OMICS Journal of Radiology
ISSN: 2167-7964

Alashwah, OMICS J Radiol 2018, 7:5
DOI: 10.4172/2167-7964.1000301

Research Article Open Access

Role of Contrast Enhanced MRI in Differential Diagnosis of Causes of Facial Pain Secondary to Trigeminal Nerve Compression

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Abstract

Aim: To differentiate the various causes of facial pain in patients with trigeminal nerve compression using different MRI sequences.

Patients and methods: Thirty one patients (18 males, 12 females and one boy) with facial pain after exclusion of dental and other causes were taken in this study. Contrast with enhanced magnetic resonance imaging examination of the brain and cerebellopontine angles were performed. Evaluation has been done along the anatomical course of the 5th cranial nerve with revision of the courses of the relevant other cranial nerves.

Results: A positive Radiological finding has been obtained in 28 patients while the pain has been classified as idiopathic in 3 patients. Compression of the nerve with tumours was evident in 18 patients, vascular compression was the cause in 5 patients and demyelination was the cause in 5 patients.

Conclusion: Contrast enhanced MRI of the brain is an excellent modality to identify any relevant abnormality along the course of 5th cranial nerve and to differentiate it from masses of other origin affect its course.

Keywords: Blood spectrophotometry; Diagnostic; Spectrum; Artificial intelligence; Statistical analysis; FTIR analysis

Introduction

The 5th cranial nerve has sensory and motor roots; it exits the brainstem at the level of pons then its course pass just lateral to the cavernous sinus where the trigeminal ganglia/Gasserian ganglia surrounded with CSF within a depression in the middle cranial fossa which called the Meckel's cave. Trigeminal nerve gives three divisions: Ophthalmic, maxillary and mandibular divisions. Both ophthalmic and maxillary divisions enter the cavernous sinus to exit through the superior orbital fissure and foremen rotundum respectively while the mandibular division exit directly through the foramen ovale to the massticator space of the neck [1].

Facial pain has many causes which differentiation from each other needs careful history evaluation in form of knowledge about the onset of the pain and what exacerbate or relief the pain. Common causes include compression of the nerve at the cerebellopontine angle by various lesions, dental problems, temporomandibular joint referred pain and psychological causes.

The pain like electrical shock along the distribution of nerve branches classically increased with effort, mastication, excessive talking and relieved with rest or carbamazepine. In some patients the pain may be stabbing, burning or dull aching pain. It considerably deteriorates the patient's quality of life and may interfere with daily activites and ability to work [1].

Patients with chronic orofacial pain get benefits from contrast enhanced MRI as it has the ability to characterize and differentiate between different causes [2].

Secondary trigeminal neuralgia (TN) from cerebellopontine angle masses as cerebellopontine angle cholesteatoma may has similar symptoms to primary trigeminal neuralgia. Early head MRI scan can provide help for early diagnosis and management as surgery and microvascular decompression should be performed [3].

Microvascular decompression (MVD) is an effective and safe operative procedure, and it should be regarded as a safe and viable alternative for treating intractable TGN in older patients [4].

Preoperative high resolution three dimensional Magnetic Resonance (MRI) in patients with classic TN has a great diagnostic and prognostic value of identifying neurovascular compressions (NVC) in patients who are candidates for surgery as micro vascular decompression is the only surgical treatment for refractory classic trigeminal neuralgia (TN) [5].

Schwannomas arising from the cranial nerves controlling extra ocular eye movements are very rare and usually present with some degree of diplopia. A recent study reported the first case of trochlear schwannoma presenting with isolated trigeminal neuralgia [6].

Patients and Methods

Thirty scans had been performed for thirty one patients who were complaining from facial pain along the distribution of nerve branches classically increased with effort, mastication, excessive talking and relived with rest or carbamazepine after exclusion of dental and psychological causes in the period from January 2017 to May 2018 [7]. An informed consent from every patient was obtained to use their data in this research. Patients with general contraindications to MRI scans have been excluded like patients with cardiac pacemakers and ocular metallic foreign bodies. The contrast media injected intravenously with dose 0.1 mmol of gadolinium-DTPA/kg. Detailed demographic data are mentioned in Table 1.

