

Role Of Imaging In Intracranial Infections And Infestations

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Abstract: Background and Objective: Conventional X –rays and cranial ultrasound have limited role in central nervous system infections and infestations, neuroimaging with CT and MRI plays significant role in understanding and diagnosing these diseases. The aims and objectives of this study are to study the CT and MRI appearance in CNS infection and infestations according to the age, sex, location, duration etiology and to analyze clinico-pathological confirmation with imaging findings and to evaluate their accuracy in final diagnosis. Methodology: This prospective study of 120 patients of all age group with no gender bias, religion or socio-economic status except pregnant patients and patients having allergy to contrast material, patients with cochlear implants, cardiac pacemaker and Ferromagnetic orthopedic implants was done during January 2014 to June 2015 using non-contrast and contrast enhanced CT and MRI scans. Result: In this study of 120 patients, CNS infection occurred maximum between 1 – 10 years of age (26.67%) followed by the group 21-30 years (21.67%). The ratio of male: female was found to be 1.07:1. Fever emerged as the overall most common presenting clinical symptom and generalized tonic clonic convulsions as the most common neurological symptom. Supratentorial lesions were more frequent (96.67%) Non contrast MRI was found to be more effective in detection of the CNS pathology together with hemorrhage (80% of cases). Non-contrast CT scan proved to be very accurate in detection of calcification (60%) while MRI was positive only in 40% of cases. MRI proved to be more positive in detection of edema (84.21%) unlike CT which showed only 15.67%. On post contrast MRI picked up 55% of cases with ring lesions while CT was able to detect them only in 45% of cases. MRI detected meningeal enhancement of 72.2% cases and mass effect in 76.1% of cases. While CT detected meningeal enhancement of CNS (27.78%) and mass effect in 23.08% cases. **Conclusion:** MRI provided better sensitivity with clinic- pathological correlation which can guide clinicians in treatment and prognosis while CT scan can be used as an initial modality of investigation and it has advantage of being done in few seconds. The comparisons were made between diabetic females of both the phases (menstruation and menopause) and age matched non-diabetic females. Further comparisons were made between diabetic females of menopause phase and diabetic females of menstruation phase. [Satodia D NJIRM 2015; 6(6):51-58]

Key Words: CNS Imaging, CT, Tuberculoma, Neurocysticercosis, Brain Abscess, Meningitis, MRI

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Introduction: Central Nervous System (CNS) infections and infestations are a group of life threatening diseases that present a formidable challenge to the physicians¹. Conventional X- rays and ultrasound of the cranium has limited role in detection of CNS infection. Neuroimaging has played key role in advancing our understanding of the pathophysiology of disease and improving the sensitivity to its detection and extent as well as the specificity to particular pathogens. Brain infections are quite common in the low socio-economic class due to poor nutrition and over populated living conditions. With the increase in the number of patients suffering from immunosuppression there is an increase of CNS infection in this group of patients. MRI is useful in the initial detection of infection as brain abscess or encephalitis⁵ have a characteristic appearance on MRI. It does not use ionizing radiation, has a greater range of availability in soft tissue contrast, depicts anatomy in greater detail and is more sensitive and specific for abnormalities within the brain itself. It also allows evaluation of

structures which are obscured by artifacts from bones in CT images but it is not cost effective. CT may be used to determine complications related to infections. This study is designed to evaluate and compare the role of CT and MRI in CNS infections and infestations.

Material and Methods: This prospective study of 120 patients was carried out during the period from January 2014 to June 2015. This study group included patients of all age group with no gender bias, religion or socio-economic status, while pregnant patients and patients having allergy to contrast material, patients with cochlear implants, cardiac pacemaker and ferromagnetic orthopedic implants were excluded. All patients were subjected either for CT brain or MRI brain.

