Role of 3D-Constructive Interference in Steady State (3D-CISS) Sequence of Magnetic Resonance Imaging in Evaluation of Trigeminal Neuralgia

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ABSTRACT

BACKGROUND

Trigeminal neuralgia is one of the most debilitating facial pain disorders. Differentiation among various aetiologies is important because the treatment strategy changes. MRI helps in diagnosing the disease, finding the cause for neuralgia and follow up of patients after treatment. We wanted to evaluate the aetiology among patients clinically suspected to be suffering from trigeminal neuralgia using 3D CISS sequence of Magnetic Resonance Imaging (MRI).

METHODS

A hospital based cross-sectional study was done from November 2017 to May 2019 in a tertiary care centre of South India, where 56 patients with clinical suspicion of Trigeminal neuralgia were evaluated with MRI of brain. The MRI data collected was analysed and described.

RESULTS

Out of 56 patients in our study group, 24 (42.9%) were males and 32 (57.1%) were females, with slightly more female predilection. Majority of patients was in the 5th decade (23.2%). Neurovascular compression was the most common aetiology accounting for 71.1% of the patients, followed by tumours (15.8%), demyelination (7.9%) and infarct (5.3%) aetiologies.

CONCLUSIONS

MRI is the best imaging modality for evaluation of trigeminal neuralgia. 3D CISS sequence helps in better depiction of neurovascular conflicts. It is the most sensitive and specific tool for characterisation of tumours involving cerebello-pontine angle, although the final tool for confirmation is histopathology. The present study was aimed at evaluating the causes of trigeminal neuralgia on MRI. This was done by correlating MRI findings with clinical features.

KEYWORDS

Trigeminal Neuralgia, Neuro Vascular Compression, Cerebello Pontine Angle, Magnetic Resonance Imaging

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BACKGROUND

Trigeminal neuralgia is the most debilitating form of neuralgia affecting sensory branches of trigeminal nerve. Its prevalence is 3-6 per 1,00,000 population.[1,2] It is commonly seen in adults in 5th -7th decade with female predilection.[2] Trigeminal neuralgia is characterized by paroxysm of pain which is short, severe in episodes and is usually unilateral along the course of nerve with more predilection towards right side. Most commonly involved is maxillary and mandibular division and rarely involves ophthalmic division.[3] The purpose of imaging in trigeminal neuralgia is to identify the cause and to further identify those patients in whom surgical treatment is possible. The superior imaging modality is MRI with 3D CISS sequence. 3D CISS is a heavily T2 weighted sequence where CSF appears bright and rest of intracranial structures including vessels and nerves appear dark.[4-6]

The aetiologies for trigeminal neuralgia vary according to the site of involvement of nerve segment. At the level of trigeminal nucleus, the common aetiologies include- a) Infarcts b) Cavernoma c) Demyelinating plaques of multiple sclerosis, d) Brain stem glioma. At the level of pre pontine cistern, the common causes are- a) Neuro vascular compression b) Aneurysms and c) Cerebello pontine angle tumours. Other causes include base of skull tumours, pituitary macro adenoma and perineural spread of salivary gland tumours. The more susceptible segment for neuro vascular conflict is the root entry zone of trigeminal nerve in pre pontine cistern. It signifies transition from central to peripheral myelin. Superior cerebellar artery is responsible for most cases followed by anterior inferior cerebellar artery and basilar artery.[7] Neuro vascular compression is graded on MRI based on the extent of the compression of nerve and vessel.[8] Grade I-Mild contact between nerve and vessel. Grade II-Mild distortion /displacement of the nerve root by artery. Grade III-Atrophy of cisternal segment of the nerve by the vessel.

METHODS

After approval from the Institutional ethics review committee, a hospital based cross sectional study was conducted. The study group consisted of 56 patients presenting to the Departments of Radiodiagnosis, Neurology and Neurosurgery in a tertiary care centre of South India from November 2017 to May 2019. Informed and written consent was obtained from all the 56 participants. Patients of age group >18 years who were clinically suspected to have Trigeminal neuralgia underwent MRI scan. Those patients with neuralgia secondary to surgery were excluded from the study.

