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MRI Findings in Trigeminal Neuralgia Without Apparent Vascular Abnormality

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Abstract

Background: Trigeminal neuralgia [TN] is a challenging health problem. It is usually ascribed to vascular abnormalities. However, a significant proportion does not show apparent abnormality in the vascular system. Thus, its diagnosis is a challenge. It is suggested that magnetic resonance imaging [MRI] could play a role in diagnosis of such cases.

Aim of the Work: This study was designed to evaluate the MRI finding in different causes of trigeminal neuralgia without apparent vascular abnormality.

Patients and Methods: This is a prospective study, including 40 cases presented clinically with TN. All were submitted to full clinical evaluation [history taking, clinical examination and laboratory investigations]. Then, MRI was performed for all patients and different measures were recorded and the diagnosis was determined.

Results: Most lesions were unilateral [47.5% on the left and 40.0% on the right]. Tumors were the most common [30.0%] followed by the vascular and idiopathic categories [each 22.5%]. The types of TN were vascular compression [22.5%], secondary types [55.0%] and idiopathic [22.5%]. The mean pontine angle was significantly lower in the affected than the non-affected side [29.3 ± 6.7° vs 37.01±7.6°]. The diagnostic performance of trigeminal pontine angle, length of cisternal segment and cross section area of CPA showed that the AUC are 0.8 and above. The best was registered for trigeminal pontine angle [0.83] followed by length of internal segment [0.81]. The sensitivity was 88.9%, 88.9% and 77.8% for trigeminal pontine angle, length of cisternal segment and cross section area of CPA, respectively.

Conclusion: MRI is an excellent imaging modality for diagnosing the etiology TN. FIESTA MRI act as adjuvant to increase diagnostic accuracy and determine specific etiology of TN through measurement of trigeminal pontine angle, length of cisternal segment of nerve and cross-sectional area of CPA, especially in idiopathic cases.

Keywords: Neuralgia; Trigeminal Nerve; Magnetic Resonance Imaging; FIESTA.

INTRODUCTION

Trigeminal neuralgia [TN] is clinically defined as paroxysmal, stereotyped attacks of intense, sharp, superficial, or stabbing pain in the distribution of one or more branches of the trigeminal nerve [1].

There are primary and secondary forms of trigeminal neuralgia; Primary for can be classified as classical and idiopathic types. Classical trigeminal neuralgia develops without apparent cause other than compression of the nerve root with nerve morphological changes [not simply contact]. It may be purely paroxysmal or present with concomitant continuous pain. Idiopathic trigeminal neuralgia is diagnosed in the absence of abnormal electrophysiological or magnetic resonance imaging [MRI] abnormalities. Although there may be neurovascular contact, no nerve morphological or nerve compression changes are evident. Idiopathic trigeminal neuralgia may be purely paroxysmal or accompanied by concomitant continuous pain. Secondary trigeminal neuralgia occurs in the presence of an underlying pathology such as a space-occupying lesion, multiple sclerosis, tumor in the cerebellopontine angle, or arteriovenous malformation [2].

The pain of TN tends to occur in paroxysms, and its maximal intensity is 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 trigeminal neuralgia may have continuous dull pain that is present between paroxysms of pain. Trigeminal neuralgia is typically unilateral. Occasionally the pain is bilateral [3].

For all patients with suspected trigeminal neuralgia, neuroimaging is recommended to help distinguish classic from secondary and idiopathic forms. 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 [4].

Many MRI findings are expected to be seen in various types of trigeminal neuralgia. In classic trigeminal neuralgia MRI [using high-resolution T2WI thin cuts sequences and MRA] will show vascular loop compressing one of the branches of trigeminal nerve. Where in secondary form, MRI will show the primary neurologic condition that is the source of the neuralgia. A tumor at the cerebellopontine angle or multiple sclerosis [the preferred sequences are FLAIR and T2WI, but delayed post contrast study may give advantage of detecting active disease] is the primary cause of TN in 15% of patients. MRI with contrast is mandatory in the diagnosis of space-occupying lesions and demyelination of their extensions and effects [5].

Most tumors that lead to TN are benign, and they often compress the root close to where it enters the pons. There is speculation that compression causes paroxysmal ectopic discharges and localized demyelination. Axonal degeneration is more likely to be caused by malignant tumors infiltrating the nerve. Malignant tumors may induce trigeminal pain; however, it often differs from pain bouts like those in trigeminal neuralgia [6].

The current work was designed to evaluate the MRI finding in different causes of trigeminal neuralgia without apparent vascular abnormality

PATIENTS AND METHODS

This was a prospective study, consisting of 40 cases who were presented clinically with TN, referred from the outpatient clinics [neurosurgery and/or dental clinics] to Radiodiagnosis and Medical Imaging Department at Al-Azhar University Hospital in New Damietta for MR examination. Males represent 19 and females 21 of the study group. Age study ranges from 6 to 65 years with mean of 46.2 ± 13.6 years, study lasts for 2 years' duration

Inclusion criteria: We included any patient [male or female] with clinically suspected paroxysmal facial pain with or without other neurological symptoms or signs.

On the other side, exclusion criteria included apparent vascular anomaly [e.g., saccular aneurysm, AV-malformation, vertebra-basilar dolichoectasis and persistent trigeminal artery]; dental and psychological causes, any surgical intervention, absolute or relative contraindications to MRI. Absolute contraindications included cardiac pacemakers or metallic foreign body in the eye. However, the relative contraindication included movement disorder that cannot be controlled or claustrophobia.

Patient evaluation: all patients were evaluated in classical manner [full history taking with collection of demographic data, standard clinical assessment with stress on symptoms and signs suggestive of TN [e.g., previous three attacks of unilateral facial pain with the following specific characters [Occurring in one or more divisions of the trigeminal nerve, with no radiation beyond the trigeminal distribution]. Pain with at least, recurring in paroxysmal attacks lasting from a fraction of second to 2 minutes or severe intensity or electric shock-like, shooting, stabbing, or sharp in quality or precipitated by innocuous stimuli to the affected side of the face. In addition, full neurological examination was performed by the neurologist to address all aspects of the nervous system. Finally, and before MRI investigation, routine laboratory investigations were performed with stress on serum creatinine levels.

MRI examination: The procedure was done using 1.5T MRI scanner [PHILIPS Achieva MRI 4 channels].

