ORIGINAL ARTICLE

Role of Neuroimaging in Ophthalmology

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ABSTRACT

Objectives: To highlight the role of neuroimaging in Ophthalmology.
Subjects and methods: We retrospectively reviewed 230 cases that were referred for Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) by different ophthalmologists from year 2000 to 2008. The patients had various kinds of ocular problems including impaired visual acuity, papilledema, visual field defects, proptosis, ptosis, diplopia, ocular motor nerve palsies, optic atrophy, recurrent optic neuritis and fracture of orbital walls. The clinical and neuroimaging record was analysed to reappraise the importance of neuroimaging in ocular diseases.
Results: Out of 230, 80 patients (34.78%) had brain diseases, 56 (24.35%) had purely orbital pathology, 52 (22.61%) had paranasal sinus diseases extending into the orbit, 13 patients (5.65%) had abnormalities of visual pathway and 29 patients (12.6%) showed normal imaging.
Key words: Neuroimaging, computed Tomography, Magnetic Resonance Imaging, Neuro-ophthalmology.

INTRODUCTION

Anatomically eyeball can be grossly divided into anterior and posterior segments (crystalline lens being the landmark). Anterior segment is easily visualized with the help of Slit Lamp Biomicroscope and for posterior segment examination, Direct and Indirect Ophthalmoscope are in common use. There is a very interesting saying that if you want to see Central nervous system with your eyes, see the optic disc, which is a part of optic nerve in the eyeball. Hence, most of the pathologies of eyes are easily accessible. Even in case of opaque media, Ultrasonography provides an excellent aid. Nevertheless, there are some diseases of brain and paranasal sinuses that directly or indirectly affect the eyes. Here comes the role of diagnostic neuroimaging.

SUBJECTS AND METHODS

We retrospectively reviewed clinical data and CT or MRI of the patients referred by ophthalmologists Heart and body Scan centre and Open MRI centre , Lahore between the year 2000 and 2008. CT and MRI with or without contrast were the techniques used in the study. Medical and ocular data was obtained which included age, gender, medical and ocular history including chief ocular symptoms or signs for which the patient was referred. The age range was from 5 months to 85 years. There were 91 females and 139 males.

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The detail of clinical findings for which the patients were referred is as follows:

Papilledema	12 patients
Hemianopias/visual field defects	12
Proptosis	68
Ptosis	25
Cranial nerve palsies/ophthalmoplegia	20
Diplopia	16
Nystagmus	1
Pain in the eyeball	12
Optic atrophy	6
Recurrent attacks of optic neuritis	2
Impaired visual acuity	88

Many patients presented with more than one positive clinical finding. There were also some patients who had associated systemic problems that included diabetes, hypertension, sarcoidosis, headache, vertigo, head injury, facial palsy, hyperthyroidism, transient ischemic attacks, tooth infection, carcinoma of prostate and breast with metastasis, acromegaly, recurrent sinusitis, stroke, neurofibromatosis, multiple sclerosis, Leukemia, Lymphoma and fever. The data was analysed and to simplify it we divided the patients into four categories.

1. Patients with diseases confined to the orbit
2. Patients with brain diseases directly or indirectly affecting the eyes
3. Patients with paranasal sinus diseases extending into the orbit
4. Patients with diseases of visual pathway

RESULTS

Out of 230, 56(24.35%) had purely orbital pathology, 80 patients (34.78%) had brain diseases affecting the eye, 52 (22.61%) had diseases of paranasal sinuses extending into the orbit, 13 patients (5.65%) had abnormalities of visual pathway and 29 patients (12.6%) showed normal imaging.

Majority of the patients with purely orbital disease presented with proptosis, impaired vision, congestion and in some cases with optic disc edema. Some cases of enophthalmos caused by fracture of the orbital wall were also included in this group. There were 28 patients with orbital tumours, which included Rhabdomyosarcoma, lymphangioma, leukaemic infiltrates and metastasis from breast and prostate carcinoma. (Table 1).

Ocular presentation of patients with brain diseases (second category) is mostly papilledema and headache. Visual field defects are common with the pituitary fossa mass. In Cavernous sinus thrombosis and Carotico-Cavernous fistula patients present with multiple cranial nerve palsies. (Table 2).