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Received September 04, 2018; **Accepted** October 18, 2018; **Published** October 25, 2018

Citation: Alashwah MA (2018) Role of Contrast Enhanced MRI in Differential Diagnosis of Causes of Facial Pain Secondary to Trigeminal Nerve Compression. OMICS J Radiol 7: 301. doi: 10.4172/2167-7964.1000301

Segment	Patient	Age	Gender	Lateralization	Category	Diagnosis
Cisternal	1	28	Male	Right	tumour	Meningioma
	2	30	Female	Left	tumour	Meningioma
	3	35	Male	Left	tumour	Meningioma
	4	42	Male	Right	tumour	Acoustic schwannoma
	5	36	Male	Right	tumour	Acoustic schwannoma
	6	38	Female	Right	tumour	Meningioma
	7	30	Female	Right	tumour	Meningioma
	8	37	Male	Left	tumour	Acoustic schwannoma
	9	31	Male	Left	tumour	Acoustic schwannoma
	10	52	Female	Right	tumour	Meningioma
	11	55	Male	Left	tumour	Acoustic schwannoma
	12	32	Male	Left	tumour	Trigeminal schwannoma
	13	44	Male	Right	tumour	Trigeminal schwannoma
	14	46	Male	Right	tumour	**Glioma**
	15	48	Female	Right	tumour	Acoustic schwannoma
	16	39	Male	Left	tumour	**Glioma**
	17	30	Female	Left	tumour	Acoustic schwannoma
	21	50	Male	Right	vascular	Vascular compression
	22	51	Male	Right	vascular	Vascular compression
	23	47	Female	Left	vascular	Vascular compression
Brain Stem	18	11	Boy	Bilateral	tumour	Brain Stem Glioma
	19	42	Female	Bilateral	vascular	Vascular compression
	20	55	Female	Bilateral	vascular	Vascular compression
	24	33	Female	Bilateral		multiple sclerosis
	25	36	Female	Bilateral		multiple sclerosis
	26	38	Female	Bilateral		multiple sclerosis
	27	34	Male	Bilateral		multiple sclerosis
	28	31	Male	Bilateral		multiple sclerosis
	29	34	Male			idiopathic
	30	41	Male			idiopathic
	31	32	Male			idiopathic

Table 1: Data collection including clinical and radiological classification of the findings according to pathology and segmental anatomy.

Magnetic Resonance Imaging Technique

The scans have been performed on GE medical, sigma explorer 1.5 Tesla scanners. The protocol includes axial fluid attenuation inversion recovery FLAIR, axial T2WI, axial T1W GronsetI cuts for whole brain including the posterior fossa and the cerebello pontine angle with coronal T2WI, sagittal T1WI post contrast and axial T1WI post contrast with Gadolinium. Axial high spatial resolution 3D constructive interference in steady state (CISS) gradient echo sequence used in the idiopathic cases to exclude small lesions.

Image Interpretation

Image interpretation has been done in systematic way for all patients including careful anatomical evaluation for the 5th cranial nerve along its whole course from its pontine exit through the prepontine cistern to the Meckel's cave and finally its branches. Evaluation has been done for the brain generally to detect any space occupying lesion or white matter lesions including accurate determination of its number, anatomical location and measurement of each lesion individually.

Results

This study includes thirty one patients includes eighteen male, twelve female and one boy. Patient age from 28-55 years old with only one pediatric patient aged 11 years old. Three male patients only shows normal MRI scan of the whole brain with no evidence of lesions compressing the nerve and the whole study shows unremarkable conclusion.

Seventeen patients including eleven males and six females shows variable size space occupying lesions which classified as four female and two male patients with meningioma, five males and two female patients with acoustic schwannoma, two male patients with trigeminal schwannoma and two male patients with glioma.

Vascular compression (vertebro basilar dolico-ectasia) seen in two male and three female patients. Multiple sclerosis with numerous plaques was seen in the brainstem seen in three females and two male patients. The definitive diagnosis of the lesions recorded in this study decided after surgical removal in the patients with space occupying lesions/neoplastic lesions causing nerve compression. The final diagnosis decided after clinical and laboratory correlation in patients with demyelination (5 cases) while vascular loop cases are evident, need no more confirmation and the definitive diagnosis made by contrast enhanced MRI.

