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Comparison of MRI brain in multiple sclerosis patients at 1.5 T and 3.0 T MRI scanners: A follow up study

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Abstract:

Objective:

The symptoms of Multiple Sclerosis (MS), a complex autoimmune disease, are numerous. Magnetic Resonance Imaging (MRI) is the most sensitive technique for diagnosis and monitoring treatment of MS. Recently, the high magnetic field MRI system performed routinely for MS patients. The purpose of the study was to retrospectively evaluate the sensitivity of MRI scanning for multiple sclerosis (MS) lesions at 1.5-T and 3.0-T during 6 month follow-up period.

Method:

We retrospectively studied brain MRI at 1.5-T and 3.0-T in 28 MS patients. MRI scans were performed on two visits, at baseline and six months later. The scanning protocol was identical at all time points and the period between 1.5-T and 3.0T scans was 72 hours. The scanning protocol included contiguous axial of FLAIR, T2WI, Proton density, T1WI, and postcontrast T1 weighted imaging.

Result:

The overall mean number of lesions was significantly higher in 3 Tesla (21 lesions) compared to 1.5 Tesla (11 lesions) ($P<0.05$). The overall mean number of lesions was significantly higher in 3 Tesla at follow up visit (25 lesions) compared to baseline visit (21 lesions) ($P<0.05$). There was no significant difference between the overall mean number of lesion between 1.5 tesla at follow up visit (12 lesions) compared to baseline visit (11 lesions) ($P>0.05$).

Conclusion:

Using high-field MRI system could improve the sensitivity for early detection of multiple sclerosis lesions. The diagnosis of multiple sclerosis would influence by strength of magnetic field scanner.

A further large cohort study is recommended for protocol optimization with different scanner strength and various imaging vendors.

Keywords: Multiple sclerosis (MS), Magnetic Resonane Imaging (MRI), sensitivity,

Introduction:

The symptoms of multiple sclerosis (MS), a complex autoimmune disease, are numerous. MS directly impairs a person's ability to work during the most productive period of their life, with significant social and economic consequences. The average age at the onset of MS is around 26 years old, and women are more likely than men to have it (2 to 1) (1).

MRI is the most sensitive technique for the detection of demyelination inflammation within the Central Nervous System. MRI reveals macroscopic tissue abnormalities in patients with Multiple Sclerosis (MS) (2-4).

Multiple sclerosis (MS) patients can be diagnosed and tracked over time with MRI, which the most effective preclinical technique. White matter (WM) disease linked to MS can be detected by MR imaging because WM alterations impact numerous quantifiable MR imaging parameters, such as proton density, water diffusion, T1 and T2 relaxation times. Variations in these parameters are thought to be signs of myelin and axon loss, which may occur after the initial inflammatory process in WM lesions caused by MS.

Conventional MR sequences, including dual-echo, fluid-attenuated inversion recovery (FLAIR), and T1 and T2-weighted imaging, both with and without the administration of a gadolinium-based contrast agent, provide crucial pieces of information for diagnosing MS, comprehending its natural history, and evaluating the effectiveness of treatment (2-7). Various studies have investigated the significance of MRI with various magnetic fields including 1.5-T, 3-T and 7-T for the diagnosis and treatment follow up of MS (2-7).

In addition, Many MS clinics now routinely perform high magnetic field MRI systems, such as 3-T and 7-T, as they are used more and more in MS clinics. Higher field intensities improve the image quality by increasing the signal-to-noise ratio. Nonetheless, certain clinics still have limited access to high magnetic field scanners like 3-T and 7-T.The purpose of this study was to retrospectively evaluate the sensitivity of MRI scanning for multiple sclerosis (MS) lesions at 1.5-T and 3.0-T during 6 month follow-up period.

Method:

This study was carried out between 2020 and 2023 in the Radiology Department at the King Salman Specialist Hospital, Saudi Arabia. It was a retrospectively descriptive study. The total number of MS sufferers in the study was 28. MS Patients were diagnosed According to McDonald criteria (8). Six months after the first MRI scan, 28 participants had a follow-up scan optimized for patients with MS.