In third category, we had patients with paranasal sinus diseases that affect the orbit by proptosis and inflammation of the eyeball. (Table 3). While Optic disc swelling, optic atrophy and visual field defects are common findings in abnormalities of visual pathway (Table 4).

Table 1: Detail of patients with diseases confined to the orbit

Orbital tumours	28
Orbital inflammation (orbital cellulitis + pseudo tumour)	8
Enlarged extra ocular muscles (hyperthyroidism)	4
Osteomyelitis of orbital bones	1
Retro bulbar haematoma (post traumatic)	1
Foreign body in the orbit	1
Fracture of orbital wall	13
Total	56 (24.35%)

Table 2: Detail of Patients with brain diseases(80) affecting the eyes

Pseudo tumour cerebri	4
Encephalomalacia/Encephalitis	4
Brain infarcts	17
Carotid cavernous sinus fistula	3
Meningitis	4
Cavernous sinus thrombosis	3
Pituitary fossa mass	43
Brain haemorrhage	1
Frontal lobe contusion	1
Total	80(34.78%)

Table 3: Detail of patients with paranasal sinus disease extending into the orbit

Sinus inflammation (bacterial)	23
Sinus inflammation (fungal)	14
Nasal tumour/ polyps	15
Total	52 (22.61%)

Table 4: Detail of patients with abnormalities of visual pathway

Demyelination of visual pathway	9
Chiasmal atrophy	4
Total	13 (5.65%)

DISCUSSION

Neuroimaging is a term used for the diagnostic techniques, which directly or indirectly image the structure and function of brain. Since the discovery of X-rays in 1895 by Rector Wilhelm Conrad Roentgen, there have been significant advances in the clinical imaging reaching the highly sophisticated techniques like Magnetic Resonance fluoroscopy, Echo planar imaging and functional imaging etc. Grossly, Neuroimaging falls into two major categories.

1. Structural imaging
2. Functional imaging

This article focuses upon the role of Structural imaging (Computed Tomography and Magnetic Resonance imaging) in Ophthalmology. CT scan uses X-ray beams to obtain tissue density values from which detailed images are formed by a computer. For orbit, axial and coronal sections are adequate[1]. Recently, multislice scanner provides thinner slices with improved spatial resolution. Intra venous contrasts are used to distinguish between various pathologies like inflammatory, neoplastic or vascular. While MRI is the technique of choice for visual pathways, it also produces remarkable images in the region of orbital apex, orbital canal and parasellar region.

In this study, the most common brain pathology, which led the patient to consult an ophthalmologist, was pituitary fossa mass (43/80) as mentioned in table 2. Of these, six patients had Craniopharyngioma and thirty-seven were diagnosed as Macroadenoma of pituitary gland. Macroadenoma usually have suprasellar extension resulting in compression of optic chiasma from below and bitemporal hemianopias. Clinically in Macroadenomas, superior temporal fields are affected first while in Craniopharyngiomas infero-temporal fields are involved before the superior temporal fields[2]. It is because, in Craniopharyngiomas tumour compresses the chiasma from above. On MRI, lesions are low to isotense on T1 weighted and hyper-intense on T2

weighted images[3,4]. Sometimes cystic components appear hyper intense on T1 weighted images. While CT scan is useful for fresh intra cranial haemorrhages, MRI is more sensitive in detecting Ischemic brain infarcts.

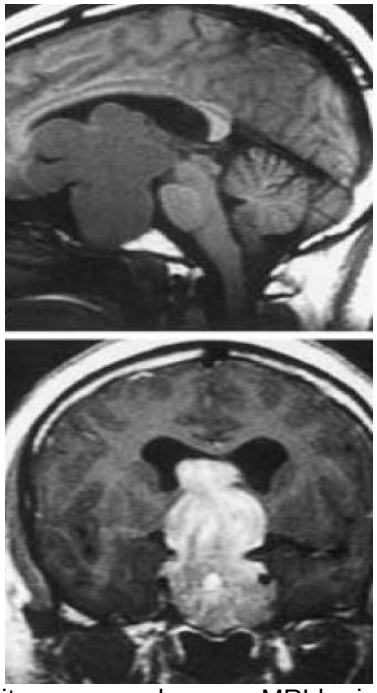

Fig -1: Pituitary macroadenoma ,MRI brain & pituitary fossa (sagittal plain T1W sequence & coronal T1post contrast), showing large lobulated pituitary mass causing mass effect on optic chiasm & extending in to 3rd and lateral ventricles with involvement of both cavernous sinuses specially the left one. Homogenous post contrast enhancement is noted.