CT scan was done on SIEMENS SOMATOM SENSATION 64 slice multi-detector CT scanner with slice thickness being 1mm, pitch 0.8, tube current 200Ma, tube voltage 120KvP. Plain CT scan was done followed by

Contrast (non-ionic) enhanced CT scan. Omnipaque was used as the non-ionic contrast media (1ml/kg body weight) after written consent of patient and administration of test dose.

MRI was done on Philips scanner. Non contrast MRI scan of the brain was performed by obtaining 5mm thick TSE T1 weighted, TSE T2 weighted, TSE T2 weighted FLAIR (Fluid Attenuated Inversion Recovery), EPI diffusion weighted and Apparent Diffusion Coefficient (ADC) axial images, 5mm thick TSE weighted FLAIR and Gradient (T2*) coronal images as well TSE T1 weighted Sagittal images. After intravenous administration of Gadolinium, 5mm T1W with MTC axial & 5mm sagittal images and 5 mm T1W with fat saturation coronal images were obtained.

Results and Discussion: In this prospective study of 120 cases, following results were analyzed.

Table 1: Age

Age In Years	No. Of Cases	Percentage
< 1 year	14	11.67
1-10 years	32	26.67
11-20 years	14	11.67
21-30 years	26	21.67
31-40 years	6	5
41-50 years	8	6.67
51-60 years	10	8.33
61-70 years	4	3.33
71-80 years	4	3.33
81-90 years	2	1.67
Total	120	100

CNS infections were common between 1st and 3rd decade.

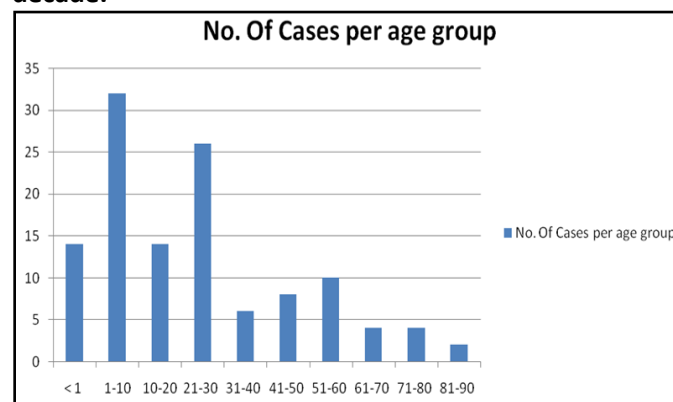


Table 2: Sex

Sex	No. Of Cases	Percentage (%)
Male	62	51.67
Female	58	48.33
Total	120	100

In this study males and females were equally affected (M: F= 1.07:1)

Table 3: Sex distribution with diagnosis

Imaging Diagnosis	Male	Female	Total
Tuberculoma	10	14	24
Toxoplasmosis		2	2
Empyema	8	2	10
Rubella	2		2
Encephalitis	10	12	22
Meningitis	12	20	32
Cerebritis	4	2	6
ADEM	4	2	6
Neurocysticercosis	4	2	6
Meningoencephalitis	8	2	10
Total	62	58	120

Meningitis was the commonest diagnosis followed by tuberculoma and encephalitis in both sexes.

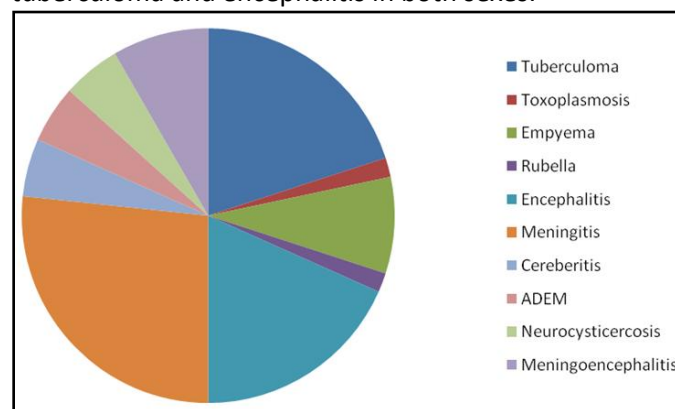


Table 4: Clinical symptoms associated CNS infections

Imaging Diagnosis	Fever	Headache	Vomiting
Tuberculoma	12	14	16
Toxoplasmosis	2		2
Empyema	10	4	6
Rubella	2		
Encephalitis	18	16	10
Meningitis	18	14	8
Cerebritis	6	4	2
ADEM	4	2	4
Neurocysticercosis		4	4
Meningoencephalitis	10	4	4
Total	82	62	56

