Original Research Article

Magnetic Resonance Imaging in Trigeminal Neuralgia

Abstract:

Background: Trigeminal neuralgia remains a severe neurologic disorder manifested as severe unilateral facial pain along with the distribution of the trigeminal nerve. Although there are no specific clinical tests for diagnosing trigeminal neuralgia, MRI stands as an excellent imaging modality for diagnosing the aetiology of this disorder. 3D FIESTA MRI act as adjuvant to conventional MRI in increasing diagnostic accuracy and detection of neurovascular compression. Other than neurovascular compression, MRI also is used in ruling out other causes of trigeminal neuralgia such as cerebellopontine angle lesions and demyelinating or inflammatory conditions.

Aim of the work: This work aimed to evaluate the role of Magnetic Resonance Imaging in diagnosing trigeminal neuralgia and its different causes.

Patients and Methods: This prospective study involved 30 patients (14 males and 16 females), their mean age was (49.6) years old who were referred from out clinics (neurosurgery and/or dental clinics) to Radiodiagnosis and Medical Imaging Department at Tanta University Hospital from January 2020 till end of the study.

Results: The commonest affected side was the left side (46.7%) followed by the right one (40%), while bilateral affection was seen in (13.3%) of cases. According to aetiological factor, trigeminal neuralgia was secondary to underlying pathology in 24 cases (80%), while idiopathic trigeminal neuralgia with no underlying pathology was found in 6 cases (20%). Neurovascular compression and neoplastic lesions had the higher incidence. The most affected segment of the trigeminal nerve was the cisternal segment that was involved in 15 cases out of 24 cases with abnormal MRI findings.

Conclusion: Many CPA lesions may cause trigeminal neuralgia such as schwannomas and meningiomas. Demyelinating disease as multiple sclerosis were reported in our study to cause also trigeminal neuralgia. MRI showed that it has significant diagnostic role denoting brain lesions in patients with TN as it has a diagnostic accuracy 62.5%, sensitivity 60% and specificity 100% ($P < 0.001$).

Keywords: Magnetic Resonance Imaging, Trigeminal Neuralgia

Introduction:

Trigeminal neuralgia (TN) is a condition of neuropathic facial pain. It is the most common form of facial neuropathic pain in elderly people and more prevalent in women than men [(1)].

The International Classification of Headache Disorders 3rd edition (ICHD-3) describes trigeminal neuralgia as either "classical trigeminal neuralgia", secondary TN and idiopathic TN. Classic TN encompasses cases related to vascular compression, while secondary TN is defined as TN caused by an underlying disease such as multiple sclerosis (MS) or a tumor along the trigeminal nerve. Idiopathic TN is called when there is no obvious etiology [(2)].

TN is defined clinically by paroxysmal, stereotyped attacks of usually intense, sharp, superficial, or stabbing pain in the distribution of one or more branches of the trigeminal nerve. The pain of TN tends to occur in paroxysms and is maximal at or near onset. Facial muscle spasms can be seen with severe pain. The pain is often described as electric, shock-like, or stabbing. It usually lasts from one to several seconds but may occur repetitively. Some patients with longstanding TN may have continuous dull pain that is present between

paroxysms of pain. Unlike some other facial pain syndromes, TN typically does not awaken patients at night. TN is typically unilateral. Occasionally the pain is bilateral [3].

The diagnosis of TN is based upon the characteristic primarily paroxysms of pain in the distribution of the trigeminal nerve. Once the diagnosis of TN is suspected on clinical grounds, a search for secondary causes should be undertaken [4].

For all patients with suspected TN, neuroimaging is recommended to help distinguish classic TN from secondary TN and idiopathic TN. Neuroimaging of the brain can be done with magnetic resonance imaging (MRI) or computed tomography (CT), though MRI with and without contrast is much preferred because its higher resolution enables imaging the trigeminal nerve and small adjacent lesions [5].

Many MRI findings are expected to be seen in various types of TN. In classic TN, MRI (using high-resolution T2WI thin cuts sequences and MRA) will show vascular loop compressing one of the branches of trigeminal nerve, the vascular loop most frequently done by the superior cerebellar artery. High-resolution MRI with thin cuts through the course of the trigeminal nerve and heavy T2 weighting (eg, a constructive interference in steady state [CISS] fusion study), is the preferred imaging modality if available. In addition, magnetic resonance angiography (MRA) may be useful for identifying vascular compression [6].