Contrast enhanced MRI shows excellent ability to characterize the neoplastic lesions as confirmation made by histopathology after surgical resection.

In this study, seven patients with facial pain and MRI shows that the cause is acoustic schwannoma (Figure 1) that show typical features of ice cream cone appearance with heterogeneous enhancement, breakdown and necrosis with typical intracanalicular extension. The lesions are large and exerting mass effect on the nerve with subsequent trigeminal pain.

In this study, six patients with facial pain and MRI shows that the cause is meningioma, two of them were classified as cavernous sinus/parasellar meningiona and four of them cerebellopontine angle CPA meningioma with extensions and mass effect on the 5th cranial nerve (Figure 2).

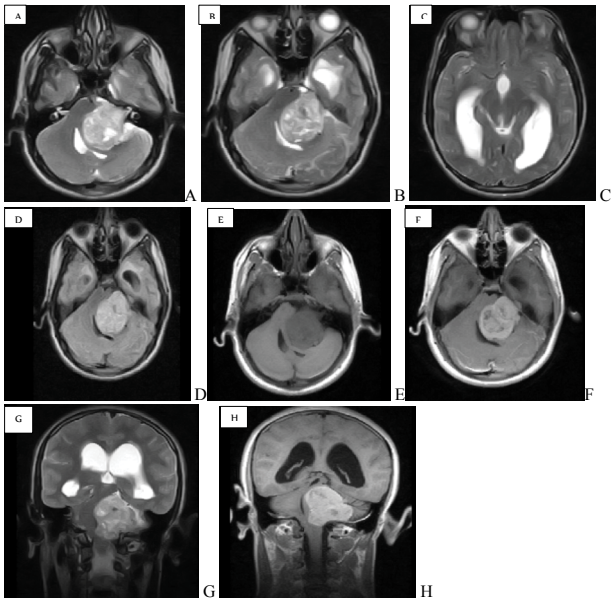

Figure 1: MRI examination of the brain (A)(B)(C) axial T2WI (D) axial FLAIR (E) axial T1WI (F) axial T1WI post contrast (G) coronal T2WI (H)coronal T1WI post contrast . There is large well defined oblong shaped extra axial posterior fossa SOL is seen in the left cerebellopontine angle cistern measures about 4.5 x 4.5 cm shows non uniform low T1 and mixed intermediate and high T2 and FLAIR signal intensities and exerts marked mass effect in form of compression of the left side of the brain stem, left cerebellar peduncles with compression of the 4th ventricle and supratentorial hydrocephalus. Extension seen within the left internal auditory canal consistent with Posterior fossa extra axial left cerebellopontine angle SOL (acoustic neuroma).

The main clinical problems of Acoustic Schwanomma are hearing deficits, tinnitus, vestibular disturbances and face numbness. When its size is considerable, it may compress the 5th cranial nerve with facial pain, hypesthesia, paresthesia, and neuralgia [6]

Trigeminal pain is considered as a rare presenting symptom in pediatric patients. In this study there is an eleven years old child presenting with weakness, double vision, headache and drowsiness plus evident facial pain. On MRI imaging, there is large brainstem glioma with mass effect on the trigeminal nerve course and supratentorial hydrocephalus (Figure 5).

Discussion

Facial pain has numerous variable causes and accurate diagnosis is crucial to identify the main problem and differentiate the organic from psychogenic causes. Dental problems represent an important item in the differential diagnosis which must be brought in mind and excluded by careful history and dental examination. Temporomandibular joint referred pain is another cause.