Imaging Techniques

MRI was performed using 1.5 Tesla Siemens Magnetom Avanto B15 machine (Siemens Medical Systems, Erlangen, Germany). All images were acquired in axial plane with 5 mm thick sections and a base resolution of 192 x 256 matrices. Routine sequences applied include T1, T2, FLAIR axial sequences, MRI TOF, Diffusion weighted sequences. In case of space occupying lesions 3D contrast enhanced fat suppressed T1-weighted imaging sequence is used. 3D CISS sequence had superior spatial and contrast resolution due to cisternographic effect and helps in effective diagnosing of trigeminal neuralgia. 3D CISS is considered to be superior to conventional plain MRI. CISS is used in assessment of anatomical variations and various pathologies involving cranial nerves and CNS. In case of trigeminal neuralgia, CISS plays an important role in detecting neuro vascular conflicts. The underlying rationale for selection of 3D CISS over conventional MRI is reasonably long T2 relaxation time that will demonstrate additional signals due to various refocused echo paths. Post Gadolinium (Gd) contrast study was performed in few patients, wherever necessary after injecting 0.1 mmol/kg body weight of intravenous Magnevist (Gadopentetate Dimeglumine) and Post Gd- T1FS images were obtained in axial, coronal and sagittal planes.

Statistical Analysis

Data was entered into Microsoft excel data sheet and was analysed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation.

RESULTS

Out of 56 patients in our study group, 24 (42.9%) were males and 32 (57.1%) were females, with slightly more female predilection. Majority of patients in the 5th decade (23.2%). Out of 56 patients clinically suspected to have trigeminal neuralgia 38 patients (67.9%) had abnormal MRI findings. Neurovascular compression was the most common cause accounting for 71.1% of the patients, followed by tumours (15.8%), demyelination (7.9%) and infarct (5.3%) Headache along with facial pain were the main clinical symptoms in affected patients. The disease was mainly seen affecting one side(96.4%) and maxillary nerve was the most commonly affected branch (53.6%). Among patents clinically suspected to have trigeminal neuralgia, 38 patients had abnormal MRI findings (67.9%). Among patients with neurovascular compression (71.1%), Superior cerebellar artery compression was seen in 74.1% and Anterior inferior cerebellar artery was seen in 25.9% demonstrable on 3D CISS sequence. Neurovascular compression was of Grade I in 48.1%, Grade II in 37% and Grade III in 14.8%.

Among 15.8% of tumours 7.9% had Vestibular schwannoma and 2.6% had Arachnoid cyst, Epidermoid cyst and Trigeminal schwannoma. 7.9% of patients had demyelinating plaques in pons near root entry zone and 5.3% of the patients had pontine infarcts.

Figure 1

MR Diagnosis: Left trigeminal neuralgia secondary to neurovascular compression: Grade II
MR Findings: Left superior cerebellar artery is in close proximity to root entry zone of trigeminal nerve causing mild displacement of the nerve.

Figure 2

MR Diagnosis: Left vestibular schwannoma causing trigeminal neuralgia
MR Findings: Typical ice cream cone appearance of a vestibular schwannoma on axial CISS image (A). The lesion appears heterogeneously hyperintense in axial T2 lesion sequence (B).

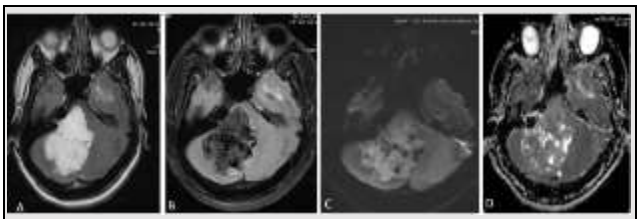

Figure 3

MR Diagnosis: Right epidermoid cyst causing trigeminal neuralgia.
MR Findings: A well-defined extra axial T2 hyperintense lesion seen in right cerebello pontine angle (A).The lesion is incompletely suppressed in FLAIR sequence. (B) Axial diffusion weighted image and corresponding ADC map demonstrating diffusion restriction in the lesion (C and D).