While in secondary TN, MRI will demonstrate the major neurologic disease that causes the neuralgia. A tumor at the cerebellopontine angle (MRI with contrast is mandatory in diagnosis of space occupying lesions and delineation of its extensions and effect) or MS (the most preferred sequences are FLAIR and T2WI, also, delayed post contrast study may give advantage of detecting active disease) causes TN in 15% of patients. Tumors leading to TN are mostly benign and typically compress the root near its entry into the pons. The compression induces focal demyelination and is thought to trigger paroxysmal ectopic discharges. Malignant tumors are more likely to infiltrate the nerve and lead to axonal degeneration. If malignant tumors cause trigeminal pain, it usually does not resemble the pain attacks experienced in TN [7].

Finally in idiopathic TN, MRI examination of the brain will be normal (in all sequences) with no detected any abnormality along the trigeminal course, yet MRI examination is mandatory to exclude the possibility of secondary TN [8].

Patients and Methods

This prospective study involved 30 patients (14 males and 16 females), their mean age was (49.6) years old who were referred from out clinics (neurosurgery and/or dental clinics) to Radiodiagnosis and Medical Imaging Department at Tanta University Hospital from January 2020 till June 2022.

Patient demographics: Full history data were collected from the patients included: age, gender, and complaint.

Inclusion criteria:

Patients with paroxysmal facial pain with or without other neurological symptoms or signs

Exclusion criteria:

1. Dental and psychological causes.
2. Patients who have a cardiac pacemaker.
3. Patients who have a metallic foreign body in their eye.
4. Patients with movement disorder that cannot be controlled.
5. Patients who have a hypersensitivity to the contrast or renal impairment.
6. Patients with claustrophobia.

Each patient underwent the following:

1.Clinical assessment

2.Neurological examination

3.MRI examination

- MRI sequences:
- 3D FIESTA
- T1WI
- T2WI
- FLAIR images
- T1 C+ (Gd)
- Diffusion weighted images (DWI)

Image assessments:

- Neurovascular compression of the trigeminal nerve was evaluated in TN patients on the side of the pain, as well as on the contralateral side as following:
- Assessment of the angle between the trigeminal nerve and the pons (the trigeminal-pontine angle) in patients with idiopathic TN
- Measuring the cross-sectional area of the CPA cistern and trigeminal nerve cisternal length bilaterally in patients with primary TN.
- Smaller CPA cisterns and short cisternal trigeminal nerves impact the pathogenesis of essential TN by facilitating the neurovascular conflict, especially in younger patients.

Ethical considerations

- The study was accepted by the Research Ethics Committee of Faculty of Medicine Tanta University before starting the field work.
- An informed consent was signed by all the patients.
- Explanation of the study aim in a simple manner to be understood by the common people.
- The patient had the right to get a copy from the informed consent.
- No harmful maneuvers were performed or used.
- All data were considered confidential and did not used outside this study without patient's approval.
- All patients were notified with the results of imaging.
- Patients had the right to withdraw from the study at any time without giving any reason and were excluded from the study.
- The patient did not pay for any investigations in the research.

Statistical analysis:

- Data were presented as mean or number.
- Normally distributed continuous variables were compared using Student t-test when comparing mean of variable among two groups.
- Normally distributed continuous variables were compared using ANOVA test when comparing mean of variable among more than two groups.
- Categorical variables were compared by the Chi-square test or Fisher's exact test, as appropriate.
- Statistical analysis included estimation of sensitivity, specificity, accuracy, Positive Predictive Value (PPV) and Negative Predictive Value (NPV) for all the examined criteria gathered by MRI.
- P-value less than 0.05 were considered statistically significant.

Result:

This is a prospective study, consists of 30 cases who presented clinically with T.N, Males represent 46.7% and females represent 53.3% of the study group. Age study ranges from 5 to 65 years with mean 46.23 ± 13.63 years. We found that the most affected decade (30 - > 40 **yrs.**) and females more affected than males (16 / 30 patients) (table 1).

