conflict as the primary cause and can be saved from unnecessary surgeries.

Methods: A retrospective observational study was conducted on 105 MRI brain scans of asymptomatic individuals for trigeminal neurovascular relationships by two expert neuro-radiologists. Percentages calculated for categorical variables and for continuous variables Shapiro–Wilk test were used. The Fisher Exact test is used to assess the association between conflict and other variables. Inter-rater reliability was computed for the outcome and other variables and Cohen's kappa to evaluate the strength of agreement. All calculations were performed using STATA version 17.0.

Results: Out of 105 cases, neuro-vascular contact was identified in 64 cases. The most common contacting vessel was the superior cerebellar artery. The most common nerve segment involved was the cisternal segment, followed by the Root entry zone and porous trigeminus. In about 54 cases, the vessel was abutting the nerve, while in eight cases, it was compressing and, in two cases, displacing the nerve. The superior surface of the nerve was commonly involved. The inter-rater reliability between both neuroradiologists showed significant agreement.

Conclusion: Neurovascular contact is found in asymptomatic individuals, so just the presence of contact in symptomatic individuals on MRI should not be considered as only the cause of trigeminal neuralgia. It is important to identify nerve thinning and distortion, which are more reliable signs.

Keywords: 3D-constructive interference in steady state, 3D-fast imaging employing steady-state acquisition magnetic resonance imaging, Magnetic resonance image, Neurovascular conflict, Trigeminal neuralgia

INTRODUCTION

Trigeminal neuralgia is sudden, severe, paroxysmal, and recurrent neuropathic pain affecting the sensory supply of one or more branches of the trigeminal nerve. Vascular compression is considered one of the most common causes of refractory Trigeminal neuralgia.[1-5,9,10,13-26] According to the theory of Gardner (1962) and Jannetta (1967), the pulsation of the nearest vessel causes chronic compression on the nerve and results in repeated traumatic demyelination, which leads to paroxysmal neuropathic pain.[6,11,23]

Microvascular decompression is the most widely used surgical intervention for neurovascular conflicts.[3,10,16]

Magnetic resonance image (MRI) with high-resolution three-dimensional fast imaging employing steady-state acquisition (FIESTA) sequence or constructive interference in steady state (CISS) sequence is considered as diagnostic imaging of choice to determine neurovascular conflict.[13,16] It has greater specificity but lesser sensitivity.[3] At present, no tool is available to confirm these imaging findings as the primary cause of trigeminal neuralgia due to the limited data on normal neurovascular relationships in asymptomatic individuals. Few studies have reported a high rate of contact between the cisternal segment of trigeminal nerves and vessels in asymptomatic individuals.[23] Autopsy studies have revealed neurovascular contact in 16–58% of asymptomatic individuals.[18] Understanding the frequency and characteristics of neurovascular conflicts in asymptomatic individuals is essential to prevent labeling every trigeminal neuralgia patient undergoing MRI as having neurovascular conflict as the primary cause. This study examines the vascular relationships of the trigeminal nerve in asymptomatic individuals.

MATERIALS AND METHODS

A retrospective observational study was conducted, and about 105 MRI brain scans containing complimentary FIESTA sequences were selected from an institutional database, which was done for some other reason, that is, persistent frontal or occipital headache, vertigo, dizziness, and tinnitus but without any complaint of facial pain or trigeminal neuralgia. This was a retrospective study and did not involve the patient directly, so patient's consent was not required, and an Ethical Review Committee exemption certificate was also taken. These scans were reviewed for relationships of vascular structures with Trigeminal nerves by two expert neuro-radiologists with 5 years of experience in neuroradiology.

Inclusion criteria

All the patients undergoing an MRI brain with FIESTA sequence for reasons other than trigeminal neuralgia will be included in the study.

Exclusion criteria

1. Patients have cerebellopontine (CP) angle tumor
2. Patients who underwent surgery for trigeminal neuralgia
3. Age <18 years or more than 80 years.

