ORIGINAL ARTICLE

Role of Magnetic Resonance Imaging in Intracranial Infections at a Tertiary Level Medical College

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Abstract:

Background: Intracranial infections range from indolent to life threatening and from self limited to relentlessly progressive. Early detection and accurate characterization with MRI can allow appropriate therapy to be initiated and complication to be managed appropriately. *Aim and Objectives*: This prospective diagnostic study was conducted to evaluate role of MRI in diagnosis of intracranial infection and to study its specificity in various intracranial infections. *Material and Methods*: A prospective study of 100 patients with clinical presentation of intracranial infections was conducted in the Department of Radiodiagnosis at the tertiary care hospital in Goa (Goa Medical College), over a period of one year and six months by using 1.5 Tesla superconductive unit. *Results and Conclusions:* MRI is undoubtedly an indispensible tool to evaluate patients presenting with intracranial infections. Careful evaluation of magnetic resonance behaviour of infectious lesions helps in identifying not only the precise location and extent of the lesion, but also in proposing a specific etiology in many such patients.

Keywords: MRI(Magnetic Resonance Imaging), Intracranial Infection

Introduction:

Many patients are routinely referred with clinical presentation suggestive of intracranial infection to tertiary care hospital. Performing MRI in these patients is highly beneficial in diagnosing or ruling out presence of intra cranial infection and it often helps in suggesting nature of infection. Foerster *et al* [1] also concluded that the radiologist play central role in the diagnosis and management of patients with intracranial infections. MRI is much more sensitive than CT scan for defining the extent of infection, and identifying infection related complications such as subdural effusion. A thorough understanding of the imaging patterns associated with common intracranial infections allows radiologist to help narrow the differential diagnosis and facilitate early implementation of appropriate therapies. This article describes the MRI findings of 100 patients referred to tertiary hospital in Goa Medical College with clinical presentations suggestive of intracranial infection.

Material and Methods:

A prospective diagnostic case series study of 100 patients with clinical presentation of intracranial infections was conducted in the Department of Radio diagnosis at the tertiary care hospital in Goa (Goa Medical College), over a period of one year and six months. During October 2009 till April 2011 a total 100 patients who reported to the Neurosurgery, Medicine or Neurology Departments with signs and symptoms of intracranial infections were included in the study. Exclusion Criteria were patients with pacemakers, ferromagnetic prosthetic valve, aneurysm clips and Claustrophobia. Findings of laboratory investigations e.g. CSF analysis, IgG antibody titres (eg. toxoplasmosis) were recorded

in the proforma of the study. Ethical Clearance for the study was obtained before commencement of the study from Institutional Ethics Committee, Goa Medical College, Bambolim Goa. Diagnosis was confirmed on CSF analysis and/or response to appropriate therapy. Images were acquired on a 1.5 Tesla superconductive unit (Magnetom "Avento", Siemens), using a dedicated head coil. In some patients intravenous Gadolinium (MRI contrast agent) was injected wherever indicated. No specific patient preparation was required for the normal level study; however patients were advised to remain fasting for at least 4 hrs for contrast imaging study. It was ensured that renal function test were within normal limits before injecting contrast agent and no contraindications to Magnetic Resonance Imaging existed among the patients. Standard MRI sequences were used and MR imaging protocol was as per accepted norms. These included cross sectional axial images in T1 weighted imaging (T1WI) and T2 weighted imaging (T2WI). Images were also obtained in coronal and sagittal plane using T1WI and T2WI. Wherever necessary special sequences were obtained. This include Fluid attenuated inversion recovery (FLAIR), Diffusion weighted Imaging (DWI) and Apparent diffusion co-efficient (ADC). Additional MR sequences like Gradient echo sequences and MR spectroscopy were performed as and when indicated. Paramagnetic MR contrast medium, intravenous Gadolinium enhanced T1 weighted images were obtained whenever considered necessary. Finally, the results of Magnetic Resonance Imaging were correlated with the histopathological, CSF & other laboratory investigation findings.

