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Original research article

BRAIN LESIONS IN CORTICAL AND JUXTACORTICAL REGIONS: IMAGING BY 3D DOUBLE INVERSION RECOVERY, 3D FLUID ATTENUATED INVERSION RECOVERY AND 2D FLUID ATTENUATED INVERSION RECOVERY

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Abstract

Multiple sclerosis is believed to result from a cell-mediated autoimmune response against one's own myelin components, with loss of oligodendrocytes, with little or no axonal degeneration in the acute phase; however, in later stages, loss of oligodendrocytes results in axonal degeneration. Demyelination occurs in discrete perivenular foci, termed plaques, which range in size from a few millimetres to a few centimetres. 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. 3D DIR images showed more cortical, Juxtacortical, lesions in comparison with both 3D FLAIR and 2D FLAIR sequences.

Keywords: 3D DIR, 3D FLAIR, 2D FLAIR

Introduction

Multiple sclerosis (MS) is a relatively common acquired chronic relapsing demyelinating disease involving the central nervous system, and is the second most common cause of neurological impairment in young adults, after trauma. Characteristically and by definition, multiple sclerosis is disseminated not only in space (i.e. multiple lesions in different regions of the brain) but also in time (i.e. lesions occur at different times) [1].

A number of clinical variants are recognized, each with specific imaging findings and clinical presentation. They include [2]:

- Classic multiple sclerosis (Charcot type).

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- Tumefactive Multiple Sclerosis.
- Marburg type (acute malignant).
- Schilder type (diffuse cerebral sclerosis).
- Balo concentric sclerosis.

The presentation is usually between adolescence and the sixth decade, with a peak at approximately 35 years of age. There is a strong, well recognised female predilection with a F:M ratio of approximately 2:1.

Multiple sclerosis has a fascinating geographic distribution: it is rarely found in equatorial regions (e.g. 15 per 100,000), with incidence gradually increasing with distance from the equator (e.g. 250 per 100,000) [3].

Clinical presentation is both highly variable acutely, as a result of varying plaque location as well as over time, with a number of patterns of longitudinal disease being described:

Upon presentation patients often have evidence of multiple previous asymptomatic lesions, and the diagnosis of multiple sclerosis can be strongly inferred. In other instances patients present with the first plaque. This is known as clinically isolated syndrome (CIS) and not all patients go on to develop multiple sclerosis [4].

Radiologically isolated syndrome (RIS) is another entity based on MRI brain findings which described as incidental white matter lesions suggestive of MS on imaging in a patient without associated clinical symptoms.

Symptoms may be sensory or motor or mixed, including cranial nerve involvement, e.g. trigeminal neuralgia or optic neuritis.

The exact aetiology is poorly known although it is believed to have both genetic and acquired contributory components. An infectious agent (i.e., EBV), or at least a catalyst, has long been suspected due to the geographic distribution and presence of clusters of cases; however, no agent has yet been firmly confirmed. Some authors also suggested that "chronic cerebrospinal venous insufficiency" can cause or exacerbate MS but this theory has not been proven by further investigations.

Multiple sclerosis is believed to result from a cell-mediated autoimmune response against one's own myelin components, with loss of oligodendrocytes, with little or no axonal degeneration in the acute phase; however, in later stages, loss of oligodendrocytes results in axonal degeneration [5, 6].

Demyelination occurs in discrete perivenular foci, termed plaques, which range in size from a few millimetres to a few centimetres.

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

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and 2D Fluid attenuated inversion sequences.

The DIR sequence has two different time inversions (TI1=2550, TI2=450ms): suppressing cerebrospinal fluid (CSF) and white matter signal.

MRI sequence parameters

Parameter	3D DIR	3D FLAIR	2D Flair
Field of view (mm)	250x250	250x250	230 x230
Matrix	210x210	210x210	270x180
Slice thickness (mm)	1	1	5
Voxel size	0.98	0.98	0.8
Repetition time (ms)	5500	4800	11000
Echo time (ms)	300	334	125
Inversion time (ms)	2550/450	1650	2800
Number of signals averaged (NSA)	2	2	2
Acquisition time (min:sec)	6.20	7:46	2:12

Data analysis was performed using the SPSS version 20, and p-value was gained from the patient-wise analysis by Wilcoxon analysis and paired samples t-test for matched pairs.