Other cases with brain pathology included three patients with post-traumatic Carotid Cavernous sinus fistula. Although Arteriography is the best technique for such cases but CT and MRI also play an important role in diagnosis. Imaging findings include Proptosis, distension of affected Cavernous sinus and asymmetric dilatation of superior ophthalmic vein[5].

In the present study, orbital diseases included abnormalities of bony orbit and soft tissues. For orbital bony anatomy, CT scan is the technique of choice (13 cases of orbital wall fracture in our study). For intra orbital foreign bodies thin section (1.5mm or less) are usually required. Orbital apex lesions and intra cranial extension of orbital tumors are best detected with MR scans[6]. Most of our patients with orbital soft tissue abnormalities had orbital tumors (28 patients). Primary tumors of optic nerve and meningiomas of optic nerve sheath are relatively less common. Optic nerve gliomas do not calcify and meningiomas show calcification that is best detected on CT scan. Thus, CT or MRI can be used for these tumours[7]. Other tumours included Rhabdomyosarcoma, Leukemic infiltrates, Lymphomas, Metastatic tumours.

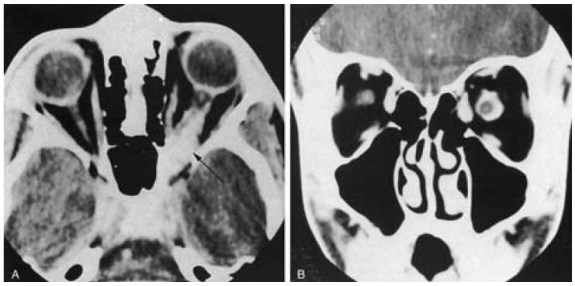

Fig-2: Axial and coronal images of CT scan orbit showing high density mass around optic nerve, favoring left optic nerve meningioma.

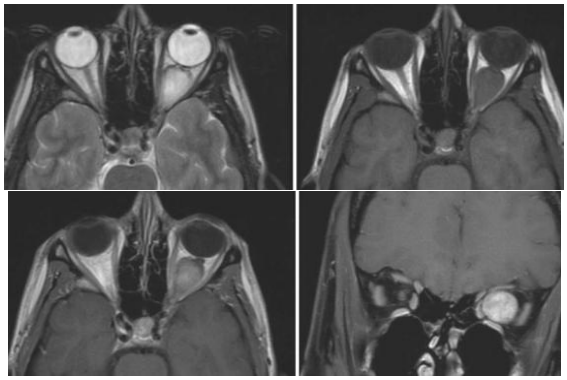

Fig-3: MRI of orbit (T2, T1 axial & coronal fat sat sequences) showing left optic nerve glioma.

In thyroid ophthalmopathy (4 patients), CT and MRI show fusiform enlargement of extra ocular muscles sparing the tendons. While in orbital pseudo tumour and orbital celluilitis, there is extension of inflammation to the tendons, lacrimal apparatus, sclera, optic nerve sheath and orbital fat as well[8].

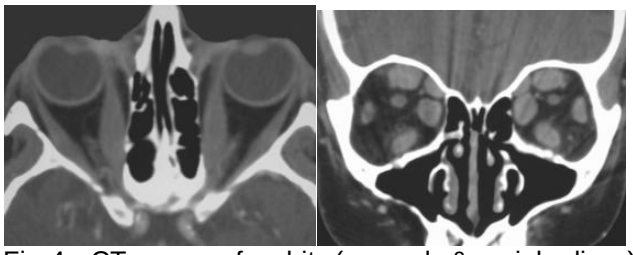

Fig-4: CT scan of orbit (coronal & axial slices) showing swollen extra-ocular muscles , sparing their tendons in thyroid ophthalmopathy.