MRI technique: All patients were assessed using 3D FIESTA sequences centered on the pons, as well as a standard brain protocol including axial T1, T2, FLAIR and GRE sequences to exclude other pathologies that could cause TN. Post-contrast T1-weighted sequences were also performed on conventional transverse, sagittal and coronal sections in cases with space occupying lesions. The contrast media was injected intravenously with gadolinium-diethylenetriamine Penta acetic acid Gd-DTPD [Magnevist®, Schering, Berlin, Germany] at a dose of 0.1 mmol/kg.

MRI sequences:

3D FIESTA: Sequence [TR, 5.5 ms; TE, 2.1 ms; flip angle, 60°; matrix, 360 x 360; section thickness, 0.6 mm; acquisition time, 4 minutes 10 seconds]. Reconstruction images were done in sagittal and coronal planes. It increases the contrast between CSF and

tissues, allowing a fine anatomical analysis of the vasculo-nervous structures of the cerebellopontine cistern.

T1WI: Sequence [TR 600 msec, TE 10 msec]; whole brain axial, sagittal and coronal. It screens brain anatomically.

T2WI: Sequence [TR 4320 msec, TE 107 msec.]; axial, sagittal and coronal with special emphasis on posterior fossa [medulla tothe upper pons] with thin slices. It assesses the trigeminal nerves from their origin at the mid pons anteriorly, through the prepontine cistern until the Meckel's cave [trigeminal ganglion].

Fluid-Attenuated Inversion Recovery [FLAIR] images: Sequence [TR 7000-9000 msec, TE 110 msec]; whole brain axial and coronal images. They assess white matter as signal abnormality. We add sagittal sequence in cases of multiple sclerosis.

T1 C+[Gd] [axial and coronal]: It is only done in some selected cases including space-occupying lesions.

Diffusion weighted images [DWI]: Sequence with ADC map [TR 7000-9000 msec, TE 110 msec and b value 500-1000]; whole brain axial. It is done in post-stroke cases.

Imaging analysis: Images were transferred to a workstation with GE ready view software for post-processing and analysis.

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; sharp trigeminal-pontine angle increased the chance of neurovascular compression on the medial side of the trigeminal nerve. In addition, measuring the cross-sectional area of the CPA cistern and trigeminal nerve cisternal length bilaterally in patients with primary TN. The cisternal segment of the trigeminal nerve emerges from the lateral pons at the root entry zone [REZ] and passes through an opening in the dura matter [the porus trigeminus] to the Meckel cave.

In short, the axial section passing through the trigeminal nerve REZ was identified and selected in all patients. It gives true anatomical borders of the CPA cistern. We defined the cerebellar flocculus as the posterior limit and the basilar artery in the prepontine cistern as the anterior limit. If the basilar artery was displaced the midline was considered the anterior limit. The cross-sectional area of the CPA cistern was measured bilaterally. Trigeminal nerve cisternal length was measured in the same axial images from the REZ to Mackel's cave.

Smaller CPA cisterns and short cisternal trigeminal nerves impact on the pathogenesis of essential TN by facilitating the neurovascular conflict, especially in younger patients. Trigeminal nerve cisternal measurement provided an easy and direct estimation of the CPA area.

Image interpretation: Evaluation of the trigeminal-pontine angle in individuals with idiopathic TN. Measuring the trigeminal nerve's cisternal length and the cross-sectional area of the CPA cistern bilaterally in individuals with primary TN. Smaller CPA cisterns and short cisternal trigeminal nerves impact the pathogenesis of essential TN by facilitating the neurovascular conflict, particularly in younger individuals, smaller CPA cisterns and short cisternal trigeminal nerves have an impact on the etiology of essential TN by promoting the neurovascular conflict.

Statistical analysis: The collected data was coded and fed to software computer package for analysis. The continuous normally distributed data were summarized by their means and standard deviation, while categorical data were summarized by relative frequencies and percentages. Values between normal and affected sides were compared by independent samples student "t" test. In addition, the receiver operation characteristic [ROC] curve was built, and the diagnostic accuracy of different measurements were determined. The area under the curve [AUC] above 0.75 reflected the good performance of the test in detection of TN etiology. P value < 0.05 was set as the marginal significance value. All tests were performed by the statistical package for social Science [SPSS Version 16].

RESULTS

This is a prospective study, consisting of 40 cases who presented clinically with TN, referred from outpatient clinics [neurosurgery and/or dental clinics] to Radiodiagnosis and Medical Imaging Department at Al-Azhar University Hospital in New Damietta for MR examination. Males were 19 representing 47.5% and females were 21 representing 52.5% of the study group. Age study ranges from 6 to 65 years; the mean values were 46.2 ± 13.6 years [Data not tabulated].

Table [1] showed characterization of trigeminal neuralgia of study subjects. Most lesions were unilateral [47.5% on the left and 40.0% on the right]. The bilateral lessons were reported in 12.5%. In addition, the diagnosis categorization showed that tumors were the commonest [30.0%] followed by the vascular and idiopathic categories [each 22.5%]. On the other hand, multiple sclerosis and post-stroke were the lowest diagnosis [each 12.5%]. The types of TN were classical types [vascular compression] [22.5%], where secondary types were 55.0%] and the idiopathic were 22.5%.

The classification of secondary types according to etiology were detailed in table [2]. Benign tumors were 12/22 [54.5%]; malignant glioma was reported in one patient, while postinfarction, cavernous hemangioma, and multiple sclerosis were reported in 4, 1 and 5 patients, respectively.

The segment of the lesion was in pons and cisternae in 12 and 19 cases respectively [Table 3]. The mean angle of pontine angle was significantly lower in the affected than the non-affected side [29.3 ± 6.7° vs 37.01 ± 7.6° respectively], $p < 0.05$ [Table 4].

Table [5] showed that there is a wide difference in length of cisternal segment of trigeminal nerve [mm] between affected and unaffected side in cases number 1, 6, and 7 [8.4 mm, 8.4 mm, and 7.6 mm, respectively], while there is a narrow difference in 3 cases [6.8 mm, 9.2 mm, and 8.3 mm, respectively], and there is statistically significant [p-value = 0.035] decreased length of Cisternal segment of trigeminal nerve in affected side [8.03 ± 0.68 mm] when compared with unaffected side [9.6 ± 1.93 mm].

Table [6] showed that there is a wide difference in cross-sectional area of CPA between affected and unaffected side in 3 cases [0.9 cm^2, 0.7 cm^2, and 0.5 cm^2, respectively], while there is a narrow difference in 3 cases [0.1, cm^2, 0.1 cm^2, and 0.3 cm^2, respectively], and there is statistically significant [p-value = 0.019]

decreased cross sectional area of CPA in affected side [1.34 ± 0.19 cm^2] when compared with unaffected side [1.7 ± 0.35 cm^2].