Results:

Maximum of 56 (56%) patients with intracranial infection were < 30years of age with peak incidence at 20-30 year. 31 (31%) of patients were between the 30-50 years. Only 13 (13%) patients were above the age of 50 years (Table 1). Seizure (64%) was the most common presentation in patients with intracranial infection, followed by fever (39%) and altered sensorium (25%) (Table 2). Tuberculosis was the most common intracranial infection found in the current study, followed by parasitic, pyogenic (bacterial) and viral. Fungal infection was the least common. Amongst parasitic neurocysticercosis was the most common. Most common imaging manifestation of pyogenic (bacterial) infection is meningitis; followed by brain abscess and sub/epidural empyema (Table 3 and 5). Out of total 100 patients with intracranial infections 23 (23%) patients were HIV positive. Tuberculosis (30.4%) was the most common intracranial infection found in HIV positive individuals, followed by toxoplasmosis (26%). Least common intracranial infection associated with HIV is Progressive

Multifocal Leukoencephalopathy (0.04%) (Table 4).

Table 1: Age and Sex Distribution in Intracranial Infections

Age Group	Male		Female		Total	
	Number	Percent	Number	Percent	Number	Percent
0-10	10	16.3	2	5.1	12	12
11-20	10	16.3	8	20.5	18	18
21-30	14	22.9	12	30.7	26	26
31-40	10	16.3	8	20.5	18	18
41-50	10	16.3	3	7.6	13	13
51-60	5	8.1	4	10.2	9	9
61-70	2	3.3	2	5.1	4	4
Total	**61**	**100**	**39**	**100**	**100**	**100**

Table 2: Symptomatology in 100 Patients Suspected To Have Intracranial Infections

Symptoms/Signs	Number	Percent
Seizures	64	64
Fever	39	39
Altered Sensorium	25	25
Headache	13	13
Vomiting	5	5
Neck stiffness	3	3
Visual disturbance	2	2
Cranial Nerve Palsies	2	2
Dementia	2	2
Hemiplegia	1	1
Behavioural abnormality	1	1
Total	**100**	**100**

Table 3: Distribution of Intracranial Infections

Type of Intracranial Infection	Number	Percent
Tuberculosis	44	44
Neurocysticercosis	20	20
Pyogenic Meningitis	6	6
Toxoplasmosis	6	6
Herpes Simplex Encephalitis	5	5
Pyogenic Abscess	4	4
Fungal	4	4
Pyogenic subdural/epidural effusion	2	2
Japanese Encephalitis	2	2
Acute Disseminated Encephalomyelitis	2	2
Human Immune Deficiency Encephalopathy	2	2
Progressive Multifocal Leukoencephalopathy (PMLE)	1	1
Sub-Acute Sclerosing Panencephalitis	1	1
Creutzfeldt Jacob Disease	1	1
Total	**100**	**100**

Table 4: Intracranial Infections among HIV infected patients

Type of Intracranial Infection	Number	Percent
Tuberculosis	7	30.4
Toxoplasmosis	6	26.0
Bacterial	4	17.3
Fungal	3	13.0
HIV Encephalopathy	2	8.6
PMLE	1	4.3
Total	**23**	**100**

Table 5: Types of Lesions

Sr. No	Type of Lesions	Number (Percent)	MRI Diagnostic Ability (%)
1	**Tubercular**	44 (44)	70 %
2	**Parasitic**	26 (26)	90 %
3	**Pyogenic**	12 (12)	83 %
4	**Viral**	12 (12)	66 %
5	**Fungal**	4 (4)	50 %
6	**Miscellaneous**	2 (2)	-
	Total	**100**	

1. **Tuberculosis**: In 31 patients (70%) confident diagnosis of intracranial tuberculosis was made based on characteristic MRI findings. The remaining 13 patients (30%) required combination of clinical, CSF changes and imaging findings to conclude the diagnosis.
2. **Parasitic**: Presumptive diagnosis of intra cranial parasitic infection was made in 23 patients (90%) based on typical MRI findings which were later confirmed with supportive laboratory findings.
3. **Pyogenic**: Diagnosis of intracranial pyogenic infection was made in 10 patients (83%) based on MRI findings only. Remaining 2 patients (17%) required clinico-laboratory correlation before initiating therapy.
4. **Viral**: Out of total 12 patients with viral intracranial infection 8 patients (66%) were diagnosed based on MRI findings alone. The remaining 4 patients (34%) required imaging and clinico-laboratory correlation to reach to diagnosis of viral etiology.
5. **Fungal**: Diagnosis of fungal intra-cranial infection was made in 2 patients (50%) based on MRI findings alone; whereas the remaining 2 patients (50%) required correlation with clinical, microbiological and imaging findings to conclude the diagnosis.