As far as the paranasal sinus disease extension to the orbit is concerned, we had thirty seven patients with paranasal sinus inflammation spreading to the

orbit (23 bacterial and 14 fungal). Orbital extension of Sino-nasal infection occurs through frontal sinuses in adults and ethmoid sinuses in children[9]. In such cases CT scan gives an advantage in that it not only shows fluid of the inflammatory process in the sinuses but also shows the region of bony defect from where the infection has spread to the orbit[10].

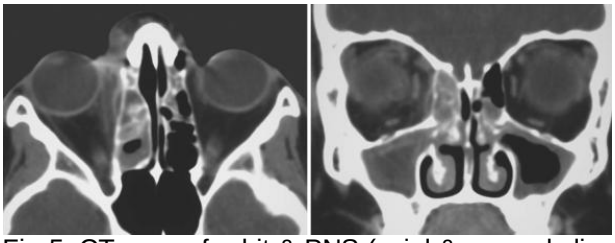

Fig-5: CT scan of orbit & PNS (axial & coronal slices) diffuse inflammatory changes are noted in maxillary & ethmoid sinuses, predominantly on right side ,extending in to right orbit with inflamed medial rectus muscle.

MRI studies have the edge in maping the extent of Sino-nasal mass or inflammatory process. In addition, MRI also helps to distinguish inflammatory disease from the Sino-nasal tumors[11].

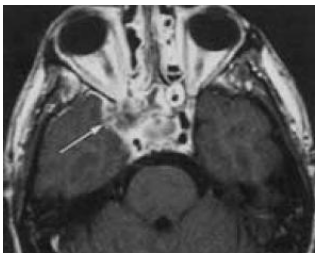

Fig-6: MRI brain & orbit (axial post contrast) image showing diffuse inflammatory changes involving ehtmoid and sphenoid sinus, extending in to apex of the of right orbit, & in right middle cranial fossa with the involvement of right cavernous sinus.

As all the four paranasal sinuses lie adjacent to the orbit. There are also foramina in the walls to allow nerves and blood vessels to pass through. These act as routes for the invasion of Sino-nasal tumors to the orbit. MRI also helps to establish the route of spread of tumor to the orbit[12].

MRI also has a key role in anatomical localization and characterization of demyelination, inflammation and vascular lesions of visual pathway.[13] In demyelination, Multiple Sclerosis is the most common[14].

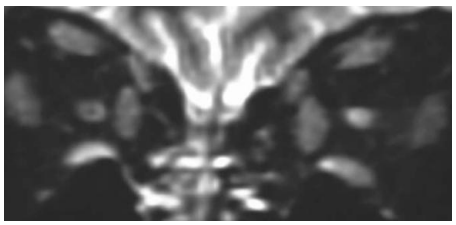

Fig-7: MRI of orbit, coronal T2-fat suppression images showing focal bit swollen left optic nerve with mild increased signals favoring MS-plaque.

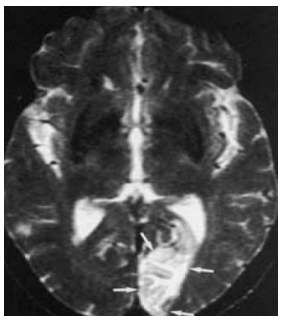

Fig-8: MRI brain (axial T2Wsequence) showing ischemic insult in left occipital lobe.

There were 29 cases where the CT and MRI showed no abnormality. Many of these patients had isolated cranial nerve palsies, headache or amaurosis fugax. Thus, normal imaging results do not necessarily mean absence of any pathology. It could be normal in the presence of definite disease[15]. It can be correlated with the study of Harooni H et al,[16] according to whom the diagnostic value of scanning in patients with facial and eye pain is low. Furthermore, there is also significance of negative findings in neuroimaging. For example, in cases of pseudo tumour cerebri or Idiopathic intracranial hypertension the CT and MRI can be normal[17].

CONCLUSION

CT and MRI have a vital role in neuro-ophthalmology that can be summarized as follows:

1. It helps in diagnosis of certain ocular diseases.
2. It gives information about the location of a lesion in an already diagnosed case including the nature and extent of the lesion.
3. It can act as a tool in follow up and prognosis of a disease.

   However, it is very important for the referring ophthalmologist to provide complete and accurate clinical profile of the patient.

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