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Magnetic Resonance Imaging Evaluation of Various Orbital Pathologies

Nilesh Chaudhari[1], Parag Garse[2], Shopnil Prasla[3]

[1]Associate Professor, Department of Radio-diagnosis, Dr.VasantraoPawar Medical College Hospital & Research Centre, Nashik, Maharashtra, India

[2]Junior Resident (III), Department of Radio-diagnosis, Dr.VasantraoPawar Medical College Hospital & Research Centre, Nashik, Maharashtra, India

[3]Junior Resident (III), Department of Radio-diagnosis, Dr.VasantraoPawar Medical College Hospital & Research Centre, Nashik, Maharashtra, India

Abstract: ***Background*: In the modality of choice in most cases of orbital pathologies, Magnetic resonance imaging (MRI) is an obligatory diagnostic technique due to its better soft tissue contrast resolution and no ionizing radiation property. *Purpose of study*: Our aim was to study role of MRI finding in various orbital etiologies and importance of MRI in differentiating various orbital pathologies. *Results*: Total 35 patients were testified with various conditions. Variety of study showed that 11(31.4%) out of 35 patients were encountered with common etiology of infective/inflammatory lesions followed by neoplastic lesion in 7(20%) patients, Vascular condition had 5 (14.2%) patients, 2 (5.7%)patients with congenital lesions and 4 (11.4%) patients with endocrine pathology were diagnosed. Paranasal sinus lesion with orbital extension was seen in the 6(17.1%) patient. *Conclusion*: MRI plays significant role in the diagnosis of numerous orbital pathologies.***

Keywords: Magnetic resonance imaging (MRI), Orbit

1. Introduction

Eyes are very important organs of our visual system. Eyes have very complex function of collecting light from surrounding, regulate its intensity and focused though adjustable lenses to form an image which transmit the electric signals to brain [(1)]. Orbital anatomy consist of anterior compartment be made up of eyelids, lacrimal apparatus and anterior soft tissue. Posterior compartment divided into intraconal and extraconal space and conal space consist of extraocular muscle and envelope of fascia[(2)] .Orbital lesions are the most challenging and common basis of the consultation encountered by the radiologist and ophthalmologist [(3)].

Orbital lesion have broad spectrum of pathologies including congenital, vascular, infective/inflammatory, endocrine and neoplastic tumors[(4)]. These lesions produce the symptom such as proptosis/exophthalmos diplopia, diminished vision, enophthalmos, leucocoria and pain. Radiological assessment plays a vital role in revealing cause of the visual symptom and verdict the number, size and extent of the lesion.

Magnetic resonance imaging (MRI) has become an indispensable diagnostic tool in the field of radiology. Due to superior soft tissue contrast resolution and no ionizing radiation, it has turn out to be the modality of choice in most cases of orbital / ocular pathologies [(5,6,7)].

Recent technical advances, including orbital surface coils, fat suppression techniques, fast gradient-echo pulse sequences, and MR contrast agents which permit noninvasive modality to provide excellent spatial and contrast resolution of the orbital soft tissues with direct multi planar imaging. It allows studying the lesion itself and its effect on the surrounding structures [(8,9)].

Aim and Objective

1) To study the role of MRI finding in various orbital pathologies.
2) To study clinical features of orbital pathologies.
3) To set characteristic imaging features to differentiate orbital pathologies.

2. Material and Methods

We studied 35 patients who presented in department of Radio Diagnosis at Dr. VasantraoPawar hospital and research center, Nashik. All patients referred to the Radio Diagnosis department for MRI examination.Patient of the irrespective of age and sex referred to radiology department was included in the study. All MRI examinations were performed on 1.5 T magnet MR systems (Siemens MagnetomEssenza).

Patient preparation

Patients were prepared after taking written consent. Patients were asked to remove all metal objects. Chaperone provided with claustrophobic patients. Before scan procedure was explained with clarified contrast injections benefits and risk [(6)].

Imaging Techniques

Suspected orbital masses can be evaluated with magnetic resonance imaging (MRI), computed tomography (CT), ultrasound (US). But MRI is imaging modality of choices and in cases with suspected bony pathology and MRI cannot be performed in such cases, CT should be done. High resolution MRI (HR MRI) gives superior soft tissues contrast than CT and allows more accurate detailing of the different orbital compartments. MRI examinations can either be performed on a 1.5 T or a 3 T scanner using a combination of head and surface coils. The standard

protocol for MRI in most institutions consists of axial SET1W sequences, coronal STIR sequences, and axial and coronal SET1W sequences with fat saturation obtained after intravenous administration of gadolinium chelates. The recommended slice thickness is 2-3mm with a 512*512 matrix. 3D FT heavily T2W sequences (CISS, FIESTA, or DRIVE) and 3DFTT1W sequences with 0.6-1mm thin slices. In patients with suspected orbital masses, for evaluation of calcifications, bony orbital lesions and in patient with possible penetrated foreign body, CT is the modality of choices. CT examinations are usually done using 0.6-1mm thin slices after intravenous injection of iodinated contrast material. Thin-slice HR multi detector CT provides quick volumetric acquisitions and precise depiction of the globe, optic nerve, intraconal, and extraconal spaces. Standard coronal and sagittal reconstructions are routinely obtained with bone and soft tissue settings [(4)].