Findings in Pyogenic Intracranial Infections:

Meningitis / Cerebritis

Six cases of pyogenic CNS infections who presented with headache, vomiting and neck stiffness were studied. 4 patients were females and 2 were males. Maximum incidence was in the age group of 11-20 years. Isolated focal cerebritis was seen in 3 (50%) patients, isolated meningitis was seen in 2 (33.3%) patients and both meningitis and cerebritis was seen in 1 (16.6%) patient. The lesion appeared isointense in 4 (66%) patients and hypointense in remaining 2 (34%) patients on T1WI. On T2WI the lesion appeared isointense in 3 (50%) patients and hyperintense in 3 (50%) patients. These changes represent ischemia and / or edema. All these lesions showed restricted diffusion on DWI. Gd- DTPA enhanced scans were performed in all 6 patients and found that 2 (33.3%) patients showed isolated meningeal enhancement, 3 (50%) patient showed gyriform enhancement and 1 (16.6%) patients showed both gyriform and meningeal enhancement.

Subdural / Epidural effusions / Empyemas

Two patients presented with high fever and altered sensoriums were studied in this group. The site of empyema was the interhemispheric fissure in 1 case, and cerebral convexity in the other case. In

both the cases, the collections were isointense to hyperintense on T1WI and hyperintense on T2WI. In the present study, rim enhancement of the collection with associated meningeal enhancement was noted in both cases on post contrast images (Fig.1).

hypointense on T2WI in all 4 patients. Surrounding perilesional hyperintensity was seen on T2WI in all the cases suggestive of perilesional edema. Mass effect on surrounding structures was seen in 3 patients. On contrast injection, rim

Fig. 1:Sagittal Post Contrast T1WI Fat Sat: Shows A Multi-Loculated Extra Axial Collection Over Right Cerebral Convexity Showing Peripheral Rim Enhancement with Associated Meningeal Enhancement along the Right Tentorium Cerebelli.

Pyogenic Abscess

Patients in this group presented with high fever, seizures, and one of the patients with right sided hemiplegia. The incidence was found to be higher in the first and second decade of life; mostly due contiguous spread of infection from otitis media which is common in younger age groups. The abscesses were single in 1 patient and multiple in 3 patients. In 2 (50%) patients, the abscesses were supratentorial and in the remaining 2 (50%) patients, the abscesses were infratentorial. In all 4 patients, the abscess cavity was hypointense on T1WI and hyperintense on T2WI and FLAIR. The capsule was hyperintense on T1WI and enhancement was seen in all cases with smaller daughter abscesses seen in 2 patients (fig. 2). In our study, none of the patients showed intraventricular extension / rupture. The role of DWI in distinguishing a pyogenic abscess from a necrotic tumor was studied. It was found that in all 4 cases, the abscesses were hyperintense on DWI and showed low ADC Values, in comparison to necrotic tumors which are hypointense on DWI and hyperintense on ADC. MR Spectroscopy was performed in 3 cases. Lipid lactate peaks at 0.3 ppm were obtained along with amino acids at 0.9 ppm in all 3 patients.

Fig. 2: Axial Post Contrast T1WI Fat Sat: Shows a Large Rim Enhancing Lesion in the Left Parietal Lobe, With a Smaller Daughter Abscesses Anterior to it. The Abscess is Causing Mass Effect on the Lateral Ventricle and Midline Shift to the Right.

Findings in Intracranial Tuberculosis

Forty four patients of intracranial tuberculosis were studied. The maximum incidence of intracranial tuberculosis was in the age group of 21-30 years. 35(79.5%) cases presented with seizures, 26(59%) with fever, 8(18%) with headache, 8(18%) with cranial nerve palsies, 7(15.9%) with altered sensorium, 4(9%) with vomiting, 2(4.5%) with neck stiffness and 1(2.2%) with visual disturbance. 34 cases (77.2%) had isolated parenchymal enhancing lesions, 3 patients (6.8%) showed isolated leptomeningeal enhancement (tuberculous meningitis) and 5 patients (11.3%) had both parenchymal and leptomeningeal enhancement.

Contrast enhanced scans were obtained in all cases of suspected tuberculosis and significant enhancement of the meninges and basal cisterns was seen in 8 (18.8%) cases, out of which 5 (11.3%) cases had associated enhancing granulomata and 3 (6.8%) had isolated enhancement of meninges. Associated ependymal enhancement was seen in 2 patients (4.5%).