Fever was the commonest symptom in encephalitis and meningitis ; headache was common in patients of encephalitis while vomiting was common in patients of tuberculoma.

Table 5: Location

Location	Cases		Total
	Male	Female	
Supratentorial	62	54	116
Infratentorial	20	18	38
Intra-axial	48	46	94
Extra-axial	34	34	68

Table 6: Post contrast appearance of ring lesion Number

Imaging Diagnosis	MULTIPLE		SOLITARY		Total
	Cases	%	Cases	%	
Tuberculoma	20	83.33	4	16.67	24
Toxoplasmosis	2	100			2
Rubella			2	100	2
Cereberitis	2	33.33	4	66.67	6
Neurocysticer cosis	2	33.33	4	66.7	6
Total	26	65	14	35	40

Table 7: Associated parenchymal changes

Imaging Diagnosis	Edema	Hydrocephalus	Meningeal Enhancement	Vascular insult	Necrosis	Mass effect	Bone involvement
Tuberculoma	16	6	6	2	4	6	
Toxoplasmosis		2	2				
Empyema	10	4	10	2		10	4
Rubella	2		2			2	
Encephalitis	14	2		4		6	
Meningitis	14	18	32	6		10	2
Cereberitis	6		6	4	2	2	2
ADEM	2		4	2			
Neurocysticer cosis	2						
Meningoencephalitis	10	2	10	2	2	6	
Total	76	34	72	22	8	42	8

- Edema was detected by MRI in 84.21% and by CT in 15.67 %.
- Hydrocephalous was detected in 58.28 % by MRI and in 41.17 % by CT.
- Meningeal enhancement was observed in 72.2 % by MRI and in 27.78 % by CT.
- Vascular insult was demonstrated in all 22 cases by MRI and in none by CT.
- Necrosis was demonstrated in all 8 cases on MRI.
- All 8 cases revealed bone involvement on MRI.
- Mass effect was seen in 23.08 % on CT and In 76.1% on MRI