Table 1: Age and sex distribution of the study group (n=30)

Age(yrs.)	SEX		Total No.	%
	Male	Female		
0 - < 10	-	1	1	3.33
10 - < 20	-	-	0	0
20 - < 30	2	-	2	6.67
30 - < 40	1	7	8	26.67
40 - < 50	3	2	5	16.67
50 - < 60	3	4	7	23.33
60 - < 70	5	2	7	23.33
Total	14	16	30	100

This table showed that left sided TN was more common (46.7%) in comparison to righted sided ones (40%) and bilateral TN was present only in 4 cases (13.3%) (table 2).

Table 2: Lateralization of TN in 30 patients of our study

Lateralization	**N**	**%**
Left	14	46.7
Right	12	40
Bilateral	4	13.3
Total	30	100

All 30 cases of our study underwent MR examination. Out of 30 included patients who presented with TN. 9 cases showed tumors (30%), 7 patients showed vascular causes (23.3%), 6 cases were idiopathic (20%) and 4 with MS (13.3%), and last 4 one with pontine-infarction as shown in table 3.

Table 3: MR aetiological classifications of 30 cases of our study

Aetiology of diagnosis	**N**	**%**	**Chi square**	**P.value**
Multiple sclerosis	4	13.3	3	0.5578
Post Stroke	4	13.3		
Tumor	9	30		
Vascular	7	23.4		
Idiopathic	6	20		
Total	30	100		

The 30 patients who included in this study and presented by TN where classified through MR examination into; three categories according to the aetiology of TN; into: Classical TN (vascular compression) in 6 patients. Secondary TN in 18 patients (9 with tumors, 4 with MS, 4 with pontine-infraction and 1 patient with cavernous heamangioma). Idiopathic in 6 cases as shown in table 4. We found that secondary type were the most common cause (18/30) 60%.

Table 4: MR aetiological classifications of 30 patients with TN

Type of TN	**No. of cases**	**%**
I. **Classical type (vascular compression)**	6	(6/ 30) 20%
II. **Secondary type**	18	(18/ 30) 60%
▪ **Tumors**	9	
▪ **MS**	4	
▪ **Infarction**	4	
▪ **Vascular malformation**	1	
III. **Idiopathic type**	6	(6/ 30) 20%
Total NO.	**30**	100%

The secondary type of TN was the most common type (18/30) 60%;(9 with tumors, 4 with MS, 4 with pontine-infraction and 1 patient with cavernous heamangioma).Benign tumors

were the most common cause of TN (secondary type); (8/18) (44.44%) and Shwanoma were the most common (5 cases) (3 with Trigeminal Shwanoma and 2 with Acoustic Shwanoma) (table 5).

Table 5: TN classifications of secondary type according to aetiology

Lesion	N	%
Tumors: - Benign • Trigeminal Shwanoma • Acoustic Shwanoma • Epidermoid Cyst • Meningioma - Malignant • Glioma	8 3 2 1 2 1 1	(9/18) 50%
Pontine-Infarction	4	(4/18) 22.22%
Cavernous Heamangioma	1	(1/18) 5.56%
Multiple Sclerosis	4	(4/18) 22.22%
Total	18	100