Participants with MS who do not have any cognitive impairments were eligible for inclusion in the study; participants of both sexes and ages (20–60) were included. Participants with medical history of other immunologic disease, malignancy, or vascular pathology, brain surgery; absolute contraindication to MRI scanning including known claustrophobia or allergy to a gadolinium-based contrast agent, and those pregnant were excluded from the study. The participant's age, gender, body mass index, residence, lifestyle, educational background, smoking history, and eating habits were all included in the data.

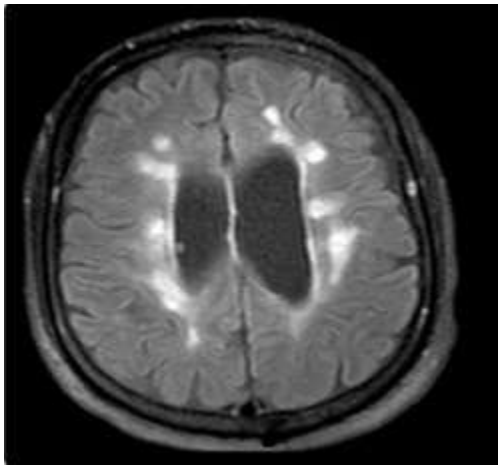
MRI protocol were performed for multiple sclerosis participants with post contrast (gadolinium) injection images. Scans were performed at both 1.5-T (Magnetom Vision; Siemens Medical Systems, Erlangen, Germany) and 3.0-T (Magnetom Trio; Siemens Medical Systems, Erlangen, Germany) scanner during two sessions

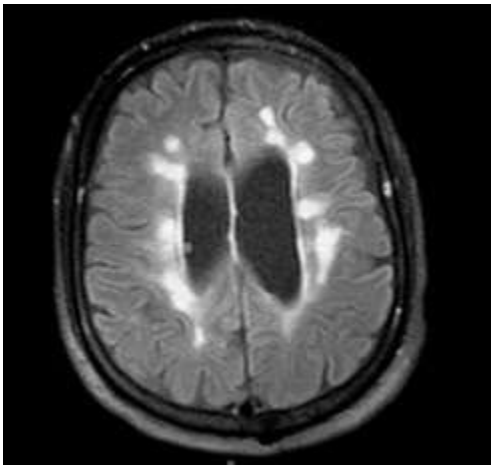
separated by 1 to 3 days. These scans were performed in two visit: at baseline and at 6 month later. all participants were scanned while they were in supine position (Figure 1).

On each scanner, a clinical MRI protocol was acquired identical as described previously (9). It was performed at all visits and including; an axial 3D FLAIR (Fluid Attenuated Inversion Recovery) sequence and a sagittal 3D T1-weighted imaging (T1WI) turbo field echo sequence. axial T2-weighted imaging (T2WI) and proton density (PD), double inversion recovery (IR) and Postcontrast T1 weighted brain imaging. The spinal cord was acquired with sagittal T1WI, T2WI and PD. All lesions larger than 3 mm at baseline or at follow-up visits were counted.

Statical analysis using SPSS 26.0. Categorical data were summarized as numbers and percentages. A Pearson correlation coefficient was calculated to investigate any possible relationships between 1.5-T and 3.0-T. All statistical tests were two-sided. P values less than 0.05 were considered significant.

A





B

Figure 1: MS patients with Demyelinating lesions are clearly seen in a periventricular distribution at; a) FLAIR on 1.5 T, b) FLAIR on 3T. There are several periventricular hyperintense lesions. The lesions appear more well defined with higher numbers in the 3T scanner images

Result:

The study involved 28 patients with an average age of 33 ± 11 years. The participants had an average height of 175 ± 9 centimeters and an average weight of 85 ± 7 kilograms. The number of female and male was 17 and 11, respectively (table 1).

The overall mean number of lesions was significantly higher in 3 Tesla (21 lesions) compared to 1.5 Tesla (11 lesions) ($P<0.05$). The number of lesions showed significant differences between 1.5 Tesla and 3 Tesla in Periventricular, Juxtacortical and Deep white matter ($P<0.05$), while Infra tentorial and spinal cord showed no significant differences between 1.5 Tesla and 3 Tesla ($P>0.05$) (Table 2).