In the present study, complications of tuberculous meningitis like communicating hydrocephalus was seen in 6 (13.6%) patients. 41 cases of parenchymal tuberculosis were studied. Single ring enhancing lesion was seen in 19 cases (46%) and multiple in 22 (54%) cases. The lesions were supratentorial in 32 cases (78%), infratentorial in 2 cases (4.8 %) whereas in 7 cases (17%) both compartments were involved.

We characterized the parenchymal lesions based on their findings and found that in 22 cases, the tuberculomas were caseating i.e. hypointense on T1 and T2WI with surrounding perilesional edema with ring enhancement on contrast scans and in 15 cases, they were caseating with central liquefaction i.e. hypointense on T1WI and hyperintense on T2WI with ring enhancement. In 4 cases, the tuberculomas were non caseating i.e. hypointense on T1WI, hyperintense on T2WI and show homogenous/nodular enhancement on post contrast scans. Parenchymal lesions had a ring enhancing pattern in 31 cases (fig. 3.1) and nodular homogenous pattern in 3 cases. Conglomerate lesions were seen in 6 cases (14.6 %).

Seven cases of intracranial tuberculosis in HIV patients were studied. All 7 (100%) patients presented with fever, while 3 (60%) presented

with headache, 4 (80%) presented with altered mental sensorium and 2 (40%) presented with seizures. 2 (40%) patients had isolated meningeal enhancement, 3 (71%) patients had tuberculomas in both thalami (fig. 3.2), 2 (28.5%) patients had meningeal and ring enhancement, whereas 1(14.2%) patient had tuberculomas with associated ependymal enhancement. MR Spectroscopy was performed in 10 cases of tuberculomas. They demonstrate prominent lipid lactate peaks, but no amino acid peaks were seen.

Findings in Viral Intracranial Infections: Herpes Simplex Encephalitis (HSE)

5 cases of HSE who presented with fever, behavioural abnormality and altered sensorium, were studied. The incidence was highest in the age group of 11-20 years. The characteristic sites were medial temporal lobe in 4 (80%) out of 5 cases, insular cortex in 3 patients, cingulate gyrus in 3 patients and thalami in 1 patient (Fig. 4a). The typical imaging features of HSV that we found in the present study were, increased signal seen in the temporal and inferior frontal lobes on T2-weighted with a variable degree of mass effect. The lesions were more conspicuous on FLAIR sequence (Fig. 4b).

Fig. 3.1: Axial Post Contrast T1WI Fat Sat: Shows Ring Enhancement of the Caseating Granuloma With Central Liquefaction.

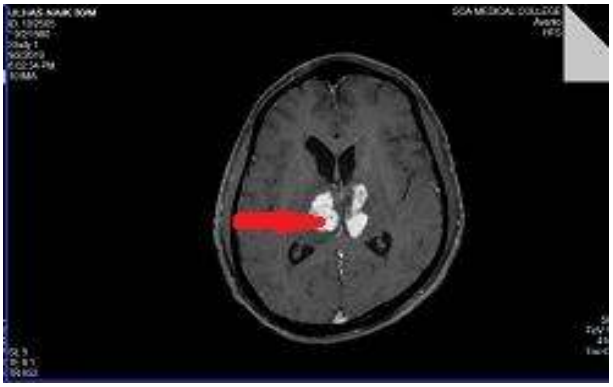

Fig. 3.2: Axial Post Contrast T1WI Fat Sat: Shows Irregular, Nodular Enhancement of Conglomerate Tuberculomas in a Seropositive Patient

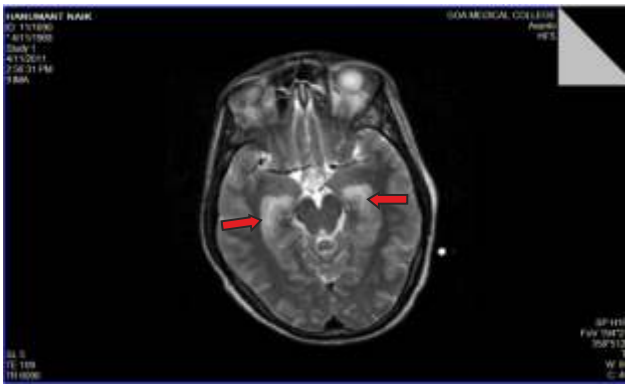

Fig. 4: Axial T2WI (a) and Flair (b): Shows Hyperintense Signal in the Hippocampal Region Bilaterally in a Patient of HSV.