Imaging acquisition techniques

All patients were scanned on a 1.5 Tesla general electric (GE) MRI machine, with the 3D FIESTA sequence acquired in axial sections using the following parameters: Matrix 320 × 320, slice thickness 0.8 mm, time to echo (TE) 2.47 ms, repetition time (TR) 6.5 ms, and number of excitations (NEX) 1.73. The images were subsequently reviewed on the departmental AGFA picture archiving and communication system (PACS) using the Multi-Planar Reconstruction technique. This allowed for the reconstruction of images in sagittal and coronal views and enabled adjustment of the angle as needed to clearly assess the course of the trigeminal nerve [Figures 1 and 2].

Image analysis

All images were reviewed by two neuroradiologists, each with at least 5 years of experience. Only cases with consensus between the two neuroradiologists were considered to have neurovascular contact. When a contact was identified between the trigeminal nerve and a vessel, the following details were recorded on an Excel data sheet: Patient's side (left or right), type of vessel (artery or vein), surface of the nerve in contact (superior, inferior, lateral, or medial),

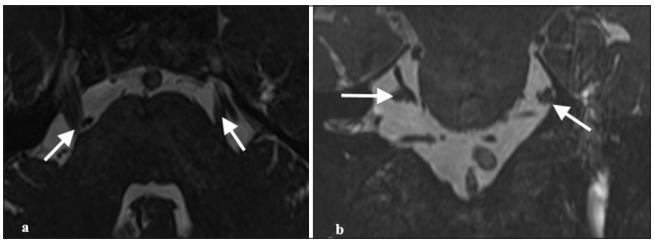

Figure 1: (a) Axial and (b) coronal fast imaging employing steady-state acquisition images show trigeminal neurovascular contact bilaterally without evidence of nerve thinning or distortion (arrow indicating nerve).

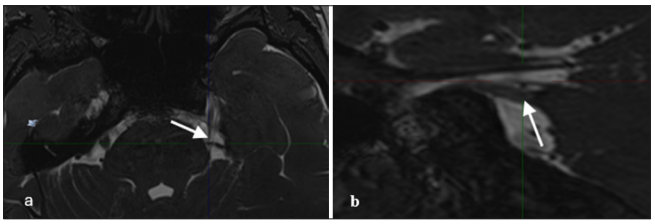

Figure 2: (a) Axial and (b) sagittal fast imaging employing steady-state acquisition images show vascular contact with the trigeminal nerve on the left side (arrow indicates nerve).

segment of the nerve (at the porus trigeminus, at the cisternal segment, or the root entry zone [7 mm from origin at the pons]), and degree of compression.

The degree of compression was classified according to Sindou *et al*.,[24] 2002, as follows:

1. Abutting: The vessel is in contact with the nerve but does not cause displacement or compression [Figures 1 and 2]
2. Displacing: The vessel is in contact with and displacing the nerve
3. Compressing: The vessel compresses the nerve, resulting in thinning of the nerve.

Statistical analysis

Frequencies and percentages were reported for categorical variables, including conflicts, gender, site, vessel, contact type, and nerve segment. For the continuous variable age, the Shapiro–Wilk test was used to assess the normality of the data, and the median and interquartile range (IQR) were reported due to its skewed distribution. The Fisher Exact test was employed to assess the association between conflict and other variables, as the expected cell frequencies were <5. Inter-rater reliability was computed for the outcome (conflict) and other variables, reported as percent agreement, expected agreement, and Cohen's kappa to evaluate the strength of agreement. $P < 0.05$ was considered statistically significant. All calculations were performed using STATA version 17.0.

RESULTS

The study included a total of 105 patients who underwent MRI brain scans for various reasons. The median age of the patients was 55 years (IQR: 22), with 55 (59.1%) being female. A total of 105 MRI brain scans containing complementary FIESTA sequences were analyzed. Conflict was identified in 64 cases (61%) [Figure 3]. Table 1 presents the frequencies and percentages of predictors associated with the outcome (conflict). All predictors (site, vessel, nerve segment, and contact type) showed significant associations with the conflict.

