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ROLE OF CONTRAST ENHANCED FLUID ATTENUATING INVERSION RECOVERY IN MAGNETIC RESONANCE IMAGING FOR EVALUATION OF LEPTOMENINGEAL PATHLOGIES.

Radiodiagnosis

Abhijit N Markande Postgraduate, Department Of Radiodiagnosis, Yenepoya Medical College, Mangalore, Karnataka, India

Devadas Acharya* Professor, Department Of Radiodiagnosis, Yenepoya Medical College, Mangalore, Karnataka, India *Corresponding Author

ABSTRACT

Introduction: Fluid-attenuated inversion recovery (FLAIR) is a special inversion recovery pulse sequence with a long TR and TE, and an inversion time (TI) that effectively nulls signals from the cerebrospinal fluid. The mild T1 effect of the FLAIR sequence is responsible for contrast enhancement on these heavily T2W images **Aims:** To compare the contrast-enhanced fluid-attenuated inversion recovery (CE-FLAIR) and the Contrast enhanced T1-weighted (CE-T1W) sequence with fat suppression (FS) for early detection and characterization of leptomeningeal pathology using 3T MRI. **Materials and method:** A total of 50 patients were evaluated retrospectively who underwent 3T Contrast MRI brain study from June 2018 to June 2019 with available contrast MRI images with CSF analysis. The MRI brain images was reviewed on PACS by two senior radiologists. **Results:** Post contrast FLAIR sequence showed more leptomeningeal abnormality than the post contrast T1 fat saturation images, more so along the basal cisterns **Conclusion:** Conclusion. Contrast-enhanced FLAIR sequence is more sensitive than contrast-enhanced T1W sequence in the diagnosis of meningitis. Post contrast FLAIR is useful adjunct and must be routinely used in suspected cases of meningitis.

KEYWORDS

MRI, meningitis, FLAIR

INTRODUCTION:

MRI imaging with gadolinium based contrast agent has demonstrated increase in sensitivity in detection of leptomeningeal abnormalities. Contrast enhanced T1 weighted fast supressed imaging is the most common sequence used in most institutions.[1]

Fluid-attenuated inversion recovery (FLAIR) is a special inversion recovery pulse sequence with a long TR and TE, and an inversion time (TI) that effectively nulls signals from the cerebrospinal fluid. The mild T1 effect of the FLAIR sequence is responsible for contrast enhancement on these heavily T2W images. Therefore, lesions showing enhancement on T1 weighted images will also show enhancement on post contrast FLAIR.[1,2]

The leptomeningeal enhancement is due to the contrast leakage into the cerebrospinal fluid space.[3,4]

Several studies have shown that post contrast FLAIR is better than T1 images. This may be due to enhancement of the normal vessel in the CSF space that can be confused for leptomeningeal enhancement on T1 weighted images whereas the post contrast FLAIR images do not show the normal vessel enhancement. It is also known that the post gadolinium effect was seen on FLAIR at lower concentrations than on T1 images. 3

Aims: To compare the contrast-enhanced fluid-attenuated inversion recovery (CE-FLAIR) and the Contrast enhanced T1-weighted (CE-T1W) sequence with fat suppression (FS) for early detection and characterization of leptomeningeal pathology using 3T MRI.

Materials and Methods

Patient Selection

All patients who underwent 3T Contrast MRI brain study from June 2018 to June 2019 with available contrast MRI images with CSF analysis.

A total of 50 cases was evaluated retrospectively among which MRI brain contrast imaging was performed in 3 Tesla MRI unit (Signa Pioneer GE Healthcare) using a head coil.

The study protocol was approved by the Institutional Ethics Committee.

Imaging Techniques:

Multi planar multi echo sequences i.e axial T1, axial T2, axial T2 FLAIR, axial DWI, axial SWI , sagittal T1 and coronal T2 sequences are routinely performed as pre contrast protocol.

Post contrast axial T1, sagittal T1 and coronal T1 as well as axial T2 FLAIR images were obtained.

Intravenous Contrast clariscan (Gadoterate Meglumine) was administered in the dose of 0.1mmol/kg.

Image analysis:

The scans were reviewed on a direct display console on PACS workstation by two Senior Radiologists for leptomeningeal abnormality. The comparison was made between post contrast T1 and FLAIR images with pre contrast T1 and FLAIR images. The Radiologists were blinded for the CSF analysis.

The conspicuity of the leptomeningeal enhancement was evaluated with four point scoring system.[5]

Score 3 - definite abnormal leptomeningeal enhancement clearly discriminated from the leptomeningeal vessels.

Score 2 - probable abnormal leptomeningeal enhancement that seemed to be different from the leptomeningeal vessels.

Score 1 - possible abnormal leptomeningeal enhancement that was not discriminated from the leptomeningeal vessels.

Score 0 - no abnormal leptomeningeal enhancement.
The final diagnosis was correlated with CSF analysis report.

RESULTS:

Abnormal leptomeningeal enhancement was seen in all patients. The semi quantitative comparison of the images is shown in table 1. The distribution of the demographics and final diagnosis is shown in table 2 and 3 respectively.

The inter observer reliability was analysed using kappa statistics to determine the agreement between observers (table1). The kappa value was 0.55which suggest moderate agreement.

The sensitivity of post contrast T1 and post contrast FLAIR is shown on table 4.