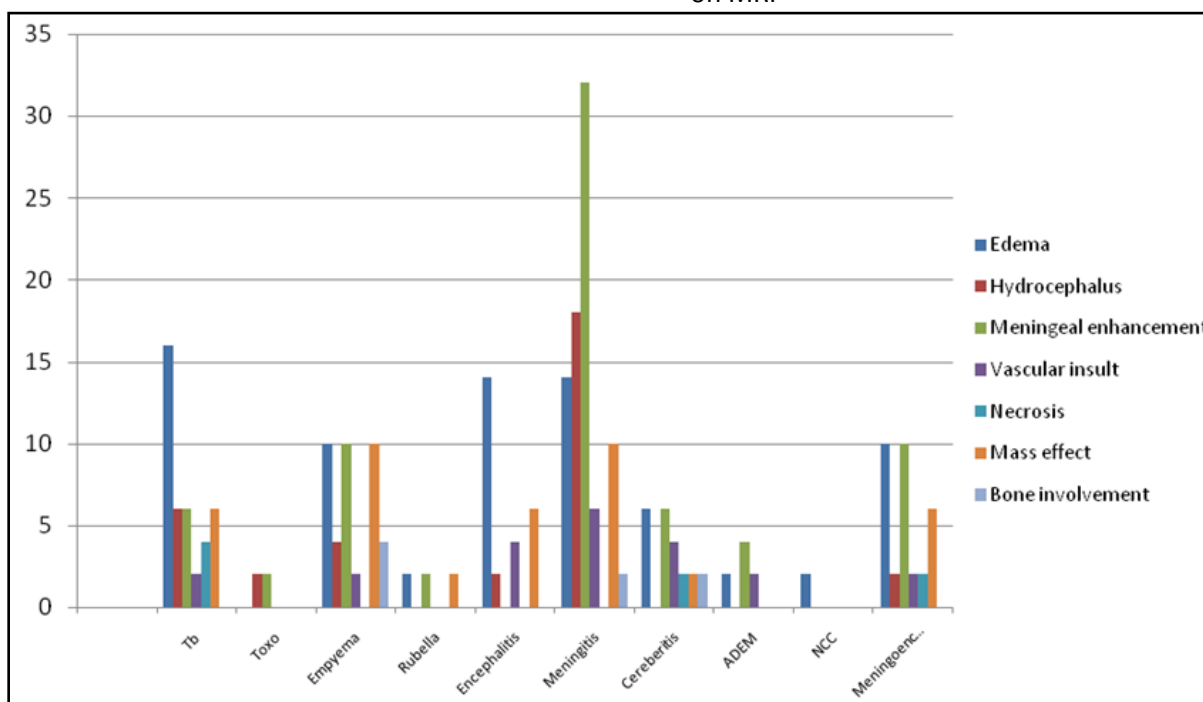


Table 8: Plain scan appearance of lesion

Imaging Diagnosis	Perceptibility	Hemorrhage	Calcification	Total
Tuberculoma	14		10	24
Toxoplasmosis	2		2	2
Empyema	10			10
Rubella	2		2	2
Encephalitis	14	6		22
Meningitis	10	2		32
Cereberitis	6		2	6
ADEM	4			6
Neurocysticercosis	6		4	6
Meningoencephalitis	2	2		10
Total	70	10	20	120

- Perceptibility of the pathology was present on non contrast scan in 56 cases (80 %) on MRI and in 14 cases (20 %) on CT.
- Hemorrhage was observed in 8 cases (80 %) on MRI and in 2 case (20 %) on CT.
- Calcification was appreciated in 12 cases (60 %) on CT and in 8 cases (40 %) on MRI

Table 9: ADC values

Imaging Diagnosis	High ADC values	Low ADC values	Total
Tuberculoma	10	2	12
Empyema	2	4	6
Encephalitis	12	6	18
Meningitis	6	4	10
Cereberitis		6	6
ADEM	4	2	6
Meningoencephalitis	4	6	10
Total	38	30	68

Cerebritis most commonly showed true restriction while tuberculoma is less likely to show true restriction.

- In this study of 120 patients, CNS infection occurred maximum between 1 – 10 years of age (26.67%) followed by the group 21-30 years (21.67%)
- The ratio of male: female was found to be 1.07:1.
- Fever emerged as the overall most common presenting clinical symptom and generalized tonic

clonic convulsions as the most common neurological symptom.

- Supratentorial lesions were more frequent (96.67%) than infratentorial lesions (31.67%) and intra-axial lesion were more common than extra-axial lesions.
- Non contrast MRI was found to be more effective in detection of the CNS pathology together with hemorrhage (80% of cases) while non contrast CT proved to be positive in only 20% CNS infections and in detection of hemorrhage. But non contrast CT scan proved to be very accurate in detection of calcification (60%) while MRI was positive only in 40% of cases.
- MRI proved to be more positive in detection of edma (84.21%) unlike CT which showed only 15.67%.
- Vascular insult was demonstrated in all 32.35% of cases by MRI while CT was unable to detect vascular insult in any of the cases.
- MRI detected meningeal enhancement of 72.2% cases and effect in 76.1% of cases. While CT detected meningeal enhancement of CNS (27.78%) and mass effect in 23.08% cases.
- Detection of low ADC values (44.11%) pointed towards the acute stage of CNS infection.
- The sensitivity of MRI with clinic- pathological correlation was found to be 97.05% and on CT it was 96.15% in this study group.