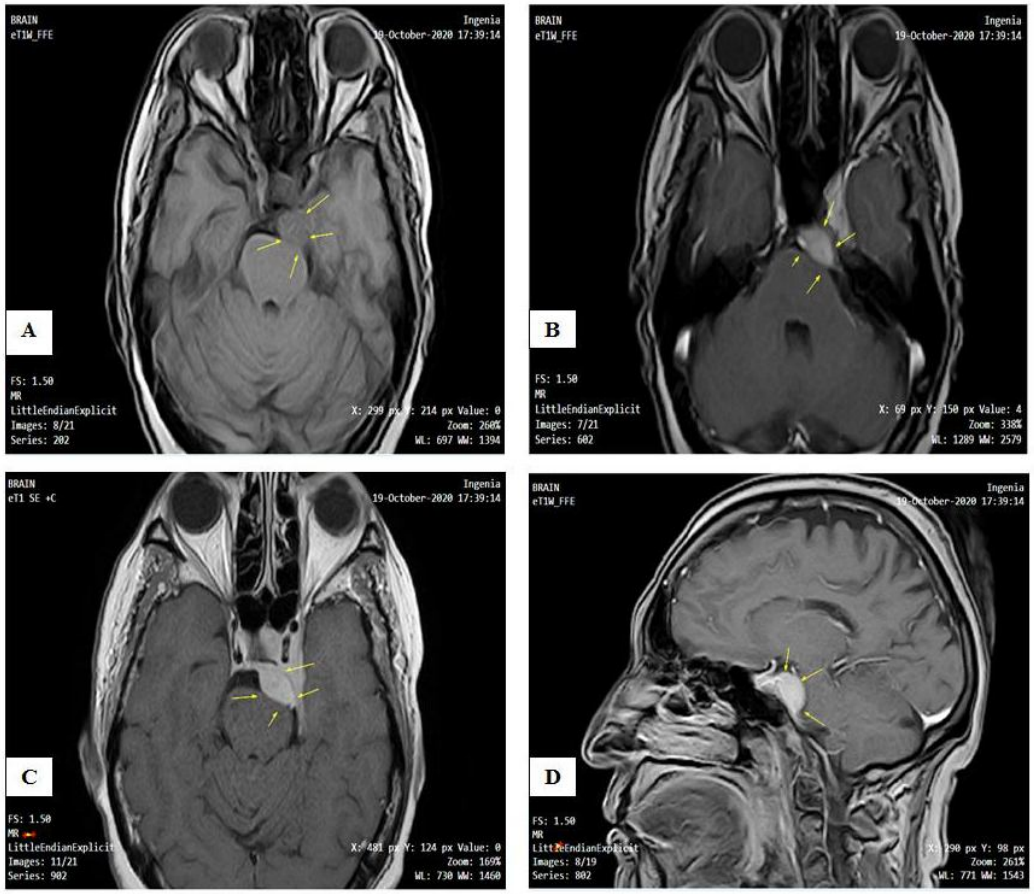

Fig. 1: Female patient 64 years old, presented by left sided trigeminal neuralgia. MRI brain revealed: (A) axial T1WI, (B)axial FLAIR WI and (C & D) axial and sagittal T1WI post contrast revealed a small well defined extra axial petrous apex space occupying lesion (Mass) seen in the left prepontine cistern and supra-sellar cistern measures about 2.1x1cm exhibits intermediate T1 and T2 signal intensities with intense homogeneous contrast enhancement with enhancing dural tail along the dorsum sellae. It exerts mild mass effect in the form of mild compression of the left side of the pons. It is more to be consistent with extra axial SOL (left petrous apex meningioma).