The size of lesions showed significant differences between 1.5 Tesla and 3 Tesla in Periventricular, Juxtacortical, Deep white matter and spinal cord ($P<0.05$), However, Infra tentorial showed no significant

differences between 1.5 Tesla and 3 Tesla (P>0.05) (Table 3).

The overall mean number of lesions was significantly higher in 3 Tesla at follow up visit (25 lesions) compared to baseline visit (21 lesions) (P<0.05). The only site showed the significant difference of number of lesions at 3 Tesla baseline (4 lesion) and follow up (8 lesions) visits was deep white matter (P<0.05). There was no significant difference between the overall mean number of lesion between 1.5 tesla at follow up visit (12 lesions) compared to baseline visit (11 lesions) (P>0.05).

Table 1: Distribution of the participants with their characteristics

Characteristics	Variables	values
Age	Mean ± SD	33 ± 11 yr
Gender	Male (%)	11 [39%]
	Female (%)	17 [61%]
Height	Mean ± SD	175 ± 9 cm
Weight	Mean ± SD	85 ± 7 kg
Body Mass Index [BMI]	Normal	19[67%]
	Overweight	7 [25%]
	Obese	2 [07%]

Table (2) Number of lesions at different sites by 1.5 Tesla and 3 Tesla

location	No of lesion 1.5 Tesla	No of lesion 3 Tesla	P value
Periventricular	3	6	P<0.01
Juxtacortical	4	7	P<0.01
Deep white matter	1	4	P<0.05
Infra tentorial	2	3	P>0.05
Spinal cord	1	1	P>0.05
Overall	11	21	P<0.05

Table (3) size of lesions at different sites by 1.5 Tesla and 3 Tesla

location	1.5 Tesla (mean ± SD)	3 Tesla (mean ± SD)	P value
Periventricular	2.6 ±0.3	1.8 ±0.9	P<0.05
Juxtacortical	2.7 ±0.4	1.9 ±0.7	P<0.05
Deep white matter	2.6 ±0.4	1.9 ±0.6	P<0.05

Infra tentorial	2.4 ±0.6	2.3 ±0.7	P>0.05
Spinal cord	2.5 ±0.4	1.6 ±0.9	P<0.05

Discussion:

The aim of current study was to retrospectively assess the sensitivity of MRI scanning for multiple sclerosis (MS) lesions at 1.5-T and 3.0-T during baseline and 6 month follow-up period. The patients in this study were 33 years old on average, with an 11-year standard deviation. Over two-thirds of the patients (61 percent) were female, indicating a female predominance. These results in age was close to previous studies (10-11).

MRI platforms with varying magnetic field strengths are used to diagnose MS. The most used magnet strengths are 3 T or 1.5 Tesla. The latter's enhanced resolution and signal-to-noise ratio have demonstrated a higher sensitivity for the identification of MS lesions. It has not been demonstrated that using high-field 3 T MRI instead of 1point 5 T improves MS early diagnosis (11).

However, both field strengths are included in the recommendations, even though 3 T MRI is the recommended magnet strength according to the modified McDonald criteria. Modified McDonald has suggested that certain MRI sequences are the most suitable for MS diagnosis (12-13). Axial proton density or T2-weighted/T2-fluid attenuated inversion recovery (FLAIR) spin echo or turbo spin echo, sagittal two-dimensional (2D) or three-dimensional (3D) T2-FLAIR, and axial 2D or 3D postcontrast T1-weighted spin echo or turbo spin echo are required sequences for multiple sclerosis protocol, according to the McDonald criteria guidelines. In addition, unenhanced 2D or high-resolution isotropic 3D T1 weighted, 2D or 3D dual inversion recovery, and axial diffusion weighted imaging (DWI) were recommended as optional sequences for MS patients (13).

Many MS clinics now routinely perform high magnetic field MRI systems, such as 3-T and 7-T, as they are used more and more in MS clinics. Higher field intensities improve the image quality by increasing the signal-to-noise ratio. Nonetheless, certain clinics still have limited access to high magnetic field scanners like 3-T and 7-T (11-13).

