OPEN AIMJ ORIGINAL ARTICLE

Neurology

Value of Magnetic Resonance Imaging in Multiple Sclerosis Patients

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Received *for publication July 26,2021;****Accepted*** *Agust 22, 2021;* ***Published online*** *August 22, 2021.*

doi: 10.21608/aimj.2021.83947.1518

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ABSTRACT

Background: Magnetic Resonance Imaging (MRI) has many advantages in the investigation of Multiple Sclerosis (MS). It delivers precise measurements of disorder activity, simplifies accurate diagnosing, and help in the evaluation of novel treatments.
Aim of the work: to recognize the roles of MRI in in the characterizations of MS-connected brain and spinal cord involvement.
Patients and methods: 30-cases relapsing-remitting MS (RRMS) cases were involved. The number, volume, and distribution of brain MRI lesions have been assessed via T2-weighted (T2W) image. Cross-sectional full normalized brain volume (NBV), normalized deep gray matter volume (NDGMV), normalized white matter volume (NWMV), normalized cortical gray matter volume (NCGMV), and normalized thalamic volume (NTV) have been calculated.
Results: MRI findings revealed that the mainstream of case's lesions were detected via T2W-imaging with a mean value of Number of lesions measured of 4.43±3.329, MRI accuracy to detect MS was 86.67% with sensitivity and specificity 88.9 and 66.7 correspondingly.
Conclusion: MRI suggestion have a supporting function in what is eventually a clinical MS diagnosing, in the suitable medical condition, and at all times at the exclusion of substitute diagnosing. MRI has improved into the most significant tool for diagnosing and screening of MS. Its elevated sensitivity for the assessment of inflammation and neuro-degenerative procedures in the brain and spinal cord has made it the commonest employed way for the valuation of MS-cases.

Keywords: *Magnetic resonance imaging; multiple sclerosis; autoimmune diseases.*

Disclosure: *The author has no financial interest to declare in relation to the content of this article. The Article Processing Charge was paid for by the authors.*
Authorship: *The author has a substantial contribution to the article.*

INTRODUCTION

Multiple sclerosis (MS), neuromyelitis optical spectrum disease (NMOSD), acute disseminated encephalomyelitis (ADEM) and myelin oligodendrocyte glycoprotein (MOG) encephalomyelitis are essential inflammatory demyelinating disorders. [1] With the provision of immuno-histochemical markers, it became obvious that there is a significant pathologic difference among those disorders and the morphologic patterns were related to various mechanisms of demyelinating. [2]

MS is an inflammatory demyelinating disorder of the central nervous system (CNS), historically described by the existence of multi-focal white matter lesions disseminated in space&time. [3]

Demyelination is the frequent ultimate phase in the pathology of MS and contains the strip of myelin lamellae and elimination of myelin remains via phagocytes. There is evidence that demyelination is done by various mechanisms comprising the adaptive and innate immune system. [4] The medical diagnosing of MS is founded on the demonstrations of demyelinating lesions disseminated in space&time. [5]

During the past years MRI has appreciably changed our capacity to look at and manipulate MS. 1st, it has supplied a comparatively precise measure of disorder activity; 2nd, it has improved our capacity to disorder diagnosing, consequently permitting preceding treatments; and 3rd, it has supplied an effective tool to examine the advantages of recent treatments. [6]

Conservative MRI sequences preserve to delivers elevated sensitivity in the MS diagnosing however absence specificity to recognize accurate pathology.[7] Conventional MRI is regularly unable to distinguish the ongoing pathology in normal-appearance white matter (NAWM), in spite of familiar disorder processes as defined with histo-pathological association. [8]

Ultrahigh-field and advanced MRI methods provide precise insight into the patho-physiology of MS together with improved specificity and enhance medical associations and prediction of the buildup of dis-ability but are confined in widespread adoption as

a result of the absence of standardized protocols and large, well-controlled trials [9]

PATIENTS AND METHODS

This work is an observational study of cases with RRMS.

Informed written agreement was attained from each patient to be included in this work.

Eligible patients were 18 to 60-yrs of age, with a medical diagnosing of reverting MS. Cases have at minimum one of the next: one or more relapses in the preceding 1-yr earlier to enrollment, or further relapses in the preceding 2-yrs, and at minimum one contrast-improved T1-weighted (T1W) brain lesion on base-line MRI. Cases as well have at minimum one T2W brain lesion, have been neurologically steady with no relapse, and have a Kurtzke's Expanded Dis-ability Status Scale (EDSS) scoring [10] starting from zero up to six.

Exclusion criteria have been used of corticosteroids (throughout the preceding 30 days), immuno-modulatory treatment (in the previous 3-mths), or immuno-suppressive therapy (e.g., azathioprine or methotrexate in the preceding 6-mths).

We gathered the demographic and clinical information such as gender, ages, disorder period from the primary symptoms, EDSS score, MS Severity Scoring (MSSS), preceding MS treating exposure including disorder-modifying drug (DMDs) or immuno-suppressive treatment.