HIV encephalopathy

In the present study, we studied 2 patients of HIV encephalopathy. 1 patient was a 25 year old male and 1 was a 60 year old female. Both patients presented with progressive dementia and unexplained weight loss. Both patients showed bilaterally symmetrical white matter hyperintensities on T2-weighted images. We compared T2WI with FLAIR sequences in detection of white matter lesions in cortical and subcortical location, in AIDS patients. Due to its improved lesion detection rate and higher overall lesion conspicuity we concluded that FLAIR sequences are superior to T2WI in detection of white matter lesions.

Acute Disseminated Encephalomyelitis (ADEM)

Two cases of ADEM were studied. One was a 25 year old male and the other was a 3 month old female infant. The infant had history of vaccination prior to development of symptoms while the adult male had an episode of flu like viral illness prior to the development of symptoms which made ADEM a likely diagnosis. The lesions were multiple in both cases. The typical sites of involvement were periventricular white matter in both cases. Hyperintense signal was seen in the periventricular white matter on T2WI and FLAIR sequences (fig. 5), which did not show restriction on DWI. No significant contrast enhancement was seen in both. MRI of the spine revealed no abnormal signal in the spinal cord.

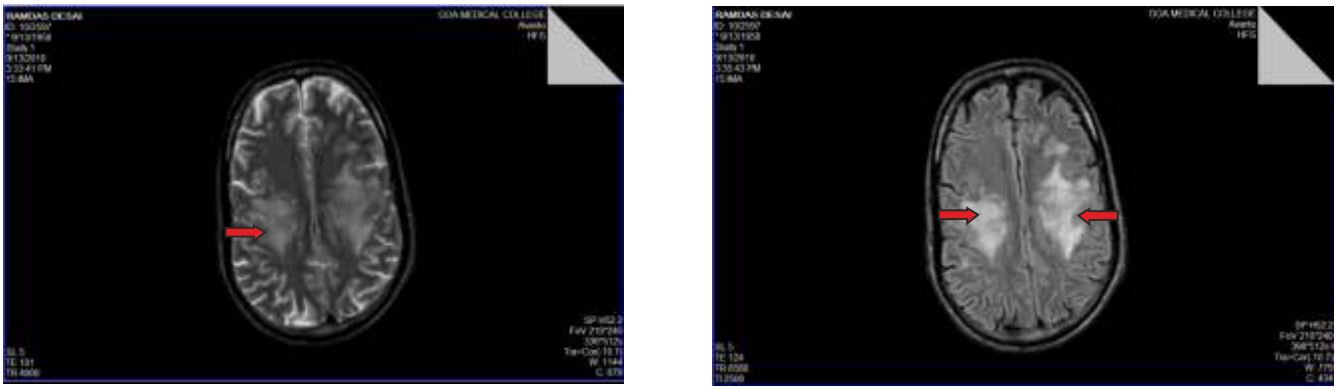

Fig. 5.: Axial T2WI and Flair: Shows White Matter Hyperintensities in Bilateral Centrum Semiovale, in a Patient with ADEM

Japanese Encephalitis

2 cases of Japanese encephalitis were studied. Both patients were males between 11-20 years. Both the patients presented with fever and altered sensorium. The characteristic sites involved were bilateral thalami in both patients and bilateral basal ganglia in 1 patient. The lesions were seen as isointense on T1WI and hyperintense on T2WI (Fig. 6a) and FLAIR (Fig. 6b).