Discussion:

MENINGITIS: (FIG 1)



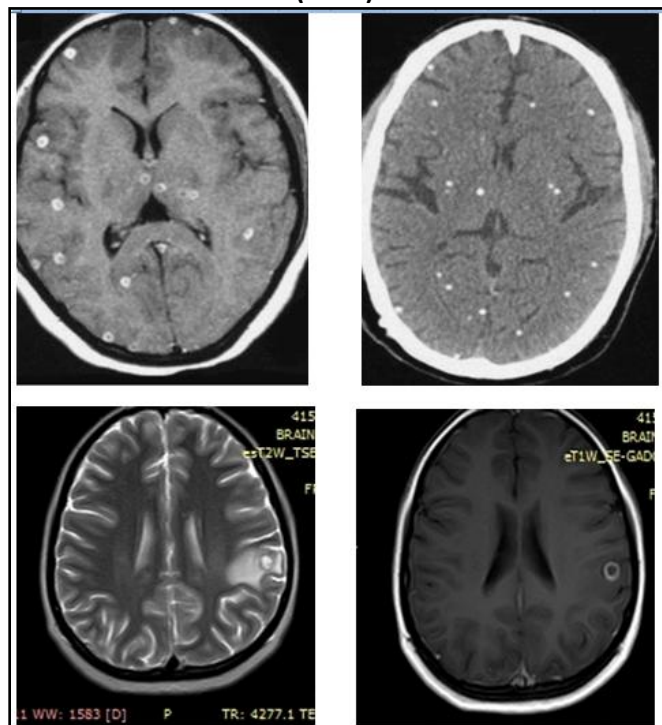
In this study series, Out of 120 cases, 32 cases presented with CT and MRI feature of meningitis of which 20 patients were female and 12 patients were male (M:F— 0.6:1). Out of 32 cases, 24 were proven to be bacterial and 8 were proven to be viral in etiology. The mean age of presentation was 29.3 year. Fever was the most common symptom of presentation (18 cases), followed by headache (14cases) and vomiting (8 cases). The neurological symptoms were altered

sensorium (16 cases), seizures (10 cases), nerve palsy (8 cases), meningeal signs (4 cases), weakness and slurring of speech (2 cases). An associated parenchymal change of edema was found in 14 cases, mass effect in 10 cases, and hydrocephalous in 18 cases. Meningeal enhancement was seen in 32 cases and bone involvement in 2 cases. Low ADC values on MRI were found in 4 cases.

In the study of Kirkpatrick B ,the most common features at presentation were fits, irritability, diarrhea and bulging fontanels, vomiting, drowsiness neck stiffness, headache were commonest in those over 10 years old. He observed that fever was common in all age groups.²

In 1997 Nozaki H studied 5 patients of tuberculous meningitis out of which he concluded MRI to be useful for detecting the lesions in most patients with tuberculous meningitis.³

NEUROCYSTICERCOSIS: (FIG 2)