Image acquisition

MRI images have been acquired via 1.5 T detectors with interleaved axial 0.3-cm-thick slices, zone of view = 0.25 m, and matrix = 128 × 128. The scaning protocols involved axial protons densities (repetition time [TR] 2800–3800 ms; time echo [TE] 14–40) and T2W fast/turbo spin echo (TR 2800–3800 ms; TE 80–1200 ms). Furthermore, T1W traditional spin echo (TR 500–650 ms; TE 10–20 ms) and post-contrast T1W spin-echo image (TR 500–650 ms; TE 10–20 ms) have been acquired.

MRI analysis

Trained and skilled operators performed T2W-lesion segmentations on T2W image via semiautomated threshold contour program with an interactive digital analyzing program. To recognize the quantity, size, and distributions of T2W-lesions we chosen only cases with MRI that fully covering the areas from the medulla to the top of the parietal lobe.

As soon as the T2W-lesions have been translated to MNI space, we automatically measured the existence or nonexistence of lesions in every brain lobe in accordance to the Talairach atlas (i.e., occipital lobe, frontal lobe, temporal lobe, limbic region, parietal lobe, sub-lobar region, cerebellum, and brainstem), in addition to the quantity and size of lesions in the entire brain.

We utilized the complete group to evaluate the complete NBV, NCGMV and NDGMV, and normalized NWMV via the Structural Images Evaluations via Normalization of Atrophy X (SIENAX) program. [11] This program makes use of a totally computerized algorithms for estimation of cross-sectional brain size via a single time-point scans [12], executes segmentations of the brain from non-brain tissues withinside the head, and calculates the exterior skull superficial.

To rise the re-producibility amongst cases, NBV, NWMV, NCGMV, and NDGMV have been evaluated in the 7.0-cm central region of the brain (z-block; MNI152 z-coordinates − 1.0-cm bottom to + 6.0-cm top). Lastly, we one by one evaluated the normalized thalamic cases from the NDGMV via the FMRIB's Integrated Registrations and Segmentations Tool algorithms [19]. We achieved a good evaluation to ensure the best segmentations of all of the compartments.

RESULTS

Thirty cases with RRMS. have been enrolled in the current work

Table (1) demonstrate demographic data for all patients and it shows that the mean of patients age was 45.00±10.498 years and more than half of them were male (53.3%). Patients' co-morbidity shows that 10(33.3%) had DM while 9(30%) had hypertension and only 2 patients had dyslipidemia. The mean of disorder duration of patients was 16.00±7.661 years and the majority of them had previous MS treatment exposure (86.7%); 12 out of them (40%) had a history of Disorder-modifying drugs (DMDs) intake while the rest of them (14 cases) had an immunosuppressive therapy history. The mean of patients EDSS Score was 3.32±0.978 while the mean of patients MS Severity Score (MSSS) was 3.10±0.923.

Age	**45.00±10.498**
Sex	
Male	**16(53.3%)**
Female	**14(46.7%)**
Co-morbidity	
DM	**10(33.3%)**
Hypertension	**9(30.0%)**
Dyslipidemia	**2(6.7%)**
Disorder duration	**16.00±7.661**
Previous MS treatment exposures	**26(86.7%)**
Disorder-modifying drugs (DMDs)	**12(40.0%)**
Immuno-suppressive therapies	**14(46.7%)**
EDSS Score	**3.32±0.978**
Multi-Sclerosis Severity Scoring (MSSS)	**3.10±0.923**

Table 1: Demographic data distribution of the Study group

Lesions detected by T2W-	**25(83.3%)**
Number of lesions detected	**4.43±3.329**

Table 2: Distribution of MS in Study group as regard to MRI findings

MRI finding show that the majority of case's lesions was detecting by T2W imaging with a mean value of Number of lesions detected of 4.43±3.329.

Table (3) reveals that MRI confirms that three patients with probable MS and five patients with possible MS. Of 17 patients with definite MS, five had acute MS, 9 had Chronic with acute exacerbation MS and 3 had Chronic progressive MS.

Definite	**17**
Acute	**5(20.0%)**
Chronic with acute exacerbation	**9(36.0%)**
Chronic progressive	**3(12.0%)**
Probable	**3**
Acute	**0(0%)**
Chronic with acute exacerbation	**1(4.0%)**
Chronic progressive	**2(8.0%)**
Possible	**5**
Acute	**1(4.0%)**
Chronic with acute exacerbation	**1(4.0%)**
Chronic progressive	**3(12.0%)**

Table 3: Distribution of MR Imaging in the Evaluation of MS (n=25)

Table (4) shows that MRI accuracy to predict MS was 86.67% with sensitivity and specificity 88.9 and 66.7 correspondingly.

	Sensitivity	**Specificity**	**NPV**	**PPV**	**AUC**	**Accuracy**
MRI Finding	**88.9**	**66.7**	**40.0**	**96.0**	**0.445**	**86.67**

Table 4: MRI sensitivity and specificity to predicted MS

DISCUSSION

The introduction of MRI in the early Eighties revolutionized the MS diagnosing and

treating by permitting un-precedented in vivo visualizations of lesional activity and load. As the technologies progressed over the subsequent 30-yrs, MRI quickly upgraded to be the most essential tool for paraclinical diagnosing and monitoring accessible; persistent technical advances have aided elucidate neuro-inflammatory disorder mechanism in methods that are extremely complementary to histo-pathological and immuno-