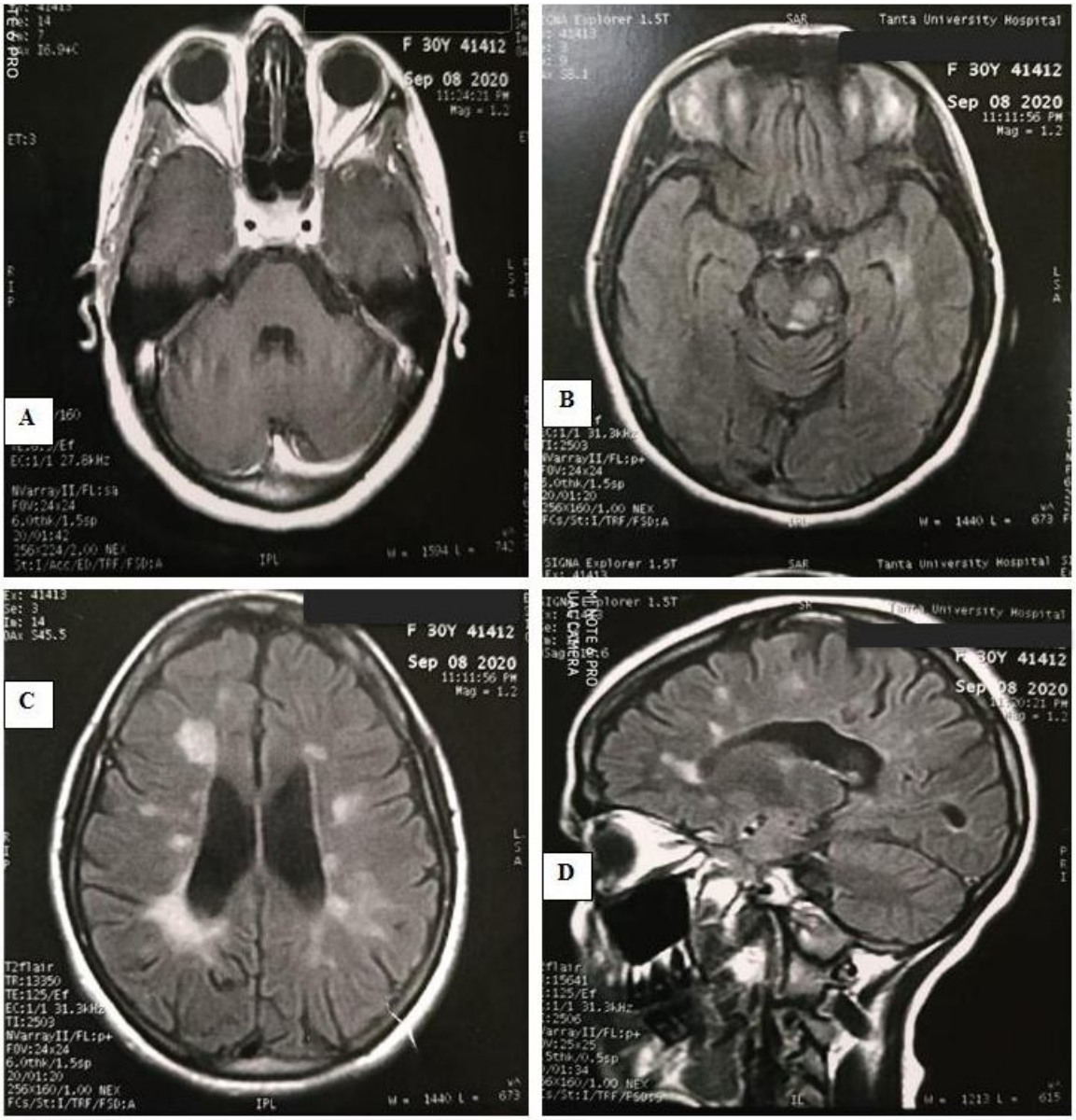

Fig. 2: Female patient 30 years old, presented by left sided trigeminal neuralgia. MRI brain revealed: (A) axial T1WI, (B,C,D) axial & sagittal FLAIR images revealed multiple variable sized patches of altered signal intensity in the form of bright T2 & FLAIR signal seen in white matter on both deep tempro-parietal region & both centrum semiovale oriented perpendicular to corpus callosum and calloso-septal space (dowsn fingers), left side of midbrain. Multiple sclerotic plaques in a known case of MS.