The diagnostic performance of trigeminal pontine angle, length of cisternal segment and cross section area of CPA showed good performance, where AUC are 0.8 and above. The best was registered for trigeminal pontine angle [0.83] followed by length of internal segment [0.81]. The sensitivity was 88.9%, 88.9% and 77.8% for trigeminal pontine angle, length of cisternal segment and cross section area of CPA, respectively [Table 7, figures 1, 2, 3].

Figures [4 through 8] presented brain MRI findings of five cases

Table [1]: Characterization of TN in 40 patients of our study

			N=40	%
Lateralization	Left		19	47.5
	Right		16	40.0
	Bilateral		5	12.5
MRI etiological classification [Category of diagnosis]	Multiple sclerosis		5	12.5
	Post-stroke		5	12.5
	Tumor		12	30.0]
	Vascular		9	22.5
	Idiopathic		9	22.5
MRI etiological classification [types of TN]	Classical type [vascular compression]		9	22.5%
	Secondary type	Tumors	12	30.0%
		MS	5	12.5%
		Infarction	4	10.0%
		Vascular malformation	1	2.5%
		Total	22	55.0%
	Idiopathic		9	22.5%

Table [2]: TN classifications of secondary type according to etiology

Lesion	No	%
Tumors		
Benign		12/22 [54.5%]
Trigeminal Shwanoma	4	
Acoustic Shwanoma	3	
Epidermoid cyst	1	
Meningioma	3	
Malignant		
Glioma	1	
Pontine-infarction	4	4/22 [18.18%]
Cavernous haemangioma	1	1/22 [4.5%]
Multiple sclerosis	5	5/22 [22.7%]
Total	22	100

Table [3]: Description of segment of lesions by MRI in the study group [n = 31]

Segment of lesions	No	%
Brainstem		
Midbrain	0	0
Pons	12	38.7
Medulla oblongata	0	0
Cisternal	19	61.3
Total	31	100

Table [4]: Trigeminal pontine angle measurement in affected and unaffected side in idiopathic cases [n=9]

Case No.	Trigeminal pontine angle degree		Difference
	Affected side	Unaffected side	
1 2	34° 34°	35° 37°	1° 3°
3	27.3°	53.6°	26.3°
4	29.2°	40.7°	11.5°
5	32.9°	34.6°	1.7°
6	26.6°	38.7°	12.1°
7	14.4°	28°	13.6°
8	27.5°	27.5°	0°
9	37.5°	38°	0.5°
Mean ± SD	29.3 ± 6.7°	37.01 ± 7.6°	
p-value	0.037 [S]		

Table [5]: Length of cisternal segment of trigeminal nerve [mm] in affected and unaffected side in idiopathic cases

Case No.	Length of cisternal segment of trigeminal nerve [mm]		Difference
	Affected side	Unaffected side	
1 2	8.4 8	10.2 8.2	1.8 0.2
3	6.8	8.4	1.6
4	9.2	10.7	1.5
5	8.3	9.7	1.4
6	8.4	14	5.6
7 8 9	7.6 7.5 8.1	9.2 7.5 8.6	1.6 0 0.5
Mean ± SD	8.03 ± 0.68	9.6 ± 1.93	
p-value	0.035 [S]		

Table [6]: Cross-sectional area of CPA [cm^2] in affected and unaffected side in idiopathic cases.

Case No.	Cross-sectional area of CPA [cm^2]		Difference
	Affected side	Unaffected side	
1	1.7	1.8	0.1
2	1.2	2.1	0.9
3	1.5	2.2	0.7
4	1.3	1.92	0.08
5	1.4	1.5	0.1
6	1.4	1.9	0.5
7	1.2	1.2	0
8	1.03	1.3	0.3
9	1.4	1.42	0.02
Mean ±SD	1.34 ± 0.19	1.7 ± 0.35	
p-value	0.019 [S]		

Table [7]: Diagnostic performance of Trigeminal pontine angle in discrimination of affected side.

	Cut off	AUC	Sen.	Spec.	PPV	NPV	p-value
Trigeminal pontine angle in discrimination of affected side	≤ 34	0.83	88.9%	77.8%	80%	87.5%	0.001
Length of cisternal segment of trigeminal nerve in discrimination of affected side	≤ 8.4	0.81	88.9%	66.7%	72.7%	85.7%	0.003
Cross-sectional area of CPA in discrimination of affected side	≤ 1.4	0.8	77.8%	77.8%	77.8%	77.8%	0.006

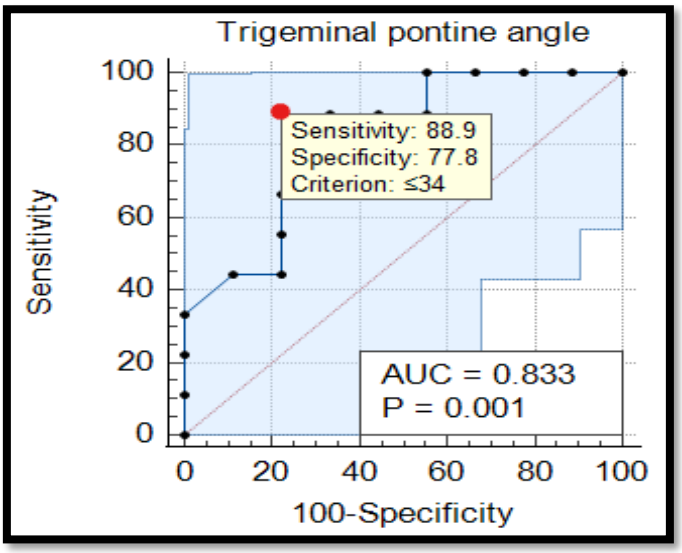


Figure [1]: ROC curve Trigeminal pontine angle in discrimination of affected side.

