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Original research article

IMAGING BY 3D DIR, 3D FLAIR, 2D FLAIR IN DETECTION OF BRAIN LESIONS IN DEEP WHITE MATTER AND PERIVENTRICULAR REGIONS

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Abstract

Fluid attenuation inversion recovery (FLAIR) is a special inversion recovery sequence with a long inversion time (TI) which results in removing signal from the cerebrospinal fluid (CSF) from the resulting images. To null the signal from fluid, the inversion time (TI) of the FLAIR pulse sequence is adjusted such that at equilibrium there is no net transverse magnetization of fluid. 3D DIR images showed more deep white matter, periventricular white matter lesions in comparison with both 3D FLAIR and 2D FLAIR sequences.

Keywords: Brain lesions, deep white matter, periventricular regions

Introduction

Double inversion recovery (DIR) is a MRI pulse sequence which suppresses signal from the CSF as well as from the white matter and hence enhances any inflammatory lesion.

To obtain such sequence in 3T MRI scanner, two inversion times are required. TI1 which is used for suppression of CSF and usually obtained at 2000-3000 msec and TI2 which is used for white matter at 450 msec [1].

Its main application is to delineate white matter plaques in multiple sclerosis, estimate lesion load, differentiate juxtacortical from mixed grey matter-white matter plaques and detect infratentorial or spinal cord lesions [2].

Fluid attenuation inversion recovery (FLAIR) is a special inversion recovery sequence with a long inversion time (TI) which results in removing signal from the cerebrospinal fluid (CSF) from the resulting images.

To null the signal from fluid, the inversion time (TI) of the FLAIR pulse sequence is adjusted such that at equilibrium there is no net transverse magnetization of fluid [3].

The FLAIR sequence is part of almost all protocols for imaging the brain, particularly useful in the detection of subtle changes at the periphery of the hemispheres and in the periventricular region close to CSF.

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The usefulness of FLAIR sequences has been evaluated in many diseases of the central nervous system such as [4]:

- Infarction.
- Multiple sclerosis.
- Subarachnoid haemorrhage.
- Head injuries and others.

Post-contrast FLAIR images have been included in protocols to assess leptomeningeal diseases, such as meningitis.

Methodology

Patients are enrolled for the study after obtaining an informed consent. After collection of demographic data, clinical history and once the patient satisfies the inclusion criteria for this study, he or she would be subjected to MRI. The patients would be briefed about the procedure. The noise due to gradient coils (heard once the patient was inside the bore of the magnet) and the need to restrict body movements during the scan time would be explained to the patient.

Imaging was performed on a 3T Philips MR system using 3D double inversion recovery (3D DIR), 3D fluid attenuated inversion recovery (FLAIR) sequences with the same parameters, including field of view (FOV), matrix, slice thickness, voxel size, and number of signal averaging (NSA) in addition to routine T1, T2, diffusion weighted and 2D Fluid attenuated inversion sequences.

Inclusion criteria

1. Patients with clinically suspected brain lesions which has imaging features of intracranial tumours/tumour mimics.
2. Patients who are already diagnosed and are under treatment.

Exclusion criteria

1. Patients with cardiac pacemakers & metallic implants will not be subjected to MRI.
2. Motion disorder and claustrophobia, if severe may make the examination difficult.

The results of the MR spectroscopy results will be compared to histopathological reports where available.

Results

Table 1: Supra Tentorial-Deep white mater distribution of patients studied

Brain lesions-Deep white mater	Frequency (%)			% Difference		
	3D DIR	3D FLAIR	2D FLAIR	3D DIR vs 3D FLAIR	3D DIR vs 2D FLAIR	3d FLAIR vs 2d FLAIR
▪ <10	24(80%)	25(83.3%)	26(86.7%)	3.3%	6.7%	3.4%

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▪ 10-20	3(10%)	2(6.7%)	1(3.3%)	-3.3%	-6.7%	-3.4%
▪ >20	3(10%)	3(10%)	3(10%)	0.0%	0.0%	0.0%

Table 2: Supra tentorial-Periventricular distribution of patients studied

Brain lesions-Periventricular	Frequency (%)			% difference		
	3D DIR	3D FLAIR	2D FLAIR	3D DIR vs 3D FLAIR	3D DIR vs 2D FLAIR	3D FLAIR vs 2D FLAIR
▪ <10	24(80%)	24(80%)	25(83.3%)	0.0%	3.3%	3.3%
▪ 10-20	3(10%)	3(10%)	3(10%)	0.0%	0.0%	0.0%
▪ >20	3(10%)	3(10%)	2(6.7%)	0.0%	-3.3%	-3.3%

Table 3: Supra tentorial distribution of patients studied

Ntracranial tumors				
▪ 3D DIR	7.63-10.63	7.63±10.63	4.00	-
▪ 3D Flair	6.73-9.05	6.73±9.05	4.00	0.012*
▪ 2D Flair	5.03-7.23	5.03±7.23	2.00	<0.001**
Periventricular				
▪ 3D DIR	7.93-8.14	7.93±8.14	5.00	-
▪ 3D Flair	7.50-7.38	7.50±7.38	5.00	0.068+
▪ 2D Flair	5.97-6.03	5.97±6.03	4.00	<0.001**

Wilcoxon Singed rank test, P values obtained in Comparison with 3D DIR.