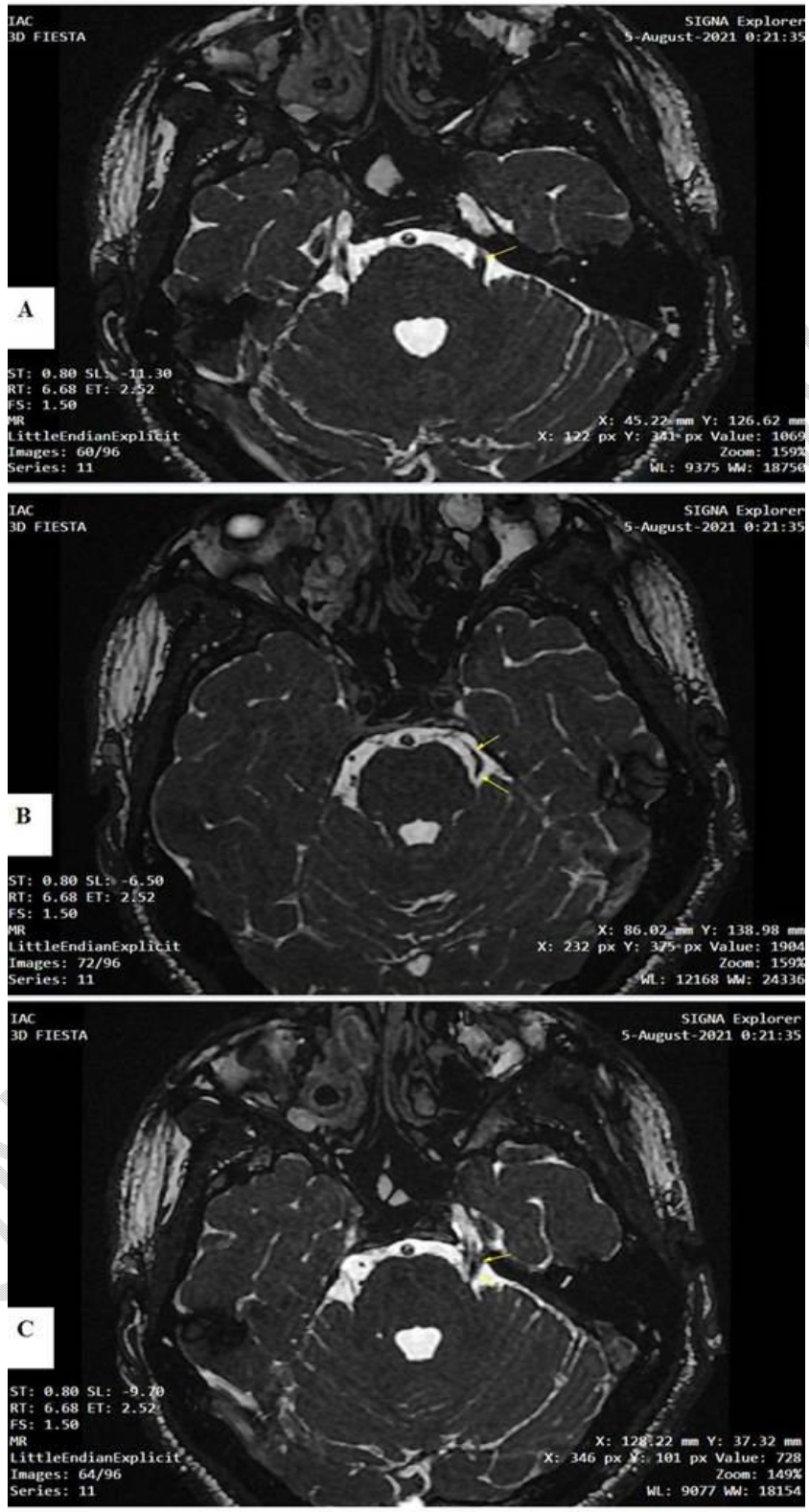

Fig. (3): Male patient 23 years old, presented by left sided trigeminal neuralgia. MRI brain revealed: (A,B,C) axial FIESTA images revealed a vascular loop,the left cerebellar artery, mildly deforming the root entery zone (REZ)of the cisternal segment of the left CN V. The finding consistent with left side vascular loop grade II.