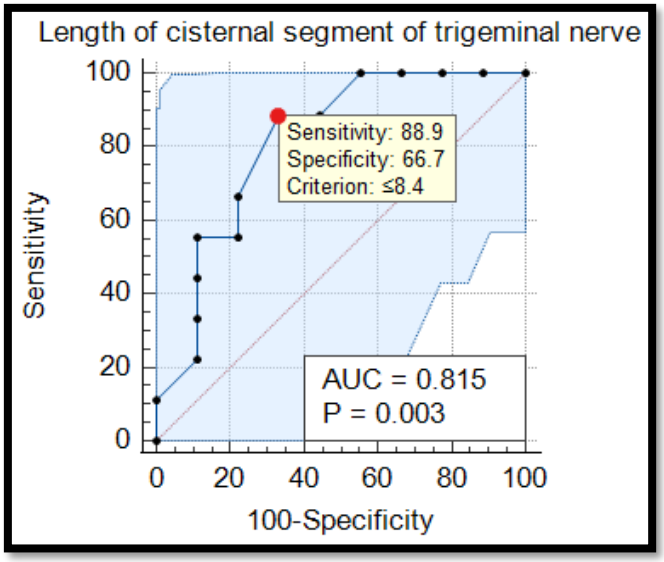


Figure [2]: ROC curve Length of cisternal segment of trigeminal nerve in discrimination of affected side.

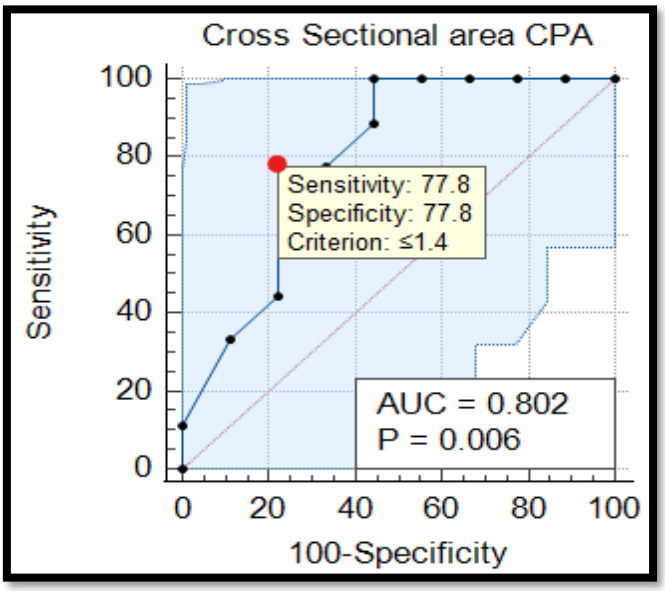


Figure [3]: ROC curve Cross-sectional area of CPA in discrimination of affected side.

Case 1:

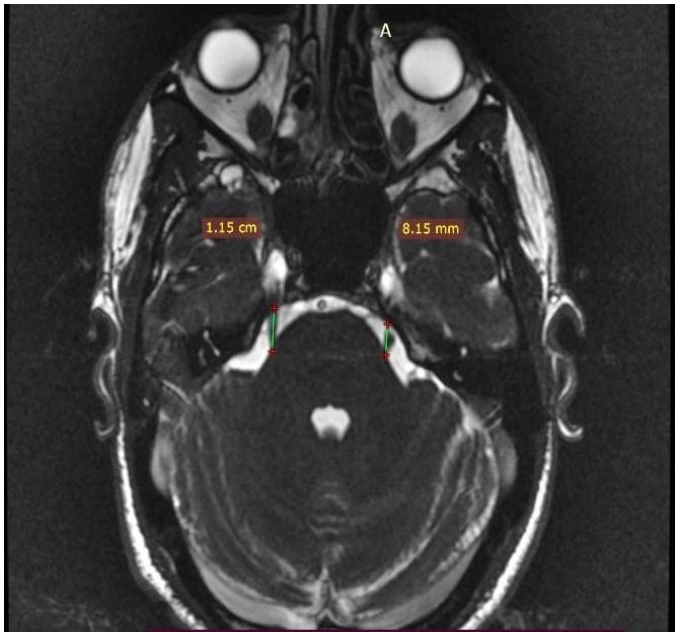
Clinical history: Male patient 49 years old, presented by left sided trigeminal neuralgia. MRI brain of the patient was presented in figure [4 A, B and C]. It showed the following:

A- Axial FIESTA images show length of cisternal part of trigeminal nerve, At the right side measured about 10 mm, at left side measured about 8.15 mm.

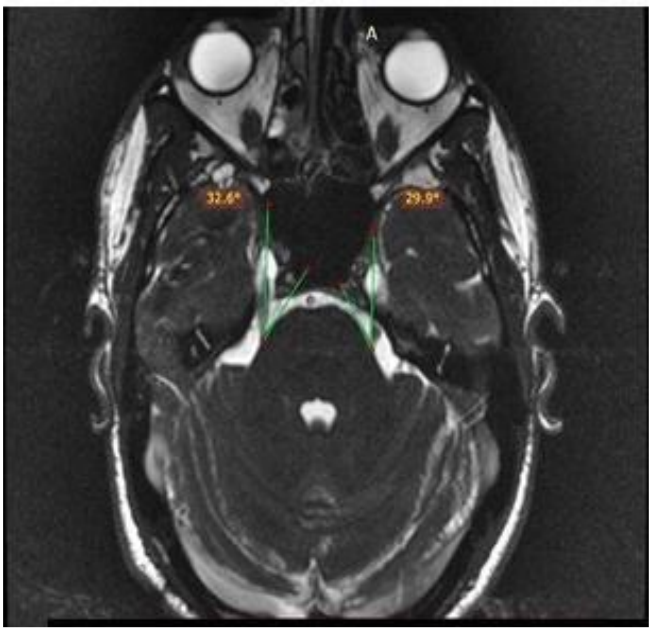
B- Axial FIESTA images show Right trigeminal pontine angle measures about 32.6º & left trigeminal pontine angle measures about 29.9º.

C- Axial FIESTA images show Cross sectional area of right CPA cistern measures about 1.85 cm2 and left cross sectional area of CPA cistern measures about 1.75cm^2.

Diagnosis: All measures on the left side are less than those on the right side. [Idiopathic case of left side trigeminal neuralgia].



A



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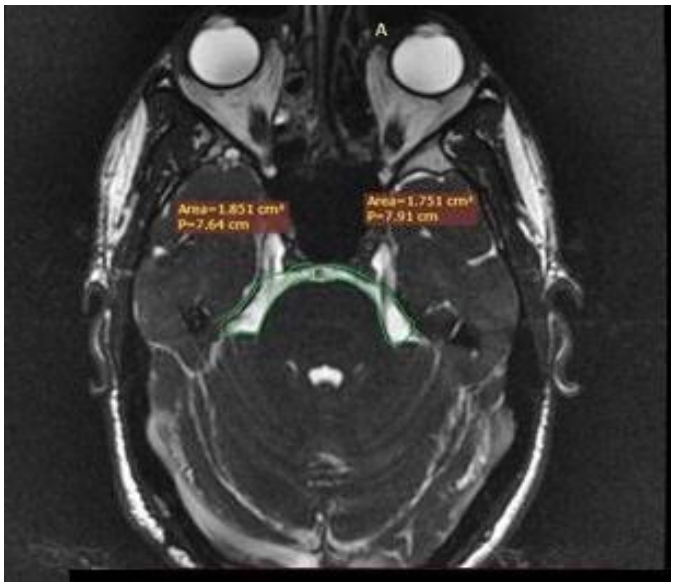


C

Figure [4]: MRI brain of case number 1.