3. Results

In this study total 35 patients were reported with various condition out of which 54.2% (n=19) were male and 45.7% (n=16) patients were female (Table.1)

Various spectrum of diseases were studied out of which most common etiology encountered was infective/inflammatory lesion accounting for 31.4% (n=11) patients followed by neoplastic lesion in 20%(n=7) patients, Vascular condition had 14.2% (n=5) patients, 5.7% (n=2) patients with congenital lesions and 11.4% (n=4) patients with endocrine pathology were diagnosed. Paranasal sinus lesion with orbital extension was seen in the 17.1% (n=6) patient (Table 2).

Infective / Inflammatory:
In respected study out of the 11 cases of infective/inflammatory etiology, out of which 5 patient had orbital pseudotumour, 3 patient were diagnosed with optic neuritis and 2 patient of orbital cellulitis and one patient with intraconal abscess (Fig. 1-4)

Neoplastic Etiology:
In total 7 patient were reported with neoplastic etiology, 5 patients were with retinoblastoma, 2 patients were with malignant melanoma (Fig. 5-6).

Vascular Lesion:
In this study vascular condition was reported in 4 patients out of whom 2 patients had carotico-cavernous fistula and 2 patients with capillary hemangioma (Fig. 7-8).

Congenital:
In the congenital pathology, 2 patients were with history of leucocoria, diagnosed as coats diseases (Fig. 9).

Paranasal Sinus Extension in Orbit:
In this study paranasal sinus infection extending into the orbital region was noted in the 6 patients (Fig. 10).

4. Discussion

The orbit is a small anatomical space with important structures within. Manifold pathologies like infective, vascular, Tumours and tumour-like lesions often arise from these orbital contents and are a collective indication for the radiological evaluation of the orbit in both adults and children [(3)].

Infective/Inflammatory lesions:
In our study the most common pathology encountered was infective and inflammatory etiology with maximum of patient of inflammatory pseudo-tumor under this category.

a) Inflammatory orbital syndrome:
Patients with Inflammatory orbital syndrome (IOS) (also called as orbital pseudotumour) present with acute or sub-acute pain and swelling linked with limited eye movements and may every so often be bilateral. CT/MRI show enlarged muscles with shaggy margins, characteristically involving the tendons up to the insertion with enhancement and obliteration of peripheral surgical fat planes, generally affecting the superior group and medial rectus. Myositicpseudotumours mainly involve the EOMs and therefore mimic thyroid associated orbitopathy (TAO) but unlike TAO it also involves the tendons [(4,10,11)].

b) Optic neuritis
Optic neuritis has a multitude of origins with multiple sclerosis being the commonest of these which is similar to our study. Visual dysfunction is the presenting indication in a third of cases, and ocular involvement occurs in up to 75% of patients throughout the course of the illness. In the acute stage MR demonstrates diffuse swelling of the optic nerve with focal plaques of T2 hyperintensity.

c) Abscesses
It demonstrates a well-described occurrence of diffusion restriction, likely related to the viscosity and dense cellular packing of purulent material. This diffusion restriction manifests as a region of intense signal on diffusion-weighted imaging (DWI) and associated low intensity on apparent diffusion coefficient (ADC) images within the central, non-enhancing portion of the abscess cavity [(8)].

d) Inflammatory orbital cellulitis
Inflammatory orbital cellulitis describes inflammation of preseptal (peri-orbital) or postsetpal (orbital) fat.Cellulitis of preseptal and orbital soft tissue is best assessed on contrast-enhanced T1 MRI with fat suppression, where the most common outcome is poorly-defined periorbital enhancement enveloping the globe and extending into post-septal fat. On T2 MRI, infectious cellulitis classically presents as a hyperintense lesion[(4,7)].

Neoplastic etiology:
In the neoplastic etiology majority of patient with retinoblastoma were children.