Trigeminal neuralgia pain is sharp along the distribution of the

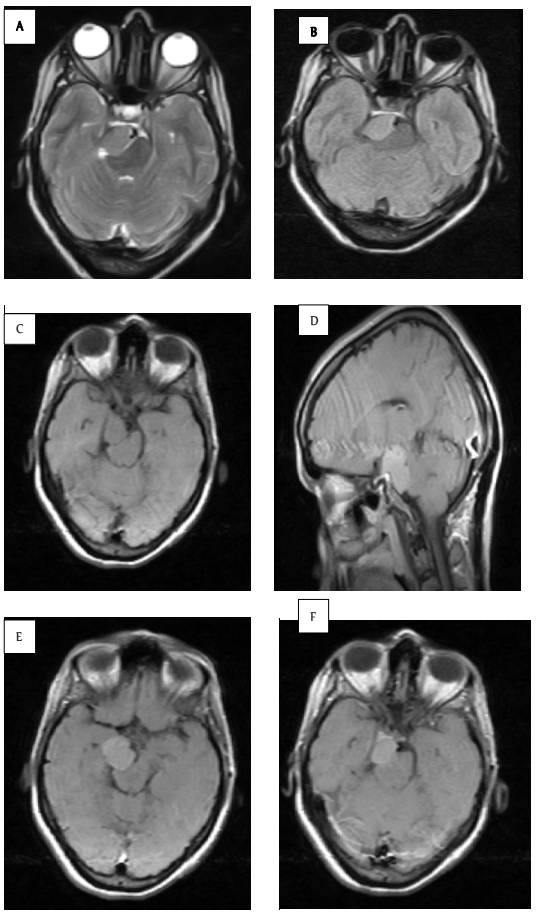

Figure 2: MRI examination of the brain (A) axial T1WI (B) axial FLAIR (C) axial T1WI (D) sagittal T1WI post contrast (E)(F) axial T1WI post contrast . There is small well defined extra axial petrous apex space occupying lesion is seen at the right pre-pontine and supra-sellar cistern measures about 2.7 x 2.3 cm exhibits intermediate T1 and T2 signal intensities with homogenous enhancement with wide dural base on the right petrous apex exerting mass effect on the surrounding structure in form of indenting the right ventral aspect of the pons .Right pre-pontine extra axial S.O.L (right petrous apex meningioma).

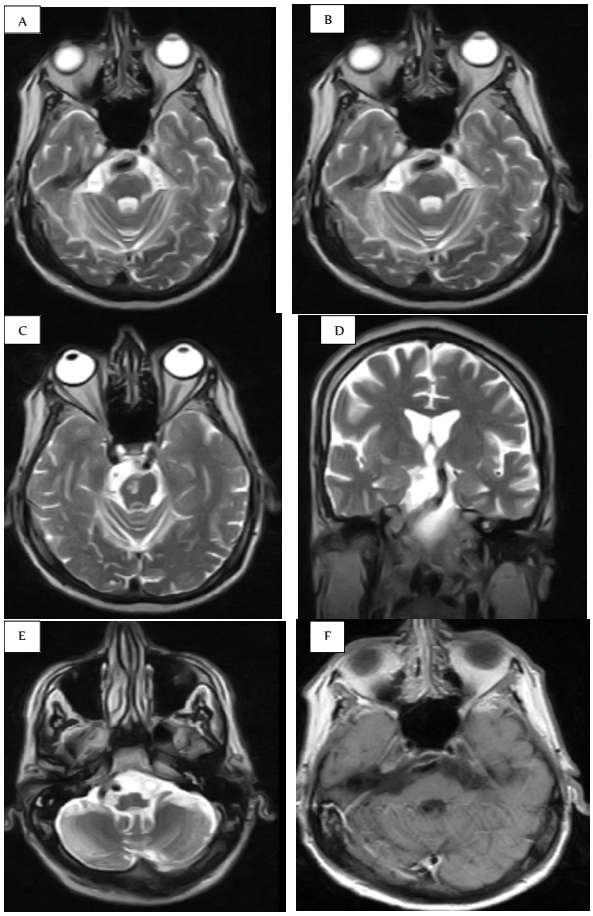

Figure 3: MRI examination of the brain (A)(B)(C)(E) axial T2WI (D) coronal T2WI (F) axial T1WI. There is dilated, elongated and tortous appearance of the distal vertebral and basilar arteries with encroachement on the related cranial nerves course. Small area of abnormal signal intensity is seen in the pons, displaying low SI in T1WI and high SI in T2WI represents ischaemia. Central and peripheral brain involutional changes in form of dilated both lateral ventricles and extra-axial CSF spaces, namely; the cerebral cortical sulci, Sylvian fissures and basal cisterns. The findings consistent with vertebro-basilar dolico-ectasia with brain stem ischaemic effect and cranial nerves compression.