There was excellent agreement between both neuroradiologists regarding the presence of conflict and various factors in patients who underwent MRI brain scans, with a statistically significant P = of 0.00 for all variables, as presented in Table 2.

DISCUSSION

Previous literature review shows that trigeminal neurovascular contact is common in asymptomatic individuals and increases with age due to the elongation of cisternal portions of arteries. Peker *et al*.[21] examined 200 trigeminal nerves of asymptomatic individuals using 3-T MRI and found that out of 200 nerves, 175 (87.5 %) nerves showed neurovascular contact, so the study concluded that vascular contact of the trigeminal nerve is not always pathological.

Klun and Prestor assessed neurovascular relationships in the root entry zone of trigeminal nerves of 65 cadavers and found 52 examples of vascular contact with or without compression of the trigeminal nerve and concluded that vascular compression of the trigeminal root entry zone may be the predominant cause, but not the sole cause of trigeminal neuralgia.[12,21] Haines *et al*. examined root entry zones of 20 asymptomatic cadavers and 40 out of these were found to be in contact with an artery. Hardy and Rhoton examined 50 trigeminal nerves and the adjacent superior cerebellar artery in 25 adult cadavers and 52% had a point of contact with this artery.[7,8,12,21]

Maurya *et al*. observed contact between trigeminal nerve and vessel in 41 (80.4%) symptomatic individuals (Significant $P < 0.001$), but neurovascular contact was also seen in 17 (28.3%) asymptomatic individuals, so they concluded that just the presence of neurovascular contact is not sufficient to say that there is a conflict between offending vessel and nerve.[16]

The most common vessel that contacts the trigeminal nerve is the superior cerebellar artery, followed by the anterior inferior cerebellar artery. Yoshino *et al*,[9,25] observed superior cerebellar artery was responsible for the neurovascular conflict in 46%, the anterior inferior cerebellar artery in 17% of both superior cerebellar artery (SCA) and anterior inferior cerebellar artery (AICA) in 9%, the basilar artery in 4%, and the posterior cerebellar artery in 2% and vein in 6% of cases. In our study, the most common contacting vessel was the superior cerebellar artery (92.2%), followed by the vein (7.8%).

Miller *et al*.,[18] observed neurovascular contact in patients with and without trigeminal neuralgia and found arterial compression in 17% of asymptomatic patients and venous compression in 30% of asymptomatic patients.

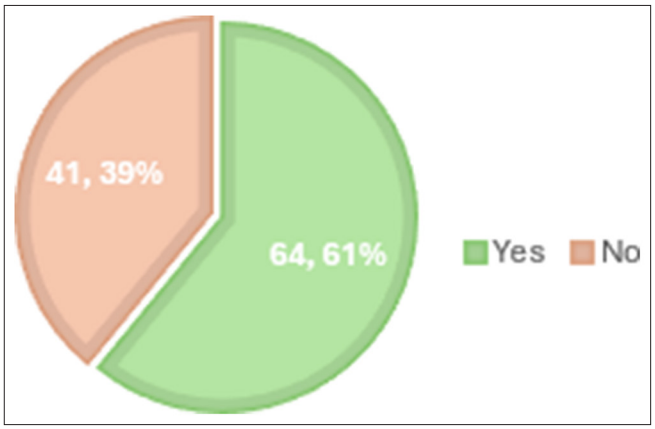

Figure 3: Percentage of cases with neurovascular contact.

Table 1: Frequencies and percentages of predictors associated with the outcome (conflict) among patients who underwent magnetic resonance imaging brain scans.