Case 2

Clinical history: Female patient 36 years old, presented by right sided trigeminal neuralgia.

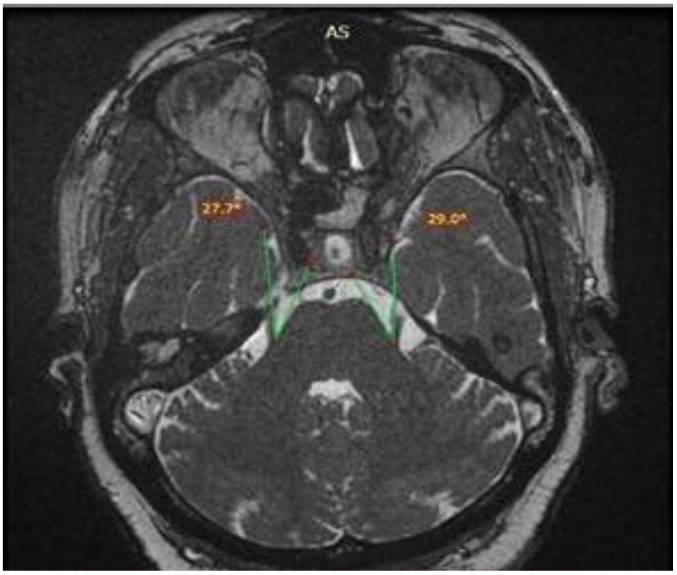
Figure. [5] [A, B and C.]: MRI brain of the patient and revealed the following:

[A] Axial FIESTA images show length of cisternal part of trigeminal nerve, Length of cisternal part of right trigeminal nerve [12.3mm] and length of cisternal part of left trigeminal nerve [15.5mm]

[B] Axial FIESTA images show Right trigeminal pontine angle measures about 27.7º & left trigeminal pontine angle measures about 29º & left trigeminal pontine angle measures about 29º.

[C] Axial FIESTA images show Cross sectional area of right CPA cistern measures about 1.53 cm2 and left cross sectional area of CPA cistern measures about 2.0cm2.

Diagnosis: All measures of the right side are less than those on the left side. [idiopathic case of right trigeminal neuralgia].



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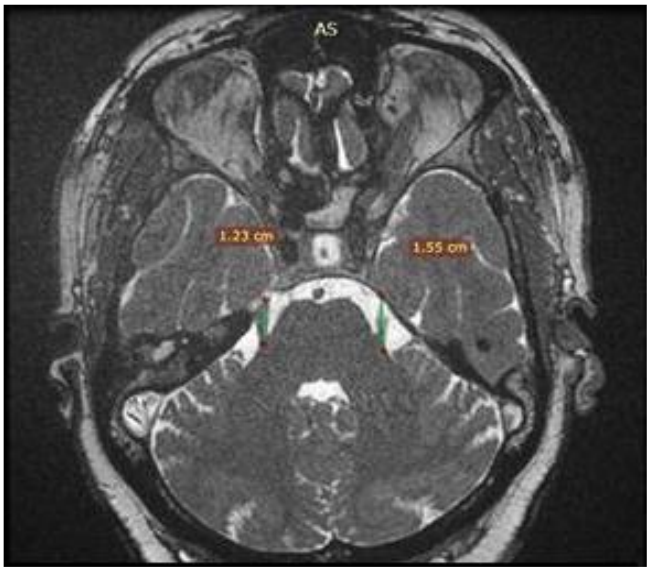

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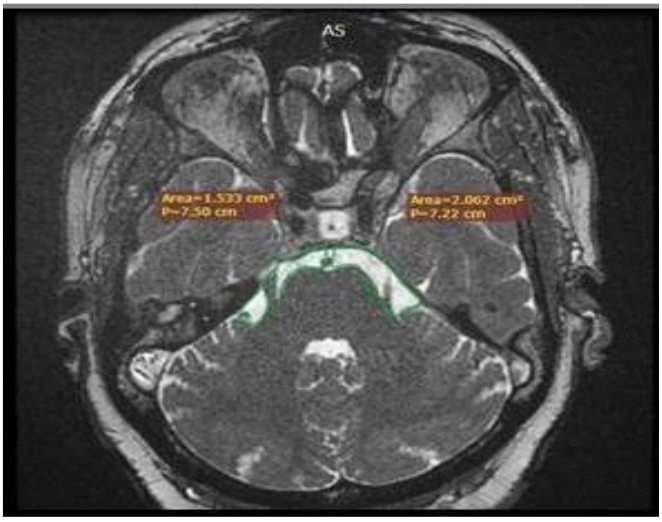

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Figure [5]: ***MRI brain*** of the second case

Case 3

A female patient aged 43 years old with left side trigeminal neuralgia.

Figure [6] [A, B, C, D, E and F]: MRI brain revealed:

[A] Axial non contrast T1W image, showing a large lobulated extra axial mass at the left cerebellopontine angle with low signal intensity and exerting mass effect on the brainstem.

[B] Axial FLAIR image, showing that the mass displays dirty CSF signal.

[C] Axial DW image, showing light bulb bright signal of the mass [restricted diffusion].

[D] Axial CISS image, showing high signal intensity of the extra axial mass, which is seen encasing the left trigeminal nerve [red arrow].

[E&F] Axial and coronal post contrast T1W images, showing no enhancement of the left CPA mass matching with epidermoid cyst.

Diagnosis: Left cerebellopontine angle epidermoid cyst.