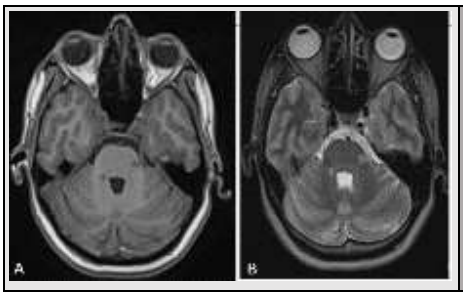

Figure 4

MR Diagnosis: Multiple sclerosis plaque causing left trigeminal neuralgia
MR Findings: Ill-defined T1 hypointense (A), T2 hyperintense lesion (B) in the anterior and left lateral aspect of the pons at the region of left trigeminal nerve root exit.

DISCUSSION

MRI is a good imaging modality to evaluate for pathologies of trigeminal neuralgia due to its ability to depict the anatomy and pathology in multiple planes without the use of radiation. It is non-invasive and has superior soft tissue contrast resolution. Our results have shown that there is high percentage of abnormal findings (38 out of 56) in MRI patients clinically suspected to have trigeminal neuralgia, with the causative lesions and their relative frequencies correlates with other studies. CISS which stands for Constructive Interference in Steady State, is a part of fast gradient echo sequences and considered to be superior to the conventional plain MRI. [9] CISS is used in the assessment of the anatomical variations and various pathologies involving the cranial nerves and central nervous system (CNS). The course of trigeminal neuralgia was traced from Meckel's cave to pre pontine cistern posteriorly. Each vessel was identified by tracing their origin from vertebral and basilar arteries. In our study with abnormal brain MRI findings 27 patients (71.1%) had demonstrable neurovascular conflict on 3D CISS sequence, of which superior cerebellar artery was implicated in 20 patients (Figure 1) and Anterior inferior cerebellar artery in 7 patients. Of all MRI sequences 3D CISS sequence has the highest success in depicting positive findings on MRI. Neurovascular compression as the cause of trigeminal neuralgia was first described by Jannetta.[10,11] In addition to 3D CISS, contrast enhanced MRI can also be used for depicting neuro vascular conflicts.[12]

MRI also helps in identifying those lesions which present with signs and symptoms of trigeminal neuralgia, the most common being cerebello pontine angle tumours. In our study we had 6 cases of tumours (15.8%) of which 3 cases were vestibular schwannoma (Figure 2) and one each of trigeminal schwannoma, arachnoid cyst and epidermoid cyst (Figure 3). Schwannomas are benign nerve tumours arising from perineural Schwann cells. Epidermoids are strong diffusion restricting tumours originating from ectodermis and are composed of desquamated squamous epithelium. Meningiomas, skull base tumours are other neoplastic lesions which can cause trigeminal neuralgia. These lesions cause trigeminal neuralgia by direct compression of nerve against the skull base or by invasion / encasement by tumour itself.[13,14]

3 patients (7.9%) had demyelinating plaques as the cause for trigeminal neuralgia and all were known cases of multiple sclerosis. (Figure 4) Multiple sclerosis is the most common demyelinating disease and results in neurologic disability. All cases had demyelinating plaque in hemi pons in the region of pontine trigeminal neural pathway.[15,16]

Trigeminal neuralgia can also be present in brain stem lesions that cannot be categorised as multiple sclerosis such as brainstem infarcts[17.] 2 patients (5.3%) had brain stem infarcts which resulted in trigeminal neuralgia. The treatment for trigeminal neuralgia includes both medical and surgical line. Carbamazepine is the drug of choice. Microvascular decompression, ablative therapy and removal of the tumour includes the surgical treatment. MRI helps in diagnosis, pre-operative planning, post-operative follow up and determining prognosis of the disease.[18]

CONCLUSIONS

MRI is an excellent modality for detection of pathologies of trigeminal neuralgia due to its superior soft tissue contrast resolution and multiplanar capacity. Knowledge of the normal anatomy and pathological imaging appearance is essential in interpretation of trigeminal neuralgia. As many disorders often present with similar symptoms, accurate imaging characterization and early diagnosis provide significant clinical benefit.

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