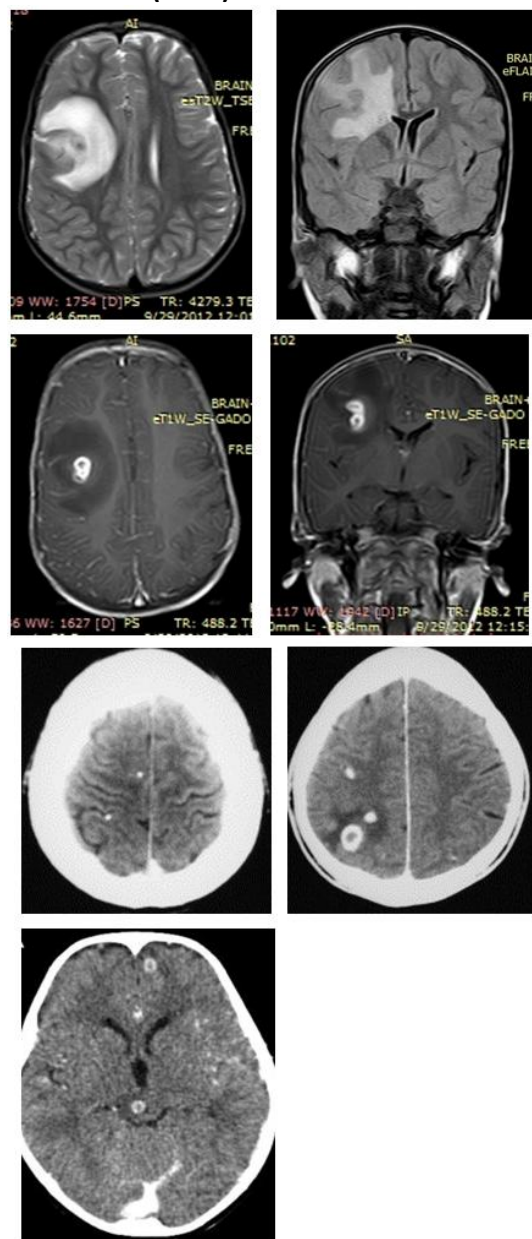
In this study, CT diagnosed cerebral cysticercosis in 6 cases of which 4 were supratentorial and 2 were infratentorial. Solitary ring was noted in 4 cases and multiple in 2 cases. All the 6 cases appeared as hypodense areas on non contrast scan which showed ring enhanced lesions on post contrast scans.

In 1980 Mervis B et al reported that CT can recognize cysticercosis patterns as

1. A diffuse low density pattern with no or little change after contrast medium.
2. Multiple low densities with small rounded central areas of enhancement.
3. Large cystic lesions which may become ring lesions after contrast enhancement.

Observations of this study fits into group 3 of the study of Mervis B et al.

TUBERCULOMA: (FIG 3)



In this study, out of 24 cases, 14 females (58.33%).and 10 males (41.67%) were affected. CT was performed in

10 cases and MRI in 14 cases. Average age of presentation was 37.58 years of age. Associated neurological symptoms were GTCS (14 cases), altered sensorium (8 cases), weakness (2 cases), abnormal movements (2 cases) and unconsciousness (2 cases).

Jayakumar et al in 1993 (79) showed supratentorial location as 55% whereas in this study it was found to be in 91.67%.⁶ Ring lesions were perceptible in 14 cases on plain scan (CT and MRI), where as in this study they are seen in all cases.

In 1991 Seow WT et al reported that the investigation of choice is contrast enhanced CT scan and the presence of a target lesion is considered to be pathognomonic of tuberculoma.⁷

ENCEPHALITIS: In 2001 Panagariya A, studied patients of HSV encephalitis spanning 30 months and he concluded males were affected more than females.¹⁰ Wherein this study shows females (54.54%) were affected more than males (45.45%). The study results of this series were contradictory to the results of the study conducted by Panagariya A.

In this study all cases were proved to be of viral etiology. Out of 22 cases MRI was done in 18 cases and CT was done in 4 cases. Pre and post contrast scans were performed in all cases. Fever, headache and vomiting were presenting symptoms. Neurological symptoms were altered sensorium, slurring of speech, weakness, GTCS and unconsciousness. MRI showed associated parenchymal changes of edema in 14 cases, mass effect in 10 cases, hydrocephalus in 2 cases, associated vascular insult in 4 cases and bone involvement in 2 cases.

In 1988 Post MJ et al discussed the value and limitations of CT and MRI in viral encephalitis. His study was a retrospective analysis of the CT scans and MRI in 22 patients. He observed that MR was more sensitive in detecting lesions and secondary parenchymal changes than was CT.¹¹

This study showed similar findings as to the above study.

