A Comparison of Sagittal Sections of Short T1inversion Recovery and T2 Weighted Fast Spin Echo Magnetic Resonance Sequences for Detection of Multiple Sclerosis Spinal Cord Lesions

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ABSTRACT

Background: Multiple sclerosis is a chronic autoimmune inflammatory demyelinating disease of the central nervous system of unknown etiology. Different techniques and magnetic resonance image sequences are widely used and compared to each other to improve the detection of multiple sclerosis lesions in the spinal cord.

Objective: To evaluate the ability of MRI short tau inversion recovery sequences in improvementof multiple sclerosis spinal cord lesion detection when compared to T2 weighted image sequences.

Type of the study: A retrospective study.

Methods: this study conducted from 15thAugust 2013 to 30thJune 2014 at Baghdad teaching hospital. 22 clinically definite MS patients with clinical features suggestive of spinal cord involvement, patients were imaged with sagittal short tau inversion recovery sequences and sagittal T2 weighted.

Results: The mean age of the patients was 32.5 ± 6.7years; female to male ratio was 2.7:1. The total number of spinal cord MS lesions was 44 of them 86.4% in the cervical spine, 68.2%of the lesions had less than one vertebra extension,79.6% of the lesions did not show changes in the spinal cord morphology. There was a significant upgrading in the lesions conspicuity at short tau inversion recovery sequence comparing to T2 weighted image, P<0.001. A significant difference had been found in artifact grading between both sequences; P<0.001.

Conclusions: short tau inversion recovery magnetic resonance image sequences improve detection of MS spinal cord plaques compared with T2 weighted image and itincreasesthe conspicuity of the visualized T2weighted image lesions, but also it accentuates theartifacts more than T2weighted image.

Keywords: multiple sclerosis,morphism, MRI,spinal cord.

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MS is a chronic autoimmune inflammatory demyelinating disease of theCNS in which the lesions are disseminated in time and space. Prevalence is higher in temperate climates further from the equator and lower in tropical and subtropical climates close to the equator. Onset is rare before puberty and beyond 60 years of age. Age of onset is 20 years in 20% of cases; 20-50 years in 50-60% of cases; >50 years in 20-30% of cases.There is a female propensity (F>M: >3:1)[(1)]. Etiology is unknown, but likely to be a misdirected autoimmune disease (because of the predilection for women, the human leukocyte antigen [HLA] association. Environmental factors, such as a virusInfection (e.g. herpes virus-6), may trigger immune-mediated demyelination in genetically predisposed individuals. Vitamin D is increasingly implicated[(2)].MS usually has a subacute onset of neurologic symptoms over several hoursto days. Infrequently the symptoms evolve quickly over minutes or slowly over weeks or months. The onset is monosymptomatic in about 75% of cases. The remainder has initial symptoms of multiple lesions within the CNS.Patients are usually present with optic neuritis, cerebellar, pyramidal ordorsal column dysfunction.Neurologists agree that patients may be groupedinto four major clinical subtypes based on the course of disease: Relapsing-remitting MS (RRMS): the most common form, affecting about85% of MS patients. It is marked by flare-ups (relapses or exacerbations)of symptoms followed by periods of remission, when symptoms improveor disappear.Secondary progressive MS (SPMS): may develop in some patients withrelapsing-remitting disease. The disease course continues to worsen withor without periods of remission or leveling off of symptom severity(plateaus).Primary progressive MS (PPMS): affects approximately 10% of MSpatients. Symptoms continue to worsen gradually from the beginning.There are no relapses or remissions, but there may be occasional plateaus.Progressive-relapsing MS (PRMS): a rare form, affecting fewer than 5% ofpatients. It is progressive from the start, with intermittent flare-ups ofworsening symptoms along the way. There are no periods of remission. [(3)]

Methods: This was a cross sectional study conducted during the period from 15thofAugust 2013 to 30thof June 2014 at Baghdad teaching hospital - Medical City complex, Baghdad - Iraq. Twenty two multiple sclerosis (MS) patients enrolled in this study, were referred from MS clinic in Baghdad teaching hospital, all were imaged on 1.5 Tesla system (Acheva Philips) in radiology department of Baghdad teaching hospital using a spine receiver coil to produce sagittal T2 weighted FSE and sagittal STIR-FSE images of the spinal cord for each

patient. The region of the spinal cord that had been imaged in each patient was determined by segmental level decided by the referring neurologist depending on the patient's clinical signs and symptoms.