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-Cortical distribution of patients studied

Brain lesions Cortical	**Frequency (%)**			**% difference**		
	3D DIR	**3D FLAIR**	**2D FLAIR**	**3D DIR vs 3D FLAIR**	**3D DIR vs 2D FLAIR**	**3D FLAIR vs 2D FLAIR**
▪ 0	9(30.0%)	10(33.3%)	26(96.7%)	3.3%	66.7%	63.4%
▪ 1-5	19(63.3%)	19(63.3%)	3(10.0%)	0.0%	-53.3%	-53.3%
▪ 6-10	2(6.7%)	1(3.3%)	1(3.3%)	-3.4%	-3.4%	0.0%

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Table 2: Supra tentorial-Juxtacortical distribution of patients studied

Brain lesions-Juxtacortical	Frequency (%)			% difference		
	3D DIR	3D FLAIR	2D FLAIR	3D DIR vs 3D FLAIR	3D DIR vs 2D FLAIR	3D FLAIR vs 2D FLAIR
▪ <10	22(73.3%)	22(73.3%)	26(86.7%)	0.0%	13.4%	13.4%
▪ 10-20	5(16.7%)	6(20%)	2(6.7%)	3.3%	-10.0%	-13.3%
▪ >20	3(10%)	2(6.7%)	2(6.7%)	-3.3%	-3.3%	0.0%

Table 3: Supra tentorial distribution of patients studied

Brain lesions -Supra tentorial	Min-Max	Mean ± SD	Median	P value
Cortical				
▪ 3D DIR	2.43-2.18	2.43±2.18	2.50	-
▪ 3D FLAIR	1.90-1.81	1.90±1.81	2.00	0.001**
▪ 2D FLAIR	0.17-0.46	0.17±0.46	0.00	<0.001**
Juxtacortical				
▪ 3D DIR	9.40-10.24	9.40±10.24	5.00	-
▪ 3D FLAIR	8.03-8.92	8.03±8.92	4.50	<0.001**
▪ 2D FLAIR	5.37-7.57	5.37±7.57	2.50	<0.001**

Discussion

C. Tsiotsios *et al*. [2] Oslo/NO Compared 3D Fluid Attenuated Inversion Recovery (FLAIR) and 3D Double Inversion Recovery (DIR) pulse sequences for the MR Imaging of multiple sclerosis at 3 Tesla. They concluded that FLAIR is a well-established pulse sequence, which is used worldwide for the detection of MS plaques in clinical practice. DIR imaging provides higher sensitivity in the depiction of MS lesions compared with FLAIR, especially in the infratentorial and cortical region, but also is more time consuming [7].

Zahra Abidi1 *et al*. conducted cross sectional study for assessment of the diagnostic accuracy of double inversion recovery sequence compared with FLAIR and T2W TSE in detection of cerebral multiple sclerosis lesions. In this study 55 patients were admitted to the MRI department in Vali-E-Asr Hospital in Qaemshahr, Iran, from May 2016 to February 2016. Imaging was performed on a 1.5 T Philips MR system using DIR, fluid attenuated inversion recovery (FLAIR) and T2-weighted turbo spin echo (T2W_TSE) sequences with the same parameters, including field of view (FOV), matrix, slice thickness, voxel size, and number of signal averaging (NSA). Data analysis was performed using the SPSS version 20 and p-value was gained from the patient-wise analysis by Wilcoxon analysis and paired samples t-test for matched pairs. They found that more lesions in number and size were depicted on the DIR sequence compared with FLAIR (p=0.000 with a relative ratio of 6) and T2W_TSE (p=0.000

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with a relative ratio of 10). DIR demonstrated significantly more intracortical lesions compared with FLAIR (p=0.000 with a relative ratio of 2.53) and T2W_TSE (p=0.000 and relative ratio of 8.87). There was significantly higher contrast ratio between the white matter lesions and the normal appearing white matter (NAWM) in all anatomical regions especially in deep white matter (p=0.001). From the study they concluded that an increasing total number of MS lesions can be detected by DIR sequence; thus, they recommend adding DIR sequence in routine MR protocols for MS patients [4].