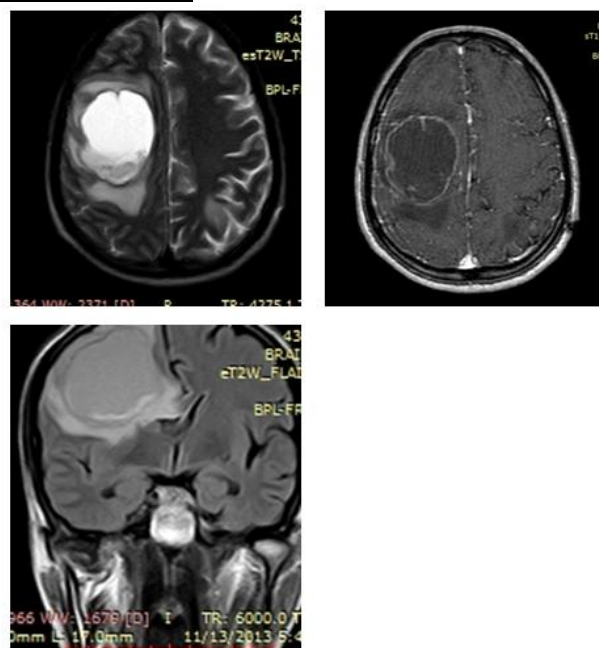
MENINGOENCEPHALITIS: Meningo-encephalitis was observed in 10 cases. Out of which were 8 were males (80%) and 2 were female (20%). All patients were HIV negative. Contrast enhanced MRI showed associated

parenchymal changes of edema in 10 cases, meningeal enhancement in all 10 cases. Associated vascular insult and parenchymal necrosis in 2 cases, mass effect in 6 cases and hydrocephalus in 2 cases were seen. Low ADC values were found in 6 cases on MRI.

In 1991 Offenbacher H et al studied the contribution of MRI in four adult patients with meningoencephalitis. Contrast-enhanced T1 –weighted MRI revealed the characteristic basal meningeal inflammation and its focal spreading into adjacent brain. They concluded MRI promises to be a useful tool for monitoring treatment response.¹³

EMPHYEMA: Empyema was diagnosed in 10 cases out of which 8 were male patients and 2 were female patient. Associated parenchymal changes of edema was found in 10 cases, meningeal enhancement in 10 cases, associated vascular insult was noted in 2 cases, mass effect was present in 4 cases, hydrocephalus in 2 cases and bone involvement in 2 cases.

ABSCCESS: (FIG 4)



Cerebral abscess accounted for 6 cases (4 males, 2 female). The average age of presentation was found to be 33.45 years. The clinical symptoms associated with abscess were fever, headache and vomiting. Out of 6 patients, 4 abscesses were located in the supratentorial region and 2 in infratentorial region. Multiple ring enhancing lesions were found in 2 cases (33.33%) and single ring was observed in 4 cases (66.67%). The associated changes with abscess were

edema, mass effect, necrosis, vascular insult and bone involvement.

In 1994 Lecuit M et al stated Magnetic resonance imaging is the most adapted imaging technique for diagnosis and follow-up.¹⁹

ACUTE DISSEMINATED ENCEPHALOMYELITIS (ADEM):

ADEM was observed in 6 cases in this study. Out of which 4 were male (66.67 %) and 2 female (33.33%). An associated parenchymal change of edema was found in 2 cases, meningeal enhancement in 4 cases, associated with vascular insult in 2 cases.

In the study of Jay Krishnan MP et al, the common presenting symptoms were fever, vomiting, headache, gait disturbance and generalized seizures.²⁰

The results of this study were similar as to those of the above authors.

Conclusion: Thus we can conclude that pre and post contrast MRI is very effective in picking up CNS infections.

On the other hand CT scan can be used as an initial modality of investigation and it has advantage of being done in few seconds.

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