Factors	Outcome		*P*-value
Site	**No conflict**	**Conflict**	
Left	0 (0)	23 (31.2)	0.00*ǂ
Right	0 (0)	33 (51.6)	
Bilateral	0 (0)	11 (17.2)	
Not applicable	41 (100)	0 (0)	
Vessel			
Vein	0 (0)	5 (7.8)	0.00*ǂ
SCA	0 (0)	59 (92.2)	
Not applicable	41 (100)	0 (0)	
Nerve segment			
At porous trigeminus	0 (0)	10 (15.9)	0.00*ǂ
Cisternal segment	0 (0)	33 (52.4)	
Root entry zone	0 (0)	20 (31.7)	
Not applicable	41 (100)	0 (0)	
Contact type			
Abutting superiorly	0 (0)	34 (53.1)	0.00*ǂ
Compressing superiorly	0 (0)	6 (9.4)	
Abutting and compressing superiorly	0 (0)	2 (3.1)	
Abutting superomedially	0 (0)	2 (3.1)	
Abutting superomedially and slightly displacing laterally	0 (0)	1 (1.6)	
Abutting medially	0 (0)	9 (14.1)	
Abutting laterally	0 (0)	2 (3.1)	
Abutting and displacing laterally	0 (0)	1 (1.6)	
Abutting inferiorly	0 (0)	7 (10.9)	
Not applicable	41 (100)	0 (0)	

**P*-value<0.05 was considered statistically significant, ǂFisher Exact test has been applied due to expected cell frequencies <5, SCA: Superior cerebellar artery

Table 2: Inter-rater reliability for different factors of neurovascular contact (*n*=105).

	Percent agreement	Expected agreement (%)	Cohen's kappa (k)
Outcome			
Conflict	100	52.4	1*
Factors			
Site	100	30.56	1*
Vessels	90.48	42.15	0.84*
Nerve segment	92.31	30.95	0.88*
Contact type	99.05	27.66	0.98*

Key	
Cohen's Kappa (k)	Strength of agreement
0.8≥k	Excellent agreement
0.4≤k < 0.8	Mild to moderate agreement
K<0.4	Poor agreement

**P*-value<0.05 is considered as statistically significant

Maarbjerg *et al.*,[15] observed that the mean age of occurrence of trigeminal neuralgia symptoms is 53 years, and the mean age at the time of diagnosis is 60.1 years. Hence, it suggests that as age increases the symptoms due to neurovascular conflict might start to occur. The mean age in our study was 55 years, and none of the patients had trigeminal neuralgia symptoms.

Hence, our study and literature review suggest that neuroradiologists must differentiate between just neurovascular contacts from a true neurovascular conflict while evaluating MRI of trigeminal neuralgia patients. This will help the neurosurgeons to opt for unnecessary surgeries and proceed with medical management.

Limitations

This study has several limitations. Its retrospective design and reliance on single-center data may limit the generalizability of the findings. In addition, we lacked follow-up information on the included patients to determine whether anyone

developed symptoms of trigeminal neuralgia over time, so a prospective study is also required in which patients are followed with a detailed questionnaire.

CONCLUSION

Neurovascular contacts can be found frequently in asymptomatic individuals, as shown by our study and other literature reviews. Just the presence of neurovascular contact in a symptomatic individual on MRI should not be considered the only cause of trigeminal neuralgia. It is important to identify the thinning and distortion of the nerve by the vessel as these are more reliable signs of a conflict between the vessel and the nerve. This will help prevent unnecessary microvascular decompression and its complications.

Ethical approval: The Institutional Review Board has waived the ethical approval for this study as it is retrospective study.
Declaration of patient consent: Patient's consent not required as patient's identity is not disclosed or compromised.
Financial support and sponsorship: Nil.
Conflicts of interest: There are no conflicts of interest.
Use of artificial intelligence (AI)-assisted technology for manuscript preparation: The authors confirms that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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How to cite this article: Kumar A, Anwar SS, Bilal K, Ahmed A, Samnani S, Zafar B. Frequency of trigeminal neurovascular contacts identified on 3D-fast imaging employing steady-state acquisition magnetic resonance imaging in asymptomatic adults. Surg Neurol Int. 2025;16:31. doi: 10.25259/SNI_1021_2024