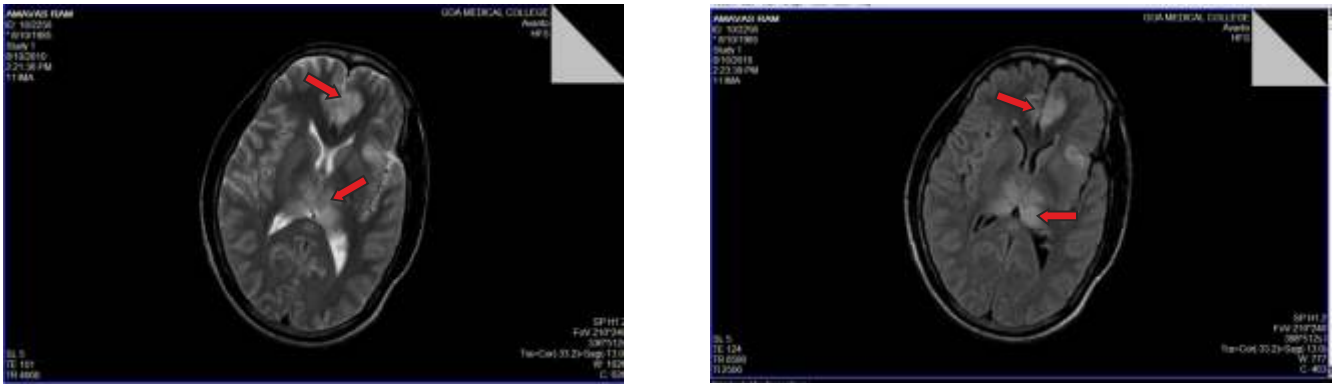

Fig. 6: Axial T2WI (a) and Flair (b): Shows Hyperintense Signal in Cingulate Gyrus and both Thalami, in a Patient with Japanese Encephalitis

Subacute Sclerosing Panencephalitis (SSPE)

One case of SSPE was studied in 18 year old female who presented with behavioral abnormalities. MRI revealed increased signal intensity in the periventricular white matter and in both centrum semiovale on T2WI and FLAIR. DWI revealed no restriction of these hyperintensities and no contrast enhancement was seen. EEG findings (Burst Suppression Pattern) in this patient were found to be consistent with the diagnosis of SSPE.

Parasitic Infections:

Neurocysticercosis

There were 20 cases of neurocysticercosis in the present study. 15 of these were males and 5 were females. The highest incidence was observed in the age group of 31-40 years. All 20 patients presented with seizures, while 5 presented with headache, 2 with fever and 1 with visual disturbance.

The lesions were single in 10 cases and multiple in 10 cases. The cysticercal lesions in our study, were parenchymal in 19 patients (95%), intraventricular in 1 patient (5%) and both intraventricular and parenchymal, in 3 patients (15%).

There were 3 intraventricular cysticercal lesions (15%). The lesion was an isolated intraventricular lesion in the third ventricle in 1 case and in 2 (66.6%) cases; the lesions were associated with parenchymal lesions. The intraventricular lesions were located in the 3rd ventricle in 1 (33.3%) cases, frontal horn of the right lateral ventricle in 1 (33.3%) and fourth ventricle in 1 patient. Associated hydrocephalus and periventricular hyperintensity was noted in 1 lesion. Out of the parenchymal lesions, 16 were supratentorial (80%) and 3 were supra and infratentorial (15%). Purely infratentorial lesions were not seen in our study. The lesions were in the vesicular stage in 9 (45%) cases, colloid vesicular in 12 (60%) cases, granular nodular in 6 (30%) patients and calcified in 1 (5%) patient. Multiple stages were found to coexist in 8 patients. T2W images showed small hyperintense rounded lesions with perilesional edema (fig.7.1b). Central high signal intensity nodule within the lesion, suggestive of scolex (fig. 7.1a), was seen in 13 cases, which was best seen on FLAIR sequences in our study. Intense ring enhancement (fig. 7.1b), with surrounding perilesional edema is noted in 15 patients suggestive of active lesions. MRI was found to be superior to CT scan for the detection and characterization of cysticerci lesions. In the present study, 5 patients underwent follow up MRI after 3 months of treatment which revealed a decrease in the number of lesions as well as perilesional edema.

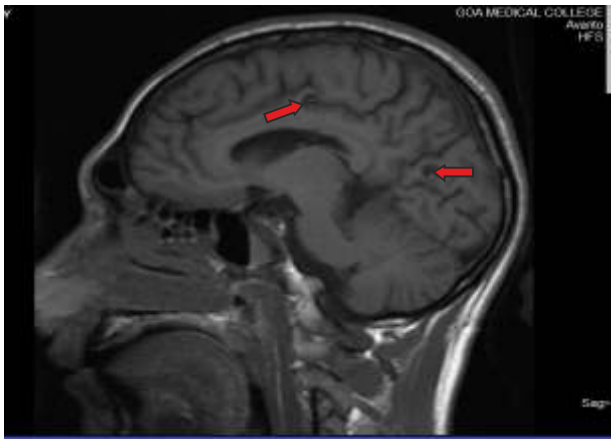

Fig. 7(a): Sagittal T1WI: Shows Hypointense Neurocysticercosis Lesions in the Parietal and Occipital Lobes Showing Hyperintense Central Foci within suggestive of Scolices.