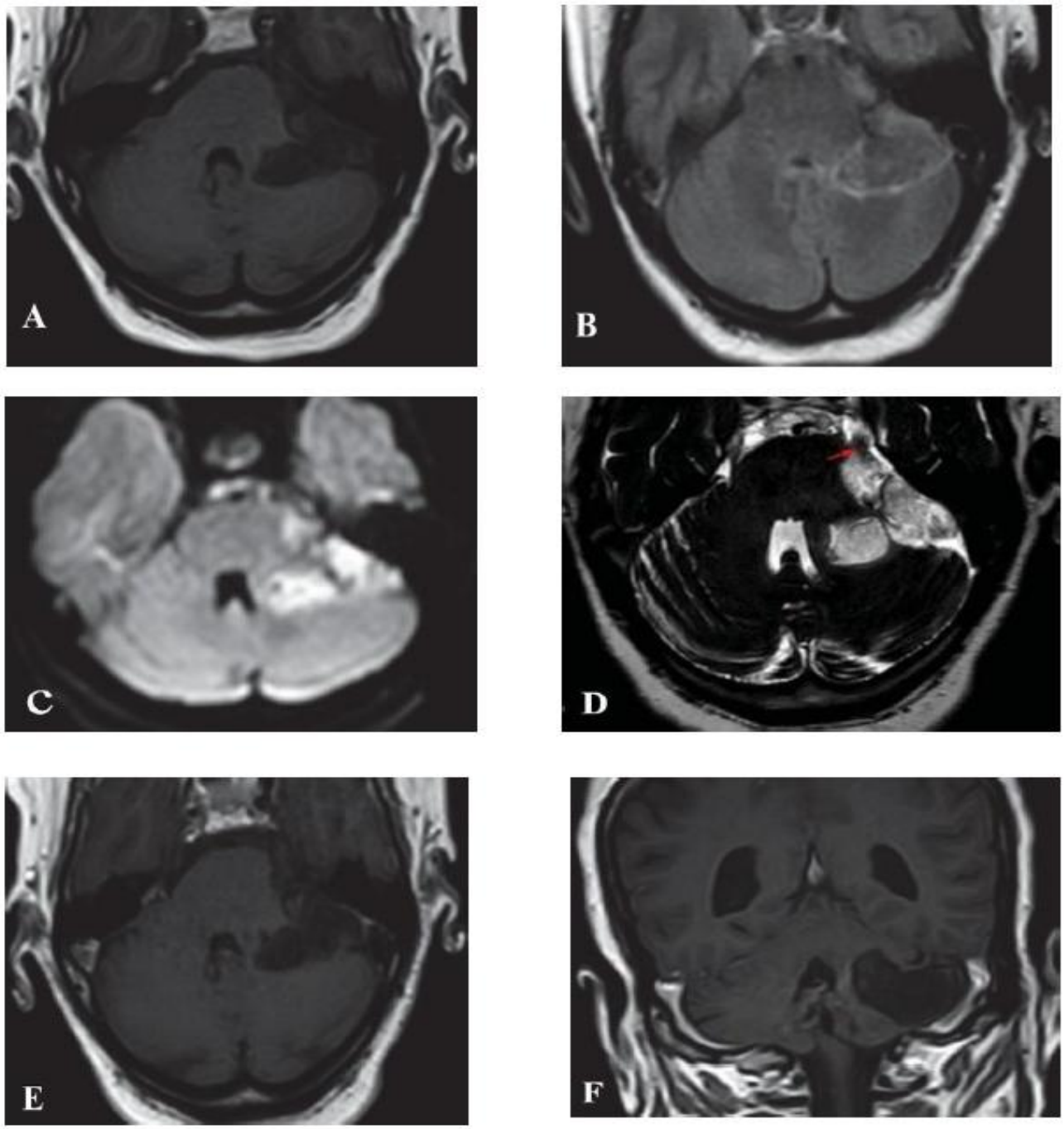

Figure [6]: MRI brain of case no 3

Case 4

A female patient aged 43 years old with right side trigeminal neuralgia and right-side facial palsy.

Figure [7] [A, B, C, D, E and F]: MRI brain revealed:

[A] Axial non contrast T1W image, [B] Axial T2W image, showing right-sided extra axial Dural based CPA lesion displaying intermediate signal intensity in both T1W and T2W images with mass effect on the right side of the pons.

[C & D] Axial CISS images, showing that the lesion is compressing and displacing the right trigeminal nerve downward [red arrow]. Note the normal anatomical site of left trigeminal nerve [blue arrow].

[E&F] Axial and coronal post contrast T1W images, showing homogeneous enhancement of the Dural based lesion, Imaging features are coping with meningioma.

Diagnosis: Right cerebellopontine angle meningioma.