5th cranial nerve with recurrent nature and usually hit the patient after effort, mastication, talking or touching the face. In some cases the pain is sever and interfere with the ability to work. In this study there are three patients were classified as idiopathic.

Diffusion tensor imaging is now widely accepted modality for evaluation of patients with facial pain on 3 tesla magnet however tractography beyond the scope of this study [8].

In this study seventeen patients are diagnosed with space occupying lesions as the cause of trigeminal nerve compression from which fifteen lesions reaching the cerebellopontine angle and the prepontine cistern and considerably compressing the 5th cranial nerve which makesthe cisternal segment of the nerve is the most commonly affected part of the nerve.

Shulev et al. (2011) found that (14 patients from 242 patients that represent about 5.8%) are secondary to cerebello-pontine angle masses. Our findings are not concordant with Shulev et al. that around 5% of cases had tumors at the cerebellopontine angle [9].

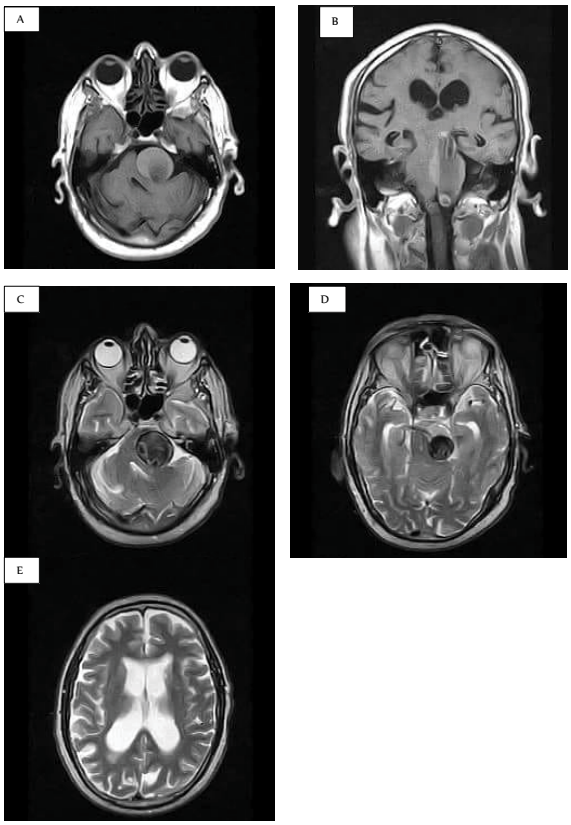

Figure 4: MRI examination of the brain (A) axial T1WI (B) coronal T1WI (C)(D) (E) axial T2WI. There is smooth margin well defined rounded space occupying lesion is seen in the prepontine cistern more to the left side displaying signal void in T2WI with signal misregistration artifacts. There is peripheral high T1 signal intensity with signal void center conistent with partially thrombosed basilar artery aneurysm exerting mass effect in form of uncal shift, brainstem and 4th ventricle compression with supratentorial hydrocephalus. Coronal image (B) shows elongated, ectatic and tortous basilar artery represents associated vertebrobasilar dolicoectasia.

Vertebrobasilar dolicho-ectasia (VBD) can be defined as dilatation, elongation, enlargement and tortuosity of the basilar artery (Figure 3). Pathologically, there is degeneration of the lamina, thinning of the media due to smooth muscle atrophy common in hypertensive patients with atherosclerosis. It may be considered as vascular variant and most patients are asymptomatic and discovered incidentally. However identification of clinical manifestation is crucial to avoid significant morbidity and mortality [10].

It has several manifestations including cranial nerve compression, ischemia, bleeding and rarely compression may affect the ventricular system with supratentorial hydrocephalus (Figure 3). Imaging modalities include computed tomography and magnetic resonance imaging to identify the basilar artery morphology and diameter, intraluminal thrombosis and its relation to the cranial nerves [10].