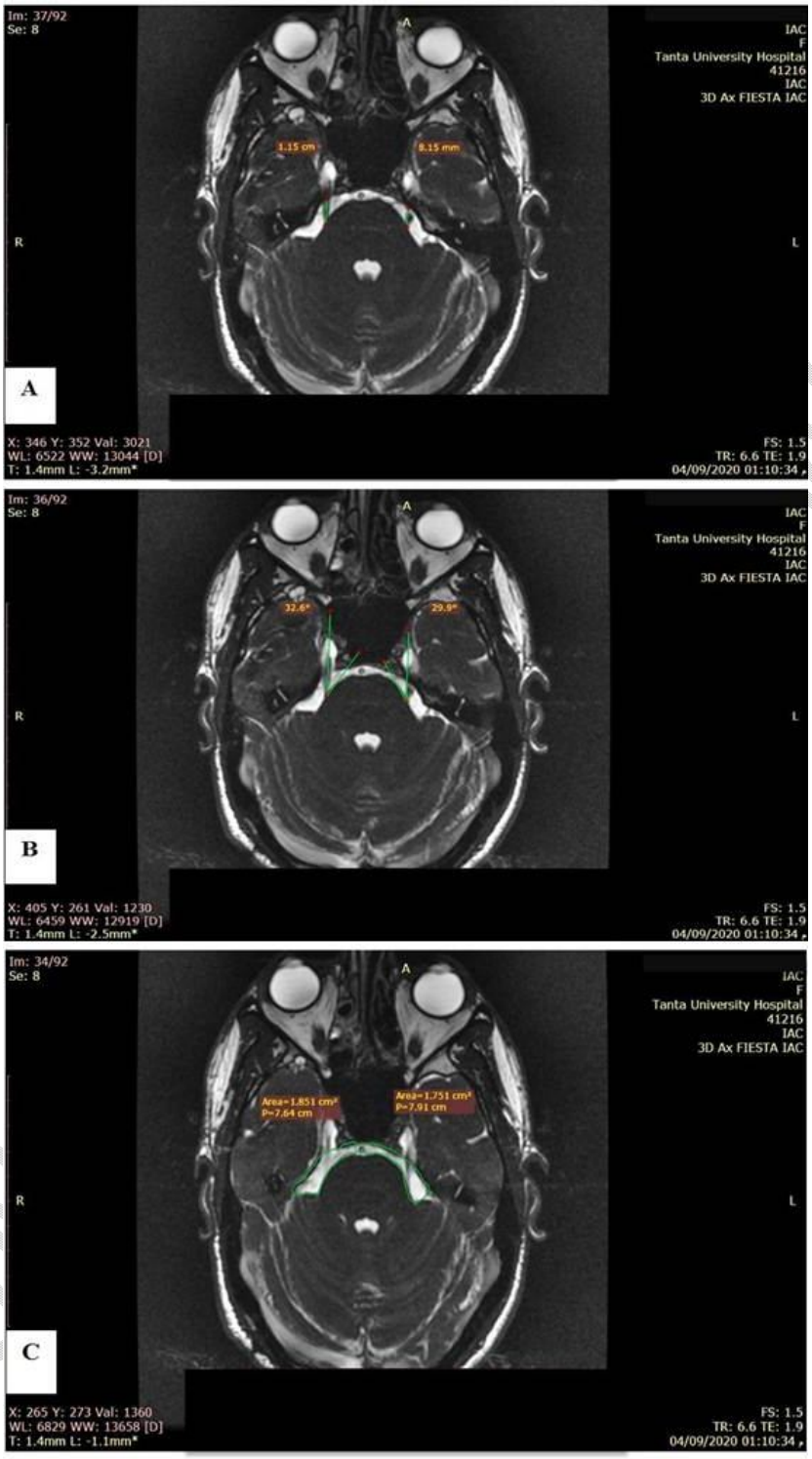

Fig. (4): Male patient 49 years old, presented by left sided trigeminal neuralgia. MRI brain revealed: (A, B & C) Axial FIESTA images revealed length of cisternal part of trigeminal nerve, trigeminal pontine angle and cross sectional area of CPA cistern respectively. Length of cisternal part of right trigeminal nerve (10mm) & length of cisternal part of left trigeminal nerve (8.15mm). Right trigeminal pontine angle measures about 32.6º & left trigeminal pontine angle measures about 29.9º. Cross sectional area of right CPA cistern measures about 1.85 cm^2 and left cross sectional area of CPA cistern measures about 1.75cm^2. All measures of the left side are less than those in right side. (Idiopathic case of left side trigeminal neuralgia).

Discussion:

Trigeminal nerve is the largest of all cranial nerves; its course can be divided into five segments: brainstem, cisternal, Meckel's cave, cavernous sinus and peripheral segments. It has extensive distribution in face and responsible for main sensory supply of the face. It can be involved by different benign and malignant neoplastic lesions, resulting in trigeminal neuralgia [(9)].

Different trials were made by clinicians to classify abnormal facial pains to provide a framework with which we can make an accurate diagnosis and to provide an adequate advice regarding treatment modalities and prognosis [(9)].

Trigeminal neuralgia is one of the most painful conditions of facial pain. It is characterized by brief electric shock-like pains, abrupt in onset and termination and limited to the distribution of one or more divisions of the trigeminal nerve. Trigeminal neuralgia can be diagnosed by history and clinical examination but radiographic imaging assessment is necessary to identify any intracranial pathology [(10)].

MRI is useful to visualize the entire course of the trigeminal nerve and to detect lesions since clinical findings in trigeminal neuralgia often do not allow accurate lesion localization[(11)].

The objective of our study was to assess value of magnetic resonance imaging in diagnosis of intracranial etiology of trigeminal neuralgia.