- R**etinoblastoma**, On MR, they appear as hyperintense to normal vitreous on T1WI, moderate to evidently hypointense on T2WI depending on the calcification with and displays marked post contrast enhancement on contrast-enhanced MRI (CEMRI)
- **Malignant melanoma** are highly malignant tumors arising from the uvea (choroid, ciliary body, iris), that tend to metastasize hematogenously to liver, lung, bone, kidney, and brain.On MR, the lesions are of moderately

high signal on T1W (paramagnetic properties of melanin or hemorrhage) and are hypointense on T2W. Imaging differentials include choroidalhemangioma, choroidal detachment, and uveal metastases [4,9].

Vascular lesion

Among the vascular lesion carotico-cavernous fistula was most common in our study.

- **Carotico-cavernous fistulae** (CCFs) may either occur extemporaneously or follow trauma. Imaging characteristically demonstrates a distended ipsilateral superior ophthalmic vein and engorgement of the ipsilateral cavernous sinus. Conventional angiography is still well-thought-out the gold standard investigation whilst proposing the possibility of endovascular treatment.
- **Capillary hemangioma** is the most common orbital vascular tumour of infancy, and has no known familial or hereditary association. There is a female preference with a male-to-female ratio of 2:3.Capillary hemangiomas demonstrate isointensity to muscle on T1W-images, and are moderately hyperintense on T2W-images.Lobules with thin dark fibrous septa, composed with flow voids at the periphery of or within the tumour itself are considered characteristic imaging feature.

Endocrine lesions

In endocrine lesion thyroid orbitopathy was evident most commonly in female patient. Thyroid orbitopathy is an immune refereed process and often exhibits a characteristic sequence of extra-conal muscle participation (inferior rectus, medial rectus, superior rectus, lateral rectus and oblique muscles respectively. In fact isolated involvement of the lateral rectus or oblique muscles should prompt the search for an alternative diagnosis. Muscular involvement is often bilateral and symmetrical and typically frees the muscle tendons ensuing in fusiform expansion of the muscles - the so called 'Coca-Cola bottle' sign [9,11].

Congenital lesions

In congenital two patient with diagnosed with Coats disease having history of leucocoria since birth.MRI is extremely useful in the diagnosis of advanced Coats' disease, but may have lesser utility during the initial stages; MRI is superior to CT, in ruling out retinoblastoma as the difference between subretinal exudation and a solid mass is clearer on MRI . Specifically, the exudate in Coats' disease is hyperintense on both T 1 - weighted and T 2 -weighted MRI images, whereas in retinoblastoma, T 1 -weighted image will show a hyperintense mass, but T 2 -weighted image shows a hypointense mass . Moreover, the use of gadolinium contrast may also aid in the differential diagnosis of retinoblastoma as it enhances the solid tumours not seen in Coats' disease [9].

Paranasal sinus disease

Secondary orbital involvement from paranasal sinus disease is not uncommon. Post-septal cellulitis can complicate aggressive paranasal sinus infections and often reflects breach of the bony orbital contour. Mucoceles and inverted papillomas may also project into the orbital cavity, and should be included in the differential diagnosis of extra-conal etiologies especially in patients with a history of atopia[10].

Advantages [12,13]:

1) Non-invasive, non-operator dependant.
2) No exposure of ionizing radiation, it offers outstanding soft tissue resolution.
3) Entire optic nerve is imaged deprived of any bony shadow interference.
4) MRI can spot any age of hematoma.
5) Bone marrow lesions have better resolution.
6) MRI practices harmless contrast agent.

Disadvantages[12,13]:

1) Costly examination.
2) Not appropriate for unstable patients who cannot lie motionless for long time.
3) Test time is long.
4) Fat saturation can causes interference in analysis.
5) MRI is contraindicated with ferromagnetic intraocular foreign body.
6) Not appropriate for bony lesions.

5. Conclusion

MRI plays a major role in characterization of orbital lesions and narrowing the differential diagnosis for these lesions, supplementing findings of fundoscopic and clinical ophthalmologic examinations. Use of MR imaging is especially valuable for assessing the extent of the disease. Precise descriptions of the lesion location, involved orbital compartments, spread to the orbital apex and associated intracranial abnormalities can be well evaluated by MR imaging for appropriate treatment.