Table 1:

Leptomeningeal Enhancement				
	T1 FS		Contrast Flair	
	RAD 1	RAD 2	RAD 1	RAD 2
Sulcal space scores				
3	12	10	36	32
2	8	10	6	10
1	26	26	0	2

0	2	2	2	2
Basal Cistern scores				
3	18	14	32	32
2	4	10	2	2
1	12	10	0	0
0	22	22	22	22

Table 2:

Age Distribution	
<20y	16
20-40y	24
40-60y	8
>60y	2

Table 3:

Distribution of final diagnosis	
Tuberculosis	26
Asptic meningitis	10
Pneumococcus	9
E. Coli	4
Metastasis	1

Table 4

Sensitivity of post contrast T1 FS	Sensitivity of post contrast FLAIR
92.60%	100%

DISCUSSION:

Infectious and neoplastic diseases of the meninges produce serious complications resulting in substantial morbidity and mortality. Early diagnosis and prompt treatment prevents permanent neurological complications.[6,7,8]

Intravenous gadolinum has been used as MRI contrast agent for characterising brain lesions. Gadolinum causes shortening of both T1 and T2 relaxation times and the contrast enhancement is due to T1 shortening.[4]

Unlike T1 weighted images the post contrast FLAIR does not show enhancement from slow flow cortical veins which may otherwise be confused in T1 images for leptomeningeal pathologies.[1,2]

The assigned scores for sulcal space and basal cistern spaces were higher for post contrast FLAIR as compared to post contrast T1 images. Interestingly the scores were more for the basal cistern evaluation for post contrast FLAIR.

The results of contrast-enhanced FLAIR sequence, in this study, are almost comparable to Allesandra et al.. Out of the total 12 patients they included in their study, contrast enhanced FLAIR was positive in all cases.[9]

In 2006, Parmar and his colleagues conducted a study to determine contrast-enhanced FLAIR in the evaluation of infectious leptomeningeal diseases ,suggested that post contrast FLAIR images have similar sensitivity but a higher specificity compared to contrast-enhanced T1- weighted images for detection of leptomeningeal enhancement. It can be a useful adjunct to post contrast T1-weighted.[10]

In a research conducted by Galassia et al[11]., they 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. 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. The results are not comparable to our study. The reason appears to be the small sample size. The total number of patients in their study was only 24. Thirty-five examinations were done in these twenty-four patients. However, in our study, 50 patients were included in the study.

In a study by Rajiv et al12 showed that the CE-FLAIR sequence demonstrated a better sensitivity (100%), diagnostic accuracy (95%), and a stronger correlation with the cerebrospinal fluid analysis compared to the CE-T1W sequences.

Another study by Balaji et al[5] showed more information on T2 FLAIR images than the T1 MPRAGE images.

The Radiologists were not blinded as to which sequences was being evaluated as the grey white matter differentiation was different that they knew the sequences at glance and this could have introduced some bias.

Finally, the results of our study is to encourage the use of post contrast FLAIR MRI to confirm the diagnosis of meningitis, because of its high sensitivity.

CONCLUSION:

Contrast-enhanced FLAIR sequence is more sensitive than contrast-enhanced T1W sequence in the diagnosis of meningitis. However, post contrast T1 weighted images add more information for overall evaluation of brain parenchyma and cannot completely be replaced. Hence post contrast FLAIR is useful adjunct and must be routinely used in suspected cases of meningitis to improve the sensitivity.

Images:

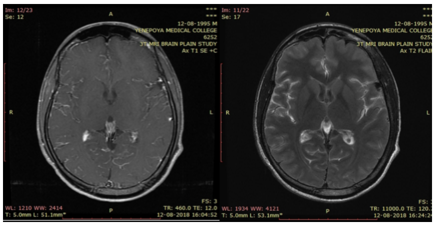

Figure 1: This was a case of E.coli meningitis showing diffuse leptomeningeal enhancement along the supra tentorial sulcal spaces which is better seen on axial post contrast T2 FLAIR as compared to post contrast axial T1fat sat.

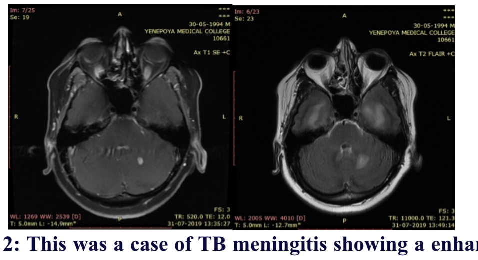

Figure 2: This was a case of TB meningitis showing a enhancing nodular lesion in the left cerebellar hemisphere on post contrast axial T1 fat sat images whereas the leptomeningeal enhancement in the basal cistern as seen on axial post contrast T2 FLAIR.

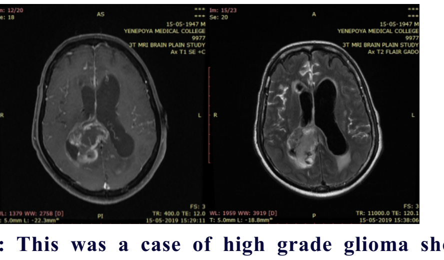

Figure 3: This was a case of high grade glioma showing heterogeneously enhancing lesion in the corpus callosum with involvement of the right choroid plexus and diffuse leptomeningeal enhancement in the as seen on axial post contrast T2 FLAIR.

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