Wattjes MP *et al*. Conducted a prospective study to determine the sensitivity in the detection of multiple sclerosis (MS) lesions by using double inversion recovery (DIR), fluid-attenuated inversion recovery (FLAIR) and T2-weighted turbo spin-echo (T2 TSE) MR imaging at 3T. In this study, seventeen patients presenting with a clinically isolated syndrome (CIS) suggestive of MS, 9 patients with definite MS, and 6 healthy control subjects were included. Imaging was performed on a 3T MR system using DIR, FLAIR, and T2 TSE sequences. Lesions were counted and classified according to 5 anatomic regions: infratentorial, periventricular, deep white matter, juxtacortical and mixed white matter-gray matter. The sensitivity at DIR was compared with the corresponding sensitivity at FLAIR and T2 TSE sequence. The contrast between lesions and normal-appearing gray matter, normal-appearing white matter, and CSF was determined for all sequences. They found that, because of higher lesion-white matter contrast, the DIR showed a higher number of lesions compared with the FLAIR (7% gain, P 0.04) and the T2 TSE (15% gain, P 0.01). The higher sensitivity was also significant for the infratentorial region compared with the FLAIR (56% gain, P 0.02) and the T2 TSE (44% gain, P 0.02). Compared with the FLAIR, no significant changes of the lesion load measurements were observed in the supratentorial brain: slightly higher numbers of periventricular and mixed gray matter-white matter lesions on the DIR were counterbalanced by a slightly reduced sensitivity regarding juxtacortical lesions. From the study, they concluded that, DIR brain imaging at 3T provides the highest sensitivity in the detection of MS lesions especially in the infratentorial region [8].

Conclusion

3D DIR images showed more cortical, Juxtacortical, lesions in comparison with both 3D FLAIR and 2D FLAIR sequences.

References

1. Moraal B, Roosendaal SD, Pouwels PJ, Vrenken H, Van Schijndel RA, Meier DS, *et al*. Multi-contrast, isotropic, single-slab 3D MR imaging in multiple sclerosis. European radiology. 2008 Oct;18(10):2311.
2. Kidd D, Barkhof F, McConnell R, Algra PR, Allen IV, Revesz T. Cortical lesions in multiple sclerosis. Brain. 1999 Jan;122(1):17-26.
3. Lucchinetti CF, Parisi J, Bruck W. The pathology of multiple sclerosis. Neurologic clinics. 2005 Feb;23(1):77-105.
4. Zhang Q, Li Q, Zhang J, Zhang Y. Double inversion recovery magnetic resonance imaging (MRI) in the preoperative evaluation of hippocampal sclerosis: correlation with volumetric measurement and proton magnetic resonance spectroscopy (1H MRS). Journal of computer assisted tomography. 2011 May;35(3):406-10.
5. Okuda T, Korogi Y, Shigematsu Y, Sugahara T, Hirai T, Ikushima I, *et al*. Brain

ISSN:0975 -3583,0976-2833 VOL13, ISSUE 05, 2022

lesions: when should fluid-attenuated inversion-recovery sequences be used in MR evaluation? Radiology. 1999 Sep;212(3):793-8.

6. Bakshi R, Ariyaratana S, Benedict RH, Jacobs L. Fluid-attenuated inversion recovery magnetic resonance imaging detects cortical and juxtacortical multiple sclerosis lesions. Archives of neurology. 2001 May;58(5):742-8.
7. Tintoré M, Rovira A, Martínez MJ, Rio J, Díaz-Villoslada P, Brieva L, *et al*. Isolated demyelinating syndromes: comparison of different MR imaging criteria to predict conversion to clinically definite multiple sclerosis. American Journal of Neuroradiology. 2000 Apr;21(4):702-6.
8. Wattjes MP, Harzheim M, Kuhl CK, Gieseke J, Schmidt S, Klotz L, *et al*. Does high-field MR imaging have an influence on the classification of patients with clinically isolated syndromes according to current diagnostic MR imaging criteria for multiple sclerosis? American journal of neuroradiology. 2006 Sep;27(8):1794-8.

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