Table 1: Number of patient taken for study according to sex distribution

Sex Distribution	*No of Patient*
Male	19
Female	16

Table 2: Number of patient diagnosed with different pathologies

Pathologies	*No of Cases*
Infective/ Inflam	11 (31.4%)
Neoplastic	7 (20%)
Vascular	5 (14.2%)
Endocrine	4 (11.4%)
Congenital	2 (5.7%)
Parasinal Infection with Orbital Extension	6 (17.1)

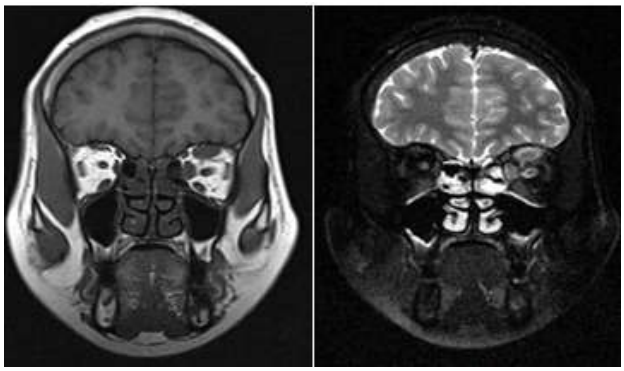

Figure 1: MRI orbit shows bulky superior rectus and medial rectus muscle at the belly as well as insertion site consistent with orbital pseudotumour.

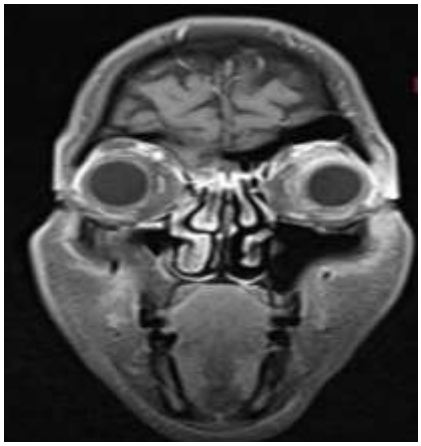

Figure 2: MRI orbit shows periorbitalpreseptal enhancing soft tissue swelling bilaterally with more prominent on the left side consistent with orbital cellulitis

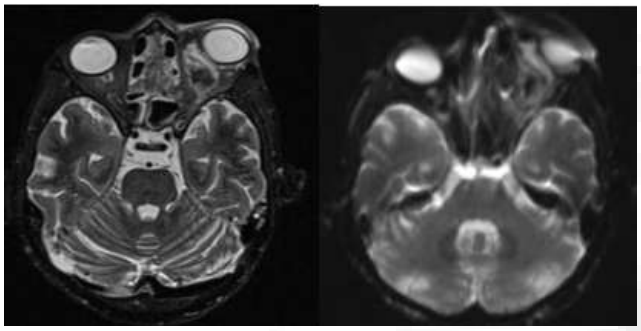

Figure 3: MRI orbit shows left orbital intraconal lesion in superomedial aspect showing diffusion restriction on DWI consistent with intraconal abscess

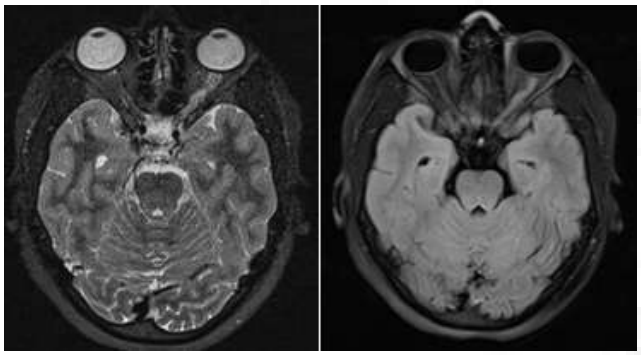

Figure 4: MRI orbit shows thickening of the left optic nerve with T2 and FLAIR hyperintense signal in the left optic nerve consistent with optic neuritis

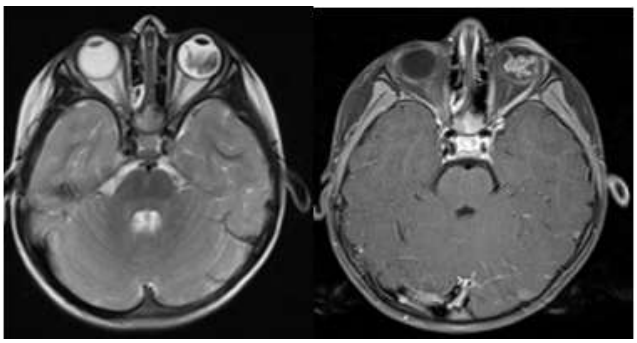

Figure 5: MRI orbit showing T2 hypointense lesion with heterogeneous enhancement noted in the left eye globe consistent with retinoblastoma