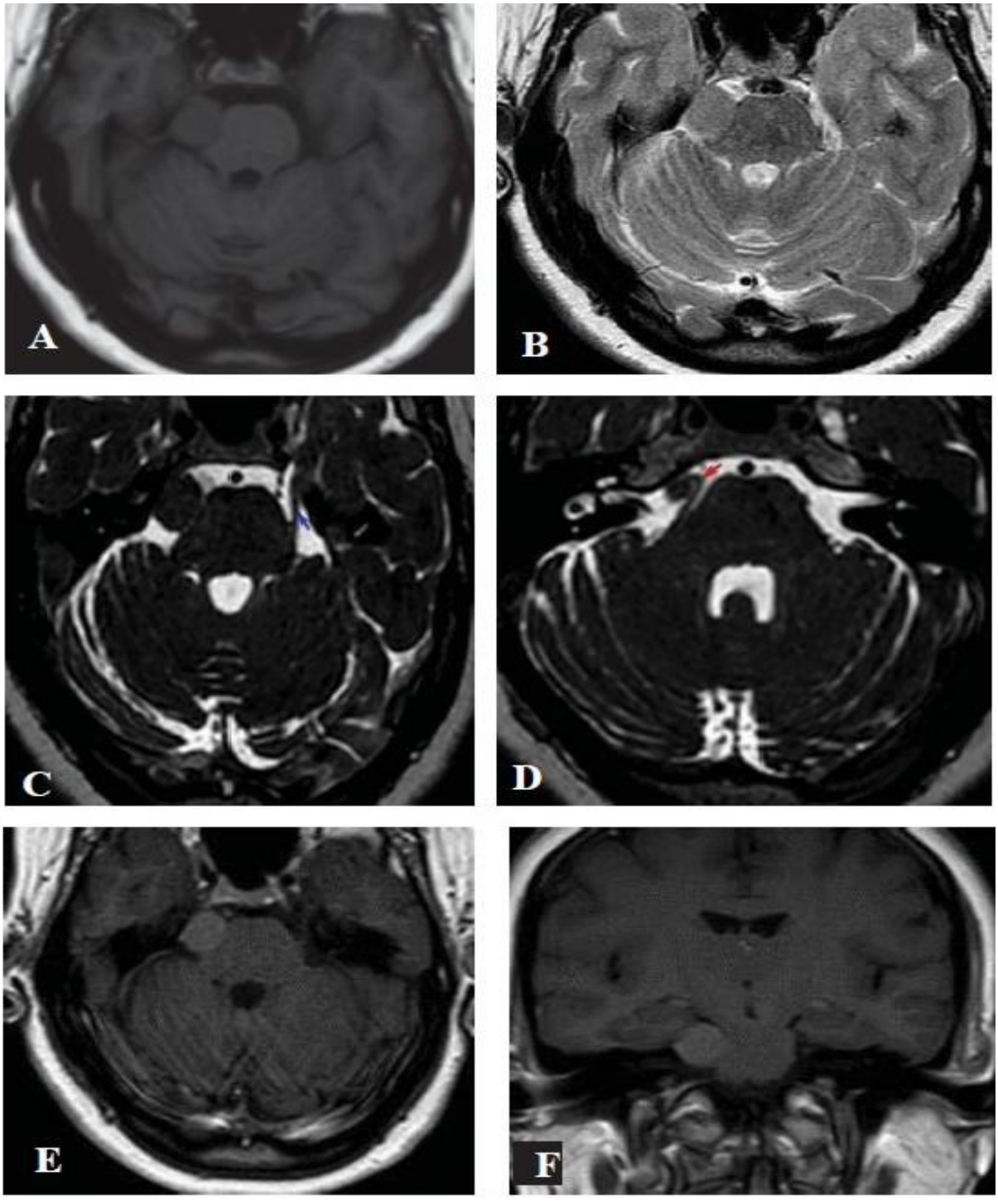

Figure [7]: MRI brain of case no 4.

Case 5

Male patient 65 years old, presented by acute right sided trigeminal neuralgia.

Finding:

Figure [8] [A, B, C and D]: MRI brain revealed:

[A] axial T1WI: Showing tiny wedge-shaped lesion at right pontine base seen iso to intermediate SI.

[B, C] axial T2WI and axial FLAIR: the lesion displacing HIGH signal intensities.

[D] axial DWI The lesion revealed restricted DWI

Diagnosis: consistent with acute pontine infarction.

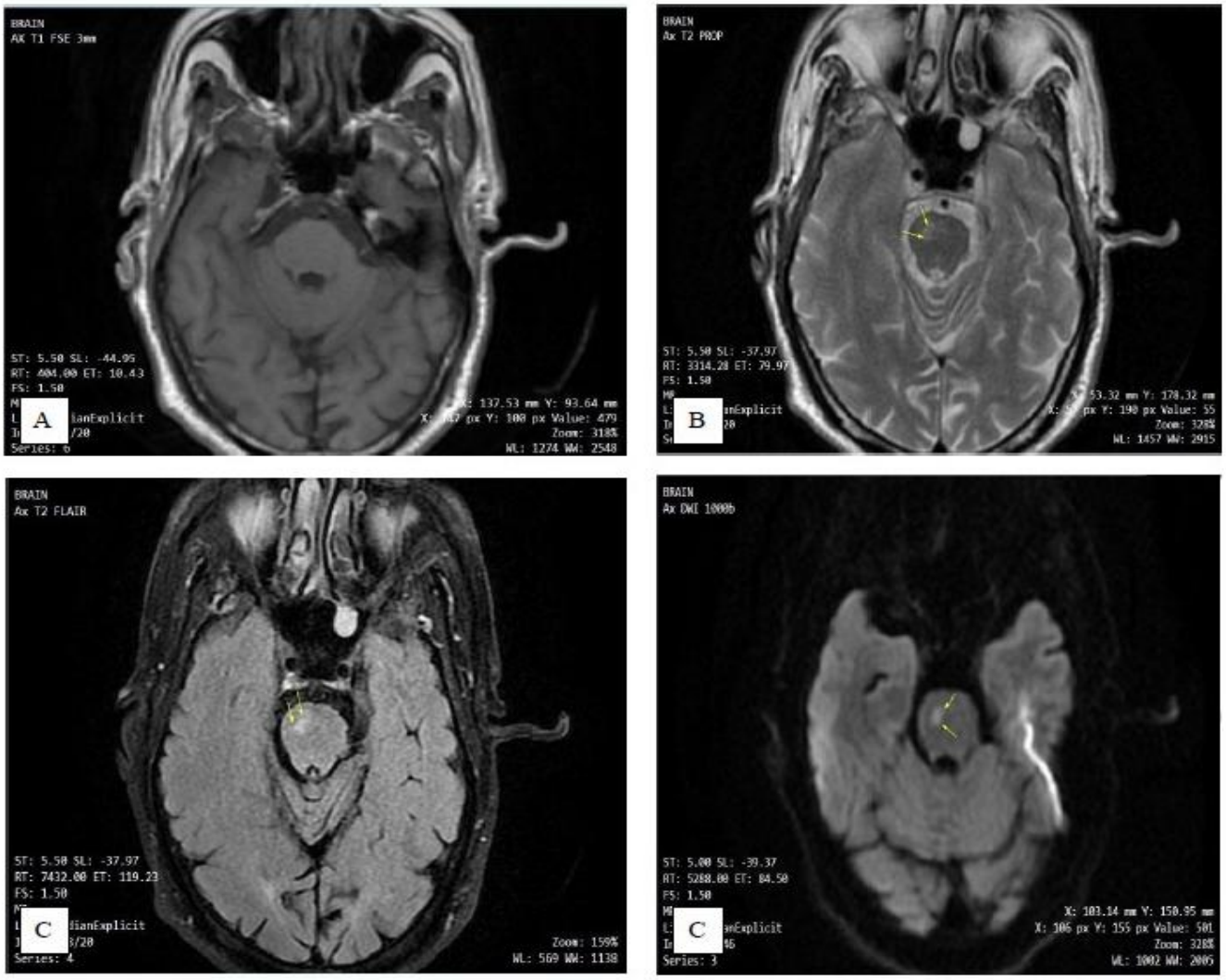

Figure [8]: MRI brain of case no 5.

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DISCUSSION

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 40 patients [19 males and 21 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 Al-Azhar University Hospital in New Damietta for MR examination. The patients of our study were presented with different causes of trigeminal neuralgia. Their ages ranged from 6 years to 65 years mean age 46.23 ± 13.63 years.

The mean age was lower in a study done by **Geneidi *et al.*** [7] 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.

The current study revealed that there was a predominance of left-sided trigeminal affection was presented in 19 patients [about 47.5% of cases] the right side was affected in 16 patients [about 40 %], and bilateral affection was denoted in 5 patients [about 12.5 %].