All the patients enrolled in this study had clinically definite MS withclinical features suggestive of spinal cord involvement, and had nocontraindication for MRI examination.Patients were recruited in the study regardless their age, gender, clinical subtype and disease duration of MS.

Spinal cord lesions which had artifacts significantly reduce the readingconfidence of the lesion. Spinal cord lesions which did not show the typical characteristics of MS spinal cord plaques, especially if spanning more than three vertebral body segments.Spinal cord lesions due to spondylotic myelopathy secondary to direct cord compression or vascular compromise caused by disc herniation and steophyte formation compounded by superimposed spinal canal stenosis. The MRI protocols and parameters that had been used in the study were fixed in the examination of all patients, these included the followings: Sagittal T2 weighted FSE sequence(TR 2038 ms /TE 100 ms, slice thickness 4 mm, interslice gap 0.4 mm, FOV 407x185x52 mm, voxel size , matrix 184x294, echotrain 1, acquisition time 1:50 min) Sagittal STIR -FSE sequence (TR 3500 ms /TE 60 ms /inversion time165 ms, slice thickness 4 mm, interslice gap 0.8 mm, FOV 300x160x52mm, voxel size I, matrix 300x117, acquisition time 1:38 min). The conspicuity of the lesions in the images of both sequences was graded using a subjective but consistent scale of I-V (grade I: non visualized lesion, grade II: poorly visualized lesion, grade III: adequately visualized lesion with poor delineation of its margin, grade IV: more adequately visualized lesion with good delineation of almost entire margin and grade V: clear demarcation of the entire lesion margin). Ghost artifacts from subject motion, cardiac pulsation, respiratory movement or CSF flow, and truncation –type artifacts in the images of both sequences were graded as; grade I: absent, grade II: present, but not affecting reading confidence, and grade III: significantly reducing the reading confidence.

Results: There were twenty two multiple sclerosis patients enrolled in this study; their demographic characteristics are shown in the following paragraphs: The mean age of the studied patients was 32.5 ± 6.7 years (range: 23 - 45years), more than half of them 12/22 (54.5%) aged 30 - 39 years, 6/22 (27.3%) aged less than 30 years and 4/22 (18.2%) aged 40 years or more (Fig. 3.1). Regarding the sex distribution, females were the dominant, 16/22 (72.7%) while males were 6/22 represented (27.3%), with a female to male ratio of 2.7:1

Table 1 Age and sex distribution of the 22 patients

Variable	No.	%	P
Total number	22	100.0	
Age (years)			
< 30	6	27.3	
30 - 39	12	54.5	**<0.001**
≥ 40	4	18.2	
*Mean ± SD**	32.5 ± 6.7	-	
Range	23 - 45	-	
Sex			
Male	6	27.3	**0.033**
Female	16	72.7	

** SD: Standard Deviation*

Characteristics of MS spinal cord lesions: The total number of MS spinal cord lesions that was recorded depending onthe STIR sequence among the patients was 44 lesions, as it shown in Table2, majority of the lesions were at cervical region; 38/44 (86.4%). Dorsal region MS lesions represented the remaining 6/44 (13.6%) lesions. while no lumber lesions had been recorded.

Table 2 Distribution of Locations of the 44 spinal cord MS lesions

Location of MS lesion	No.	%
Cervical	38	86.4
Dorsal	6	13.6
Lumber	0	0.0
Total	44	100.0
P.value < 0.001		

Conspicuity grading: In T2 WI sequence, out of the 44 lesions, 11 (25%) had conspicuity grade I,26 (59.1%) had grade II, 5 (11.4%) had grade III, 2 (4.5%) had grade IV and nograde V was recorded. In STIR sequence no lesion of grade I was recorded, 22(50%) had grade II, 20 (45.5%) had grade III, 2 lesions (4.5%) had grade IVand none of grade V (Table 3).