The same pathology and radiological features can be evident in Pateints with basilar artery aneurysm (Figure 4).

On MRI FLAIR images, decreased velocity of the blood flow may cause hyperintense vessel sign, especially in patients with posterior circulation transient ischemic attack or stroke. Slow arterial blood flow velocity in VBD has been observed at transcranial Doppler US and is attributed to the disease origin of ischemic stroke in the posterior circulation [10].

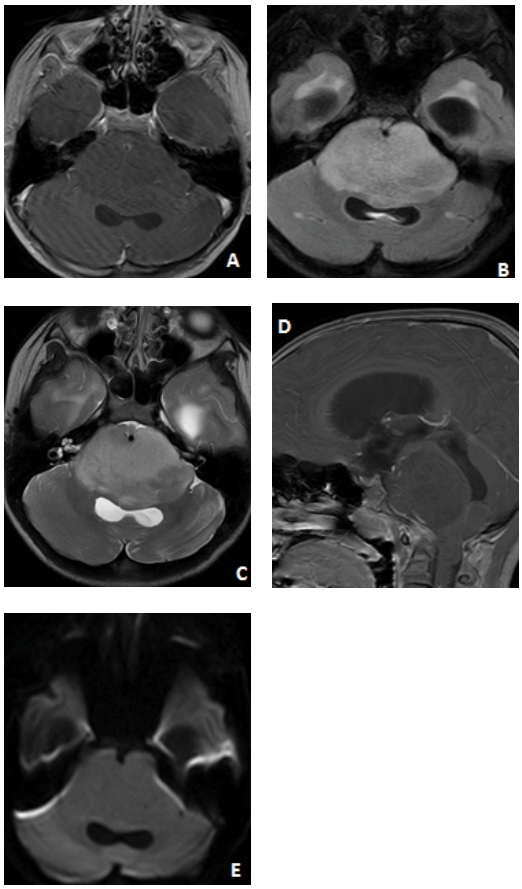

Figure 5: MRI examination of the brain (A) axial T1WI post contrast (B) axial FLAIR (C) axial T2WI (D) Sagittal T1WI post contrast (E) axial diffusion weighted image DWI. There is large diffuse space occupying lesion is seen involving the brainstem displaying low signal intensity in T1WI, high Signal intensity in both T2WI and FLAIR images with no evidence of enhancement or diffusion restriction and consistent with brainstem glioma exerting mass effect on the 4th ventricle with supratentrorial hydrocephalus.

Facial pain may be a presenting sign for intracranial tumors *via* different mechanisms which are classified by Hasegawa et al. into several types. Although this classification was based on assumption that the nerve will be compressed by ipsilateral tumour, a large tumor could affect contralateral nerve due to distorted brainstem [11].

This study showing that the location of the tumour mainly meningioma's is more important than the size in developing the pain related to the lesion as tumours near the root of the trigeminal nerve are more likely to cause pain and this concordant with Jamjoom et al. [12,13].

In this study, heavy T2WI CISS sequence has been used to improve the resolution and the detection of abberant vessels that compress the nerve. As proposed by Frieto at al., the FIESTA CISS sequence uses T2WI steady state contrast mechanism with high signal to noise ratio images with strong signal from cerebrospinal fluid CSF while suppressing background tissue for contrast and anatomical detail of small solid structures, such as cranial nerves and blood vessels. Ultra short TR and TE allow extremely short acquisition times and the images can be easily reformatted in any plane with excellent quality [14].

This sequence is also useful for evaluation of the Gasserian ganglia in the Meckel's cave and the 5th cranial nerve in the prepontine cistern [15]. The management can be medically, however in cases not responding to the conservative treatment, other options could be considered like ablation of the Gasserian ganglion and gamma knife [16].

Summary and Conclusion

MRI is an excellent modality for evaluation each anatomical segment of the 5th cranial nerve and accurate localization of the lesion in cases of facial pain after exclusion of dental and psychological factors as a cause of trigeminal neuralgia with the ability to evaluate the brain to exclude demyelinating or inflammatory causes.

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