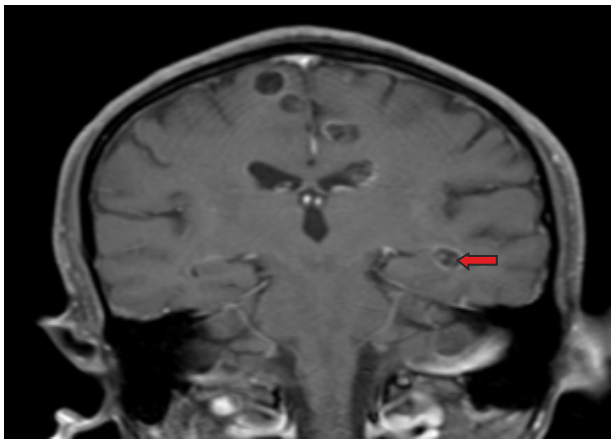

Fig. 7(b): Coronal Post Contrast Fat Sat: Ring Enhancing Lesion Seen in Left Temporal Lobe with a Central Scolex within.

Toxoplasmosis

In the present study, we encountered 6 patients with toxoplasmosis. All these patients were HIV positive. Incidence was maximum in the age group of 31-40 years. 5 patients presented with altered sensorium, 2 with seizures and 1 with fever. The characteristic sites of Toxoplasma lesions in our study were thalami in 2 (33.3%) patients, basal ganglia in 2 (33.3%) patients; corticomedullary junction in 2 (33.3%) patients and 1 (16%) patient had involvement of the infratentorial compartment. Perilesional edema was seen in all 6 patients and mass effect was seen in 2 patients. The lesions were hyperintense on T2WI and FLAIR (Fig. 8.1). On T1WI, lesions were isointense in 5 patients and hypointense in 1 patient. On contrast injection, ring enhancement were observed (Fig. 8.2) in all 6 cases with typical target pattern of enhancement being present in 3 patients. MR Spectroscopy performed showed lipid lactate peak in 5 patients. MR Spectroscopy could not be performed in 1 patient due to proximity of the lesion to skull vault.

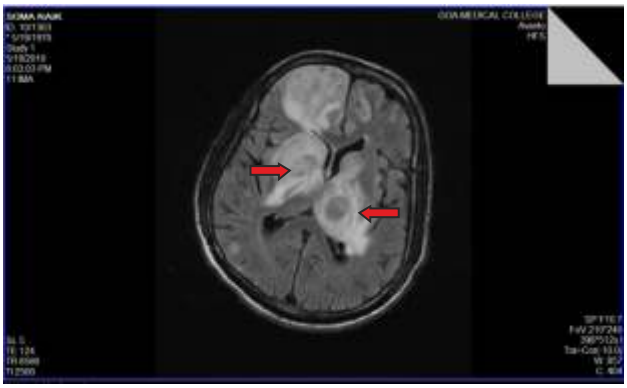

Fig. 8.1: Axial Flair : Shows Multiple, Isointense, Toxoplasma Lesions in the Right Basal Ganglia, Right Frontal Lobe and Left Thalamus, with Extensive Surrounding Perilesional Edema, in a Seropositive Patient.

Fig. 8.2: Coronal T1WI Fat Sat: In the Same Patient Shows Ring Enhancing Lesion in the Right Thalamus.

Fungal Infections

4 cases of intracranial fungal infections were studied. Three patients were HIV positive. Majority of cases were in the 50-60 years age group. All 4 patients presented with fever, 2 with altered sensorium, and 1 with headache and vomiting. In one of the HIV positive case, there was hyperintense signal intensity in the left temporo parietal region with few hypointense areas within on T2WI and FLAIR sequences and hyperintense areas were seen within an isointense lesion on T1WI and showed intense enhancement of meninges over the left cerebral convexity and the basal cisterns suggestive of meningo-encephalitis. CD4 count was 11. In the second patient, enhancing soft tissue with extension into the right temporal lobe was noted, suggestive of fungal sinusitis with intracranial extension (Fig. 9.1). In the third HIV positive patient, there were few non enhancing CSF intensity lesions in the basal ganglia corresponding to dilated Virchow Robin spaces with CSF showing lymphocytosis and Cryptococcus on India ink staining (fig. 9.2).

