ORIGINAL RESEARCH PAPER INTERNATIONAL JOURNAL OF PURE MEDICAL RESEARCH

Radiodiagnosis

KEYWORDS:
CSF, MRI, meningitis.

TO EVALUATE THE RELATIONSHIP OF MRI FINDINGS AND CSF ANALYSIS IN PATIENT DIAGNOSED WITH MENINGITIS

Volume - 6, Issue - 5, May- 2021 ISSN (O): 2618-0774 | ISSN (P): 2618-0766

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INTERNATIONAL JOURNAL OF PURE MEDICAL RESEARCH

ABSTRACT

Background- Meningitis is a serious clinical condition which proceeds immediately and can lead to significant morbidity. Even with proper treatment, meningitis can damage the brain and cause long-term complications

Methods- It was a cross-sectional observational study conducted at Department of Radio-diagnosis, Geetanjali Medical College and Hospital, Udaipur.

Results- MRI had a sensitivity of 92%, specificity of 90%, PPV and NPV of 81% and 96% respectively with a diagnostic accuracy of 92%. Among the two false negative cases, one turned out to be with no neuro-infection. This case had mild sulcal hyperintensity on T1 contrast, iso-intensity on T2 without perilesional edema.

Conclusion- MRI and CSF analysis are used for diagnosis of meningitis. MRI has a huge potential superiority in the diagnosis of meningitis. MRI can provide the images in 3D planes and various oblique planes, without causing artifacts, and it has no side effect on human body as there is no ionizing radiation. CSF may provide with etiological basis of the disease, but may miss some diagnosis, as was in our study.

INTRODUCTION

Areas of lower income are particularly vulnerable to the persistence and spread of infection due to poverty, overcrowding, inadequate access to clean water and proper sanitation systems, and insufficient access to health care overall.[1] In a systematic review by Robertson et al, low income countries had an overall incidence of 726 cases/100,000 people and middle income countries had 299/100,000, compared with approximately 11/100,000 in the high-income counterparts.[2] CNS infections are also an important cause of morbidity and mortality in children. Estimated incidence of acute encephalitis syndrome in children is 10.5–13.8/100000.[3] The case fatality rate is 30% and neurological disabilities occur in one–third of survivors.[4] Global burden of disease network (WHO) estimated that in 2010 meningitis caused approximately 422,900 deaths and encephalitis, 143,500 deaths.[5]

The primary imaging modality, like in most CNS disorders is magnetic resonance imaging (MRI).[6] Coming to an exact etiological agent on the basis of conventional MRI sequences with Gadolinium enhancement is always difficult due to overlapping imaging characteristics. The purpose of this review is to provide a rational MRI approach to narrow the list of differentials, to quickly classify and characterize CNS infections. The flow-charts presented in this review guides the radiologist to first recognize the pattern of findings on routine MRI sequences and subsequently narrow the differential diagnosis based on the addition of other MR parameters such as diffusion weighted imaging (DWI).

Cerebrospinal fluid (CSF) in normal human body has certain chemical components and pressure, which can maintain the relative stability of intracranial pressure. When there are central nervous system diseases, pathological changes will produce in the central nervous system and the metabolism of nervous cells will be disordered, which can change the property and components of cerebrospinal fluid. Therefore, the detection of cerebrospinal fluid is one of the important auxiliary diagnostic approaches for central nervous system impairment. Both MRI and cerebrospinal fluid can detect pathological changes in human body, which makes contributions to the prevention of diseases. Hence exploring MRI in combination with detection of cerebrospinal fluid has clinical values in diagnosing and identifying central nervous infection. The present study evaluated the MRI patterns of different intra-cranial infection in patients and interpreted it with respect with biochemical findings and clinical profile of the patients.

MATERIAL AND METHODS

Study Design- It was a cross-sectional observational study.

Study Duration- It was 18 months (Feb 2019 to July 2020)

Study Site- Department of Radio-diagnosis, Geetanjali Medical College and Hospital, Udaipur.

Inclusion Criteria- All cases referred to department of radio diagnosis with suspected neuro-infections.

Exclusion Criteria –

1. All patients in whom MRI is contraindicated
2. Clinical conditions precluding the conductance of MRI.
3. Hypersensitivity to contrast media
4. Pregnant patients (use of contrast is contra indicated).

Sampling- Minimum sample size required was 71 or more. During the study period, we included 74 consecutive eligible patients.

Data Collection

Data were collected using a pre-designed semi-structured study proforma. We collected information regarding demography and presenting complaints from the medical records of the patients. The final diagnosis was made by the treating physician taking to account the imaging studies, CSF biochemical examination and clinical presentation. All patients underwent MRI brain and CSF biochemical analysis.

Statistical Analysis

The analysis included profiling of patients on different demographic, laboratory and clinical parameters. Descriptive analysis of quantitative parameters was expressed as means and standard deviation. Ordinal data were expressed as absolute number and percentage. Cross tables were generated for comparing MRI impression with CSF impression and MRI impression with the final clinical diagnosis of the patients. All analyses were done using SPSS software, version 24.0

RESULTS

In the present study, 74 patients were included. Mean age of the patients was 28.67 ± 16.21 years, ranging from 7 months to 77 years.