In the current study, there were notable differences in the number of lesions between 1.5 Tesla and 3 Tesla, with 3 Tesla detecting a wider range of lesions at various sites ($p<0.05$). The overall mean number of lesions was significantly higher in 3 Tesla at follow up visit (25 lesions) compared to baseline visit (21 lesions) ($P<0.05$). Our findings were consistent with Wattjes et al study which they concluded 3T is increased lesion detection compared to 1.5T especially in periventricular, (juxta) cortical, and deep white matter locations (14).

It's still unclear if the advantages of a higher resolution and an even better signal-to-noise ratio will have practical applications. In addition, the healthy subject were not included in current study as no statistically significant difference between the 2 field strengths in lesion detection.

Conclusion:

Early detection of multiple sclerosis lesions may be more sensitive with the use of a high-field MRI system 3T in comparison with 1.5T. Thus, Multiple sclerosis diagnosis would be influenced by the magnetic field scanner's strength. It is advised to conduct a larger cohort study in order to optimize the protocol using a variety of imaging vendors and scanner strengths.

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Conflict of interest:

No

Author contribution

Authors contributed equally in the study

Reference:

1. Wootla B, Eriguchi M, Rodriguez M. Is multiple sclerosis an autoimmune disease? Autoimmune Dis. 2012;2012
2. Bakshi R, Thompson AJ, Rocca MA, et al. MRI in multiple sclerosis: current status and future prospects. Lancet Neurol 2008;7:615–625.
3. Paty DW, Oger JJ, Kastrukoff LF, et al. MRI in the diagnosis of MS: a prospective study with comparison of clinical evaluation, evoked potentials, oligoclonal banding, and CT. Neurology 1988;38:180–185.
4. Dekker I, Wattjes MP. Brain and spinal cord MR imaging features in multiple sclerosis and variants. Neuroimaging Clin N Am 2017;27:205–227.
5. Fazekas F, Barkhof F, Filippi M, et al. The contribution of magnetic resonance imaging to the diagnosis of multiple sclerosis. Neurology 1999;53:448–456.
6. McDonald WI, Compston A, Edan G, et al. Recommended diagnostic criteria for multiple sclerosis: guidelines from the International Panel on the Diagnosis of Multiple Sclerosis. Ann Neurol 2001;50:121–127.
7. Rovira A, Wattjes MP, Tintore M, et al. Evidence-based guidelines: MAGNIMS consensus guidelines on the use of MRI in multiple sclerosis: clinical implementation in the diagnostic process. Nat Rev Neurol 2015;11:471–482.
8. Thompson AJ, Banwell BL, Barkhof F, Carroll WM, Coetzee T, Comi G, et al. Diagnosis of multiple sclerosis: 2017 revisions of the McDonald criteria. Lancet Neurol. 2018;17(2):162–73
9. Hagens MH, Burggraaff J, Kilsdonk ID, et al. Impact of 3 Tesla MRI on interobserver agreement in clinically isolated syndrome: a MAGNIMS multicentre study. Mult Scler Epub 2018
10. Hagens MHJ, Burggraaff J, Kilsdonk ID, de Vos ML, Cawley N, Sbardella E, et al. ThreeTesla MRI does not improve the diagnosis of multiple sclerosis: A multicenter study. Neurology. 2018;91(3):e249–57.
11. Tallantyre EC, Morgan PS, Dixon JE, Al-Radaideh A, Brookes MJ, Morris PG, et al. 3 Tesla and 7 Tesla MRI of multiple sclerosis cortical lesions. J Magn Reson Imaging. 2010;32(4):971–7.
12. Kaunzner UW, Gauthier SA. MRI in the assessment and monitoring of multiple sclerosis: an update on best practice. Ther Adv Neurol Disord. 2017;10(6):247–61
13. Traboulsee A, Simon JH, Stone L, Fisher E, Jones DE, Malhotra A, et al. Revised recommendations of the consortium of MS centers task force for a standardized MRI protocol and clinical guidelines for the diagnosis and follow-up of multiple sclerosis. Am J Neuroradiol. 2016;37(3):394–401.
14. Stankiewicz JM, Neema M, Alsop DC, Healy BC, Arora A, Buckle GJ, et al. Spinal cord lesions and clinical status in multiple sclerosis: A 1.5 T and 3 T MRI study. J Neurol Sci. 2009;279(1–2):99–105.