Out of 26 lesions of grade II at T2 WI, 13 upgraded to grade III and 13remained grade II at STIR (Fig 4). Five lesions of grade III and 2 lesionsof grade IV at T2 WI remained the same grade (grade III and grade IVrespectively) at STIR sequence.

Table 3 Distribution of conspicuity grading of the 44 spinal cord MS lesions

	T2WI		STIR	
Grading	No.	%	No.	%
Grade I	11	25.0	0	0.0
Grade II	26	59.1	22	50.0
Grade III	5	11.4	20	45.5
Grade IV	2	4.5	2	4.5
Grade V	0	0.0	0	0.0
Total	44	100.0	44	100.0
P<0.001				

Table 4 Cross tabulation between conspicuity grading in T2WI and STIRsequences

		Conspicuity grading STIR					Total T2WI
		Grade I	Grade II	Grade III	Grade IV	Grade V	
Conspicuty gradingT2 WI	Grade I	0	9	2	0	0	11
	Grade II	0	13	13	0	0	26
	Grade III	0	0	5	0	0	5
	Grade IV	0	0	0	2	0	2
Total STIR		0	22	20	2	0	44
P< 0.001							

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Discussion: MRI of the spinal cord is thought reliable for investigation of intramedullarylesions[4] it may be considered a powerful tool to differentiate MS from other CNS conditions when brain MRI results are negative or equivocal.[5]As up to 83% of recently diagnosed patients with MS have abnormal cordlesion demonstrated on MRI, early confident detection for the presence of spinal cord lesions facilitates early diagnosis and management of MS.[6] Whereas brain imaging sequences are now fairly standardized there continuesto be debate about the optimal sequence for imaging of spinal cord.[7]Differenttechniques and MRI sequences are widely used and compared to each other toimprove the detection of MS lesions in the spinal cord. [8]The current study aimed to evaluate and compare two sequences of MRI,STIR and T2 FSE, regarding the improvement of detection of MS spinal cordlesions. We chose FSE technique for both T2 WI and STIR sequences because it is being used routinely in neuroradiologic practice for its short acquisition time.The current study revealed that STIR sequence was significantly increased the conspicuity of MS spinal cord lesions, particularly for the non- or poorly visualized lesions in T2 WI sequence. In terms of conspicuity grading, in T2 WI sequence (25%)

of the lesion were non-visualized (grade I), more than half of the lesions (59.1%) of grade II (poorly visualized), (11.4%) of grade III, (4.5%) of grade IV and none of grade V, in STIR sequence all the lesion were visualized; (95.5%) of grade II and III, and (4.5%) of grade IV, this indicated that the lesion conspicuity on T2-weighted FSE sequences was markedly lower than that on STIR images. These findings agreed that reported by Hittmair et al [11]who compared the sensitivity of T2 FSE and STIR FSE sequences in detection of multiple sclerosis of the spinal cord and found that intrinsic spinal cord lesions were seen best on STIR FSE images, lesions showedthe highest contrast, appeared larger and were better delimited on STIR FSEimages compared to T2 weighted FSE. Rocca et al[8]had mentioned an earlier study that fast STIR sequence revealed more cervical cord MS lesions than T2 weighted FSE. The high lesions contrast on STIR FSE images can be attributed to the synergistic effect of prolonged T1 andT2 relaxation time, which characterize not only spinal cord plaques but also most other types of pathological tissues [9]as well as its ability to null high signal from the fat. [10]STIR FSE sequence is obtained with a relatively short inversion time allowing this synergistic effect.With T2FSE the prolong T1 and T2 relaxation time produces antagonistic effect, and this reduces lesions contrast. The synergistic effect of long T1 and T2 relaxation time are particularly advantageous in lesions with only slightly prolonged T2 relaxation time, which might be characteristic of inactive MS plaques. [11]

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