It was observed that 14.9% of the patients were in aged less than 10 years and 11 to 20 years each, 27% were aged 21 to 30 years, 25.7% were 31 to 40 years of age, 8.1% were 41 to 50 years and rest of the 9.5% of the patients were aged more than 50 years of age. 36.5% of the patients were females (n=27) and rest being males (63.5%, n=47).

The most common clinical presentation was headache, reported by 86.5% of the patients. Fever, seizures, vomiting, altered sensorium was observed in 79.7%, 62.2%, 60.81% and 56.8% of the patients respectively. Neck rigidity was reported by 40.5% of the patients.

Table 1. Distribution Of Patients According To Their Final Diagnosis

Final diagnosis	Frequency	Percent
Meningitis	24	32%
Tuberculoma	23	31%
Neurocysticercosis	10	14%
HS encephalitis	6	8%
HIV encephalitis	4	5%
Abscess	3	4%
Creutzfeldt Jacob disease	2	3%
Astrocytoma	1	1%
Normal brain	1	1%
Total	74	100%

The most common diagnosis was that of meningitis, observed in 32% of the patients. Among these 24 cases of meningitis, 13 were that of tubercular meningitis, 8 were viral and 3 were bacterial meningitis. Tuberculoma was diagnosed in 31% of the patients. One patient who had findings of tuberculoma on MRI was diagnosed as low-grade Astrocytoma on follow up and biopsy. Neurocysticercosis was diagnosed in 14% of the patients and HS encephalitis was observed in 8% of the patients. Four patients had HIV infection. Three patients were diagnosed with abscess, two had CJD, and there was one case of astrocytoma. One patient who was suspected of meningitis was clinically and biochemically was found to be normal with no brain infection.

Table 2. Distribution Of Meningitis Patients According To Their MRI Findings

MRI findings			**FINAL**		
T1+C		**Bacterial meningitis**	**DIAGNOSIS Tubercular meningitis**	**Viral meningitis**	**Total**
Dura based thickening in basal cistern	N	0	5	0	5
	%	0.00%	38.46%	0.00%	20.83%
Meningeal enhancement	N	3	8	8	19
	%	100.00%	61.54%	100.00%	79.17%
Hydrocephalus	N	1	5	0	6
	%	33.33%	38.46%	0.00%	25.00%
Total	N	3	13	8	24
	%	100.00%	100.00%	100.00%	100.00

In cases with meningitis, all cases of bacterial and viral meningitis had meningeal enhancement, while 61.5% of tubercular meningitis had meningeal enhancement and rest had dura-based thickening of cisterns. Hydrocephalus was observed in one case of bacterial meningitis, five cases of tubercular meningitis and none of the patients with viral meningitis.

Table 3. Distribution Of Meningitis Patients According To Their Laboratory Findings

Lab investigations	**BACTERIAL MENINGITIS**	**FINAL DIAGNOSIS TUBERCULAR MENINGITIS**	**VIRAL MENINGITIS**	**Total**
Blood WBC				
Increase N	3	13	8	24
%	100.00%	100.00%	100.00%	100.00%
Blood ADA				
Normal N	3	2	8	13
%	100.00%	15.38%	100.00%	
Raised N	0	11	0	11
%	0.00%	84.60%	0.00%	45.80%
CSF appearance				
CLEAR N	3	9	7	19
%	100.00%	69.20%	87.50%	79.20%
Turbid N	0	4	1	5
%	0.00%	30.77%	12.50%	
CSF protein				
Raised N	3	13	8	24
%	100.00%	100.00%	100.00%	100.00%
CSF glucose				
Decrease	3	13	6	22
%	100.00%	100.00%	75.00%	91.70%
Normal N	0	0	2	2
%	0.00%	0.00%	12.50%	4.20%
CSF lymphocytes				
Increase N	0	13	8	21
%	0.00%	100.00%	100.00%	87.50%
Normal N	3	0	0	3
%	100.00%	0.00%	0.00%	12.50%
CSF raised monocytes				
No N	2	13	8	23
%	66.70%	100.00%	100.00%	95.80%
Yes	1	0	0	1
%	33.30%	0.00%	0.00%	4.20%
CSF raised neutrophils No N	0	10	6	16
%	0.00%	76.90%	75.00%	66.70%
Yes N	3	3	2	8
%	100.00%	23.10%	25.00%	33.30%
CSF total WBC				
Increase N	3	13	8	24
%	100.00%	100.00%	100.00%	100.00%
CSF culture				
Acid fast bacilli N	0	2	0	2
%	0.00%	15.40%	0.00%	8.30%
Gram positive N	2	0	0	2
%	66.70%	0.00%	0.00%	8.30%
Negative N	1	11	8	20
%	33.30%	84.60%	100.00%	83.30%