This was in accordance with **Tanrikulu *et al.*** [8] that included 180tients with trigeminal neuralgia who underwent magnetic resonance-constructive interference to study essential morphologic parameters in relation to the clinical appearance of patients with trigeminal neuralgia. They reported that there was a predominance of left-sided trigeminal affection, and it was presented in 100 [55.5%] patients while right side affection was presented in 79 [43.8%] patients and bilateral affection was in only one patient [0.7%]. However, these results are in contrast with **Bowsher** [9] that included 170 consecutive patients referred to the Centre for pain relief at Walton Centre for Neurology & Neurosurgery with a diagnosis of trigeminal neuralgia. The study reported that left-sided trigeminal affection was presented in 46 [36.5%] patients while right side affection was presented in 80 [63.5%] patients and no cases of bilateral affection.

In our present study 31 patients [77.5 %] were secondary to different pathologies. This is in accordance with **Rangaswamy *et al.*** [10] 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 the study by **Swetha *et al.*** [11] 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 31 patients of our study who had secondary TN, 12 cases with tumors [30%], 9 cases with vascular loop [22.5 %] and 5 cases with multiple sclerosis [12.5 %]. This is in accordance with a study by **Liu Y *et al.*** [12] 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. In addition, these results agree with the study of **Swetha et al.** [11]**.** 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.

FIESTA sequence had superior spatial and contrast resolution [due to the cisternographic effect] and it was used in the demonstration of neurovascular contact. Trigeminal nerve was identified by tracing its course from the Meckel's cave posteriorly to the pre-pontine cistern. FIESTA has been proposed as the initial screening procedure for all patients with refractory trigeminal neuralgia, especially if surgical intervention is being considered. The arteries were identified by tracing them to their origin from the basilar artery. The specific vessel was identified depending on the branching order of the basilar artery [7].

We also found that 11 patients out of 40 cases [27.5 %] had cerebello- pontine angle [CPA] lesions with different pathologies they were all referred for neurosurgical intervention. These results disagree with **Rangaswamy *et al.*** [10] who stated that trigeminal neuralgia secondary to cerebello-pontine angle lesions were found in six out of 75 patients [8%].

In addition, in a study by **Shulev *et al.*** [13] that included 242 patients with typical manifestations of trigeminal neuralgia who were operated on at Saint-Petersburg City Hospital. They reported that only 14 patients out of 242 cases [5.8%] presented with trigeminal neuralgia secondary to cerebello-pontine angle tumors.

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 11 cases out of the 40 patients, they are as the following: 3 cases with acoustic schwannomas, 4 cases with trigeminal schwannomas, 3 cases with meningiomas and one case epidermoid cyst. This was relatively like **Rangaswamy *et al.*** [10] who reported two cases with trigeminal schwannomas, two cases with vestibular schwannomas, one case with epidermoid cyst and one case with arachnoid cyst. Those CPA lesions tend to cause trigeminal neuralgia by displacement, encasement or even invasion of the trigeminal nerve. In all the 11 cases in current study, the trigeminal neuralgia was at the same side of the lesion. Demyelinating plaques of multiple sclerosis involving intra-pontine trigeminal nuclei was also reported as common MRI finding in patient with trigeminal neuralgia associating MS [14]**.**

In the present study four cases, out of 40, 5 cases [12.5 %] showed MS plaques in pons, two were presented by isolated unilateral trigeminal neuralgia and one was presented by bilateral trigeminal neuralgia. This is in accordance with the study performed by **Rangaswamy et al.** [10], three patients out of 75 cases [4%] were having MS associating trigeminal neuralgia.

The most involved segment in pathological cases was the cisternal segment, it was affected in 19 cases out of 31 cases with abnormal MRI findings either affected by vascular lesions or tumors. Our findings agree with **Geneidi *et al.*** [7], who reported that the cisternal segment was the most affected segment that was involved in 15 out of 25 cases with abnormal MRI findings. The second affected segments were brain stem which was affected in nine cases. In addition, **Swetha** [11] reported that the most frequent segment involved was the cisternal portion [42%] cases [tumors, vascular lesions and injuries], followed by the brain stem [14%] cases [tumors, inflammatory / demyelinating and vascular malformation].

We analyzed the idiopathic cases [in our study 9 cases out of 40] regarding the measurement of trigeminal pontine angle, length of cisternal segment of nerve and cross-sectional area of CPA and we found that, there was statistically significant decrease of mean trigeminal pontine angle in idiopathic cases in affected side [27.40°], in comparison to unaffected side [38.77°]. Also, our study showed that there was statistically insignificant difference in the mean length of cisternal segment of nerve in idiopathic cases, between affected side [8.12 mm] and unaffected side [10.37 mm]. As well as there was statistically significant decrease of cross-sectional area of CPA in idiopathic cases in affected side [1.38 cm^2], in comparison to unaffected side [1.82 cm^2]. This was in accordance with a study by **Pang *et al.*** [15] who reported that the mean trigeminal-pontine angle value on the affected side was significantly smaller than the unaffected side and the control group [$p < 0.001$]. When taking the conflicting vessel types into consideration, the angle affected by the

superior cerebellar artery [SCA] was statistically sharper than when affected by other vessels [p < 0.01]. However, there were no significant changes in the area of the CPA cistern or the length of the trigeminal nerve between the groups. Our measurements were compatible with **Hardaway *et al.*** [16], who reported statistically significant change in measurements between affected and unaffected sides of idiopathic trigeminal neuralgia patients.

In our study we found that there is statistically insignificant difference of diagnosis distribution in the study group, as cavernous hemangioma, glioma and epidermoid cyst represent lowest distribution [3.3%]. FIESTA played an important role in determination of the exact of the epidermoid cyst. Pontine infarcts have also been reported among the causes of trigeminal neuralgia mainly due to occlusion of pontine branches of the basilar artery at root entry zoon. Secondary trigeminal neuropathy and neuralgia due to pontine infarction is very rare [17]. Similarly, this was reported in our study as four cases of pontine infraction which showed restriction in the diffusion weighted image.

Study limitations: There were a few limitations as 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.

Conclusion: MRI stands as an excellent imaging modality for diagnosing the etiology of this disorder. FIESTA MRI act as adjuvant to conventional MRI in increasing diagnostic accuracy and detection of neurovascular compression and other causes of TN such as measurement of trigeminal pontine angle, length of cisternal segment of nerve and cross-sectional area of CPA were affected in idiopathic cases of trigeminal neuralgia

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