Fig. 9.1: Axial Post Contrast Fat Sat: Shows Intracranial Extension of the Sinusoidal Soft Tissue into the Right Temporal Lobe, in a Patient with Fungal Sinusitis.

Fig. 9.2: Sagittal Post Contrast T1wi Fat Sat: Shows Peripherally Enhancing Cryptococcal Lesions in the Left Occipital Lobe, in a Seropositive Patient.

Discussion :

MRI is the most preferred imaging modality of choice to evaluate infectious diseases of the brain due to its multiplanar imaging and anatomical details provided by various MR sequences. Besides it is radiation free, and has high sensitivity and specificity to suggest specific etiology in many infective lesions. Most commonly identified pathology was intracranial tuberculosis which was seen in 44% of the patients in both parenchymal and meningeal forms. Characterization of the parenchymal lesions as caseating, non- caseating, and caseating with central liquefaction is possible on MRI, based on their imaging features on T1WI, T2WI and post contrast imaging. Our findings were comparable to Morgado C *et al* [2] who concluded that the MRI findings of tuberculomas depend on whether the tuberculoma is caseating, and if so, whether the center is liquid or solid.

Neurocysticercosis was the most common parasitic infection of the brain (20%), encountered in this study. The most common presentation being seizure / epilepsy which were seen in all 20 patients corresponds with Sotelo *et al* [3]. MRI is far

superior to CT scan to evaluate the various stages of neurocysticercosis lesions. Multiple stages of disease were found to co-exist in 40% patients; and 15% of the patients had intraventricular cysts. FLAIR sequences demonstrated an intracystic scolex in 65% of the patients, thus helping to differentiate these lesions from a tuberculoma, which was comparable to a study conducted by Lucato *et al* [4]. We concluded that active neurocysticercosis lesions and their response to treatment were better detected with MRI than with CT (85%) which correlated with Martinez *et al* and Suss *et al* [5].

Among viral lesions herpes simplex encephalitis had the highest incidence (50%) in our study. It was observed that diffusion weighted imaging was highly sensitive in delineating the involved sites mores conspicuously vis-a-vis conventional sequences in viral encephalitis. The imaging findings correlated with Randy Jenkins and James Provenzale [6] and Sawlani *et al* [7]. With the typical location of the lesions on MRI, combined with clinical features and laboratory investigations it was possible to narrow down the differential diagnosis of viral infections in most patients.

Most patients with intracranial fungal infections were HIV positive (75%), Common MRI findings in these patients were fungal abscess (50%), meningoencephalitis (25%) and intracranial extension of fungal sinusitis (25%). All patients in our study with intracranial toxoplasmosis were HIV positive which correlated with Wright *et al* [8] who reported that cerebral toxoplasmosis was the most common opportunistic intracranial infection in AIDS patients. In all 6 patients, the lesions were multiple which correlated with Miguel *et al* [9]. The characteristic site of these lesions was found to be the basal ganglia, these findings correlated with Miguel *et al* [9, 10].MRI features when correlated with the CD4 counts assisted in pin pointing the diagnosis and administration of appropriate therapy to the patient.

MR spectroscopy was of great help in diagnosing as well as differentiating the lesion from neoplastic etiology. Lipid lactate peak were seen in both pyogenic abscess [11] as well as tuberculomas. Presence of amino acid at 0.9 ppm helped to differentiate pyogenic abscesses from tuberculomas. This correlates with Gupta *et al* [12] who used in vivo proton MR Spectroscopy imaging to differentiate tuberculous from pyogenic abscesses. Presence of lipid lactate peak in toxoplasmosis helped to distinguish toxoplasma lesions from lymphoma which showed marked elevation of choline and lipids with significant reduction of N-acetylaspartate (NAA) as demonstrated by Chang *et al* [13] in their study. In the present study role of Magnetization Transfer Imaging (MTT) and MR perfusion in intracranial infections were not evaluated. There were few limitations of MRI. Abnormalities of bone were difficult to recognize. Calcification could not be readily identified on MRI. Motion degrades images to the point that they were not interpretable, thus requiring patient co-operation, sedation or general anesthesia.

Conclusion:

MRI was undoubtedly an indispensable tool to evaluate patients presenting with intracranial infections. Most of the cases were pathognomonic in imaging appearance; while some required clinico-laboratory correlation. Careful evaluation of MR behaviour of infectious lesions helped in identifying not only the precise location and extent of the lesion, but also in proposing a specific etiology in many such patients.

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