Discussion

Abdelaziz M. Elnekeidy May A. Kamal Amr M. El-fatatry. Mahmoud L. Elskeikh conducted a study was to evaluate the value of double inversion recovery (DIR) magnetic resonance (MR) sequence in the detection of brain cortical and white matter lesions in multiple sclerosis (MS). In this study fifteen patients with remitting relapsing MS were included. Imaging was performed on a 1.T MR system using DIR, fluid-attenuated inversion-recovery (FLAIR) and T2-weighted image (T2WI) sequences. The sensitivity of DIR was compared with the corresponding sensitivity of FLAIR and T2WI sequences. The contrast between lesions and normal-appearing gray matter (NAGM), normal-appearing white matter (NAWM) and cerebrospinal fluid (CSF) was determined for all sequences. From the study, they found that DIR showed significantly more MS lesion load overall when compared to T2WI or FLAIR. Significantly higher number of lesions was seen in the supra-and infratentorial locations. DIR detected higher periventricular white matter lesions when compared to FLAIR, but did not detect significantly higher lesions when compared to T2WI. Significantly higher deep white matter, juxtacortical, and intracortical lesions were seen on DIR when compared to both T2WI and FLAIR. The image contrast measurements between the MS lesions

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and the NAWM in all anatomical locations were significantly higher in DIR sequence compared to both T2WI and FLAIR sequence. They concluded that, DIR sequence is valuable in the imaging workup of MS as it can detect more MS lesions compared to the T2W and FLAIR sequences in all anatomical locations. DIR showed better delineation between the white matter, gray matter, and the MS lesions due to its high image contrast. DIR sequence should be included in the routine MR protocol of MS patients especially to answer the question about intra-cortical and juxta-cortical MS lesions [5].

Yanbing Wang, Hong Yan, Qixing Ding, Cunhua Mao, Yelong Shen and Guangbin wang conducted a study to examine the value of three-dimensional double inverse-three-dimensional double inversion recovery (3D-DIR) in the early differential diagnostic and prognostic evaluation of NMO. Forty-eight patients with suspicious NMO were included into the study and underwent a combination of serum NMO-IgG quantitative detection and 3D-DIR examination. Forty cases (83.3%) of the suspicious cases were confirmed with NMO. The average time from onset to definite diagnosis was 3.5±0.6 days. The brain showed high T2W and fluid-attenuated inversion recovery (FLAIR) signals, involving 5.8±1.2 sites on average, distributed in the peripheral lateral ventricle, medulla, cerebral white matter, the third ventricle, peripheral aqueduct of sylvius, pons and diencephalon. The average T2W signal strength was 2.73±0.12. The signal intensity of DIR was significantly higher than that of T2W and FLAIR, and the difference was statistically significant. The optic nerve and chiasma showed a high FLAIR signal, with an average signal intensity of 2.13±0.14. The spinal cord showed swelling, necrosis and cavity lesion, involving the gray and white matter of the central site, transversely, with an average lesion length of 4.7±0.6 centrum. The relative signal intensity of DIR was significantly higher than that of T2W and FLAIR. Following treatment, the signal intensity of the brain, optic nerve, optic chiasma and spinal cord decreased significantly ($p<0.05$). They concluded that, 3D DIR has great application value in the early differential diagnostic and prognostic evaluation of NMO [6].

Improved Detection with 3D Double Inversion-Recovery MR Imaging. Jeroen J.G. Geurts, M.Sc., Petra J.W. Pouwels, Ph.D., Bernard M.J. Uitdehaag, MD, Ph.D., Chris H. Polman, MD, Ph.D., Frederik Barkhof, MD, Ph.D., and Jonas A. Castelijns, MD, PhD. prospectively compared the depiction of intracortical lesions by using multislab three-dimensional (3D) double inversion-recovery (DIR), multislab 3D fluid-attenuated inversion-recovery (FLAIR) and T2-weighted spin-echo (SE) magnetic resonance (MR) imaging in patients with multiple sclerosis [7].

Conventional T2-weighted SE and multislab 3D FLAIR and DIR images were acquired in 10 patients with multiple sclerosis (five women, five men) and 11 age-matched healthy control subjects (seven women, four men). Mean age was 40 years (range, 25-54 years) in patients and 34 years (range, 24-55 years) in control subjects. Lesions were classified according to seven anatomic regions: intracortical, mixed white matter-gray matter, juxtacortical, deep gray matter, periventricular white matter, deep white matter, and infratentorial lesions. The numbers of lesions per category were compared between techniques (Dunnett corrected analysis of variance). Gain or loss (with 95% confidence intervals [CIs]) of numbers of lesions detected at 3D DIR imaging was calculated in comparison with those detected at T2-weighted SE and 3D FLAIR imaging. From the study, they found that total number of lesions did not differ between 3D DIR and 3D

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Flair sequences, but the 3D DIR sequence showed a gain of 21% (95% CI: 4%, 41%) in comparison with the T2-weighted SE sequence. Because of high gray matter–white matter contrast, DIR images depicted more intracortical lesions (80 lesions in 10 patients) than both SE (10 lesions) and FLAIR (31 lesions) images; gains with DIR were 538% (95% CI: 191%, 1297%) and 152% (95% CI: 15%, 453%) compared with SE and FLAIR, respectively [8].

Conclusion

3D DIR images showed more deep white matter, periventricular white matter lesions in comparison with both 3D FLAIR and 2D FLAIR sequences.

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