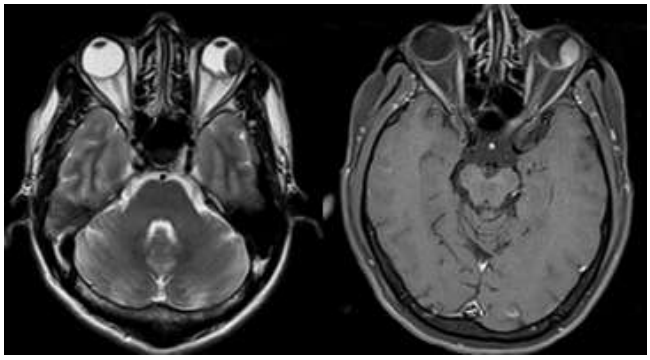

Figure 6: MRI orbit showing T1 hyperintense and T2 hypointenselesion with homogeneous enhancement noted in the left eye globe consistent with malignant melanoma

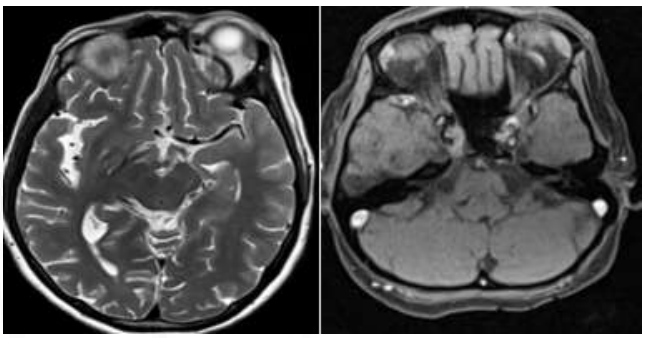

Figure 7: MRI Orbit show prominent cavernous part of the bilateral internal carotid artery and left superior ophthalmic vein consistent with carotico-cavernous fistula.

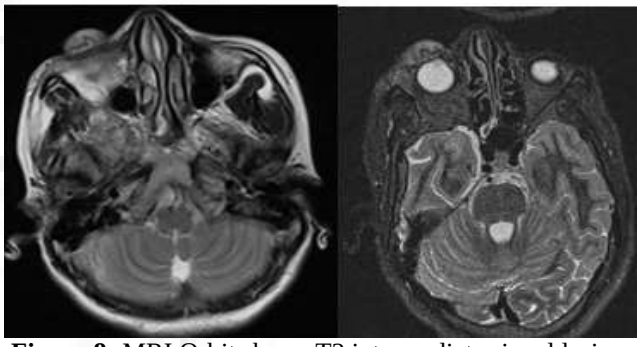

Figure 8: MRI Orbit shows T2 intermediate signal lesion noted in the anterior superior aspect of the right eye globe consistent with Capillary hemangioma.

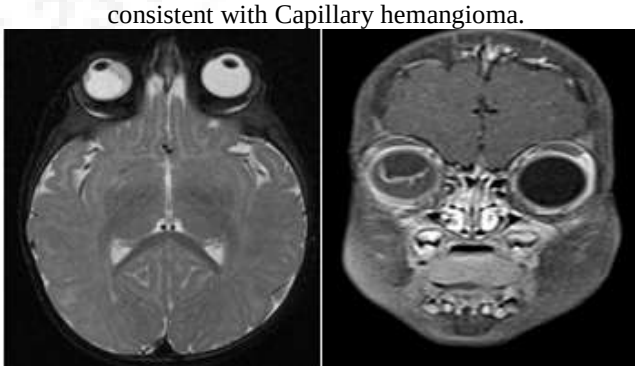

Figure 9: MRI Orbit show smaller sized right eye-globe with T2 intermediate signal along the inferior aspect with retinal detachment. No obvious post contrast enhancement seen (except margins)

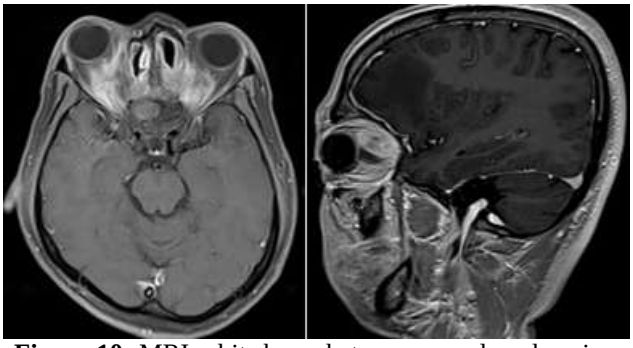

Figure 10: MRI orbit shows heterogeneously enhancing paranasal sinus soft tissue infection extending to the extraconal and intraconal space of the both orbit.

6. Declarations

- Funding: None
- Conflict of interest: None declared

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