This prospective study involved 30 patients (14 males and 16 females) with paroxysmal facial pain with or without other neurological symptoms or signs who were referred from out clinics (neurosurgery and/or dental clinics) to Radiodiagnosis and Medical Imaging Department at Tanta University Hospital.

The patients of our study were presented with different causes of trigeminal neuralgia. Their ages were ranged from 5 years to 65 years mean age 46.23 ± 13.63 years.

The mean age was lower in a study done by **Geneidi et al., (2016) [(12)]** that included 45 patients (28 males & 17 females) with trigeminal pain with or without other associated neurologic symptoms and signs to assess cases of trigeminal pain by MRI to evaluate the underlying pathology and to correlate the imaging findings with the clinical data. The mean age at presentation of the study was 37.57 ± 11.8 years.

Our current study revealed, there was a predominance of left-sided trigeminal affection was presented in 14 patients (about 46.7% of cases) the right side was affected in 12 patients (about 40 %), bilateral affection was denoted in 4 patients (about 13.3%).

In our present study 24 patients (80%) were secondary to different pathologies. This is in accordance with **Rangaswamy et al., (2016) [(13)]** that included the clinical records and imaging studies of 75 patients who presented to the Department of Radio-diagnosis to study and classify brain magnetic resonance imaging findings in patients aged >18 years who presented with clinical symptoms of trigeminal neuralgia. They reported nearly the same percentage of cases secondary to different pathologies (76%).

Moreover, In a study by **Swetha et al., (2018) [(14)]** that included 50 patients in the age group between 30-65 years who came to the outpatient Department with trigeminal pain. MRI of the brain with dedicated trigeminal nerve protocol was conducted to correlate MRI findings with clinical data. The study reported that 28 (56%) patients had an underlying pathology.

Out of 24 patients of our study who had secondary TN; 9 cases with tumors (30%); 6 cases with vascular loop (20%) and 4 cases with multiple sclerosis (13.3%).

This is in accordance with a study by **Liu et al., (2013) [(15)]** that included 16 patients with TN and 6 healthy controls who were imaged with a 3.0 T system with three-dimension time-of-flight magnetic resonance angiography to investigate microstructural tissue changes of trigeminal nerve in patients with unilateral trigeminal neuralgia. They reported that

demyelination without significant axonal injury is the essential pathological basis of the affected trigeminal nerve.

Also, with a study by **Swetha et al., (2018)** [(14)] The study reported that 9 (18%) patients had tumors, 12 (24%) patients had vascular anomalies including anatomical variants, vascular loops, and vascular malformations, 6 (12%) patients had pain due to previous trigeminal injury.

The cause of relatively higher ratio of trigeminal neuralgia secondary to CPA lesions in our study compared to the other studies may be attributed to the immediate referral for imaging by the clinicians in our institute for any case presented with associated symptom at the same side of trigeminal neuralgia.

The CPA lesions in our study included 8 cases out of the 30 patients, they are as the following: 3 cases with acoustic schwannomas, 2 cases with trigeminal schwannomas, 2 cases with meningiomas and one case epidermoid cyst.

That was relatively similar to **Rangaswamy et al., (2016)** [(13)] who reported two cases with trigeminal schwannomas, two cases with vestibular schwannomas, one case with epidermoid cyst and one case with arachnoid cyst.

Demyelinating plaques of multiple sclerosis involving intra-pontine trigeminal nuclei was also reported as common MRI finding in patient with trigeminal neuralgia associating MS[(16)].

In the present study four cases, out of 30 cases (13.3%) showed MS plaques in pons, two were presented by isolated unilateral trigeminal neuralgia and one was presented by bilateral trigeminal neuralgia.

Recommendation:

All cases found normal by MRI need FIESTA sequence to identify any idiopathic cases of trigeminal neuralgia by measurements of the following:

1. Trigeminal pontine angle.
2. Length of cisternal part of Trigeminal nerve.
3. Cross sectional area of CPA cistern.

Limitations:

In this study, there were a few limitations as, the small number of cases, no post-surgical correlation of neurovascular compression and no post-operative follow-up of pain relief in patients who underwent surgery. Many clinicians used to consider cases of trigeminal neuralgia of idiopathic type and usually they start conservative treatment without referral for imaging.

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