Total N	3	13	8	24
%	100.00%	100.00%	100.00%	100.00%

Increased blood WBC count was observed in all the cases, while raised blood ADA level was observed in 84.6% of the cases with tubercular meningitis. Turbid/hazy appearance of the CSF was observed in 30.7% of those with tubercular meningitis and 12.5% of those with viral meningitis. Raised CSF protein was observed in all cases and decreased CSF glucose was observed in all except two cases of viral meningitis. CSF lymphocytes were increased in all except those with bacterial meningitis. Similarly, monocytes were not raised except in one case of bacterial meningitis. Raised neutrophils were observed in all cases of bacterial meningitis, 23% of those with tubercular meningitis and 25% of those with viral meningitis. Increased CSF WBC was observed in all the cases. Culture was negative in 33% of those with bacterial, 84.6% with tubercular and 100% those with viral meningitis.

Table 4. Diagnostic Performance Of MRI As Compared To CSF Examination/clinical Follow Up

MRI	CSF	
	Positive	Negeative
Positive	22	5
Negative	2	45
Total	24	50

MRI had a sensitivity of 92%, specificity of 90%, PPV and NPV of 81% and 96% respectively with a diagnostic accuracy of 92%. Among the two false negative cases, one turned out to be with no neuro-infection. This case had mild sulcal hyperintensity on T1 contrast, iso-intensity on T2 without perilesional edema.

DISCUSSION

In the present study, all cases of bacterial and viral meningitis had meningeal enhancement, while 61.5% of tubercular meningitis had meningeal enhancement and rest had dura-based thickening of cisterns. Hydrocephalus was observed in one case of bacterial meningitis, five cases of tubercular meningitis and none of the patients with viral meningitis. We also observed that 21 cases were diagnosed on the basis of CSF and clinical examination, of which 19 were correctly identified in MRI. There as one false positive case as well. Thus, MRI had a sensitivity of 92%, specificity of 90%, PPV and NPV of 81% and 96% respectively with a diagnostic accuracy of 91%.

Zhang et al evaluated the MRI finding and CSF parameters in patients with meningitis.[7] In their study, the MRI results demonstrated that, the positive rate of the observation group was 96.05%; the positive rate of the tubercular meningitis group was 100%; the positive rate of the viral meningitis group and the purulent meningitis group was 90.48% and 92.86% respectively.

Vaswani et al studied 50 patients suspected of having meningitis.[8] The analysis of unenhanced images did not demonstrate an altered signal on T1-weighted or T2-weighted images but two cases showed meningeal hyperintensities on plain FLAIR images. As contrast-enhanced images are included in the evaluation, 49 patients (96%) showed pathological meningeal enhancement at MRI examination and two patients (3.9%) had normal MRI. In 35 cases (70%), the meningeal enhancement was observed in both contrast-enhanced T1-weighted and FLAIR sequences and in 14 cases (28%) enhancement was only demonstrated on postcontrast FLAIR sequence.

CSF examination was done in 57 patients, 50 patients (87.71%) had CSF positive meningitis and 1 patient showed malignant cells on CSF analysis and was also positive on postcontrast MR examination (false positive). Remaining 6 patients were true negative. Out of 50, 35 cases (70%) had bacterial (including tuberculous) meningitis, 12 cases (24%) had viral meningitis, and three cases (6%) had fungal meningitis. The authors found that with respect to etiology, no specific findings were registered on MRI to differentiate between viral, bacterial, or fungal meningitis. However, the meningeal enhancement was located in basal and subarachnoid cisterns in tuberculous and fungal meningitis whereas, in bacterial meningitis, the enhancement was located over the cerebral convexity and along sylvian fissures. Six patients also had parenchymal changes like cerebritis and tuberculomas that appeared as focal hyperintense parenchymal signals with postcontrast enhancement. In one study, Singer et al reported non-contrast FLAIR sequences to be superior to post contrast T1W1.[9] The reason for the difference in observation is most likely that the diagnosis of meningitis on FLAIR depends on the CSF protein concentration. In studies which concluded that contrast-enhanced T1WI are better than FLAIR, it could have been because of less protein concentration in the CSF of their patients. Other reasons could be different imaging parameters, different MRI machines with different specifications, and different sample sizes.

Galassia et al showed that abnormal meningeal enhancement was positive in 35 contrast-enhanced T1-weighted MR images with Fat Saturation and in 33 contrast- enhanced FLAIR studies. [10] They concluded that contrast-enhanced T1-weighted MR imaging with Fat Saturation is superior to contrast-enhanced FLAIR imaging in most cases for depicting intracranial meningeal diseases.

CONCLUSION

MRI and CSF analysis are used for diagnosis of meninigitis. MRI has a huge potential superiority in the diagnosis of meningitis. MRI can provide the images in 3D planes and various oblique planes, without causing artifacts, and it has no side effect on human body as there is no ionizing radiation. CSF may provide with etiological basis of the disease, but may miss some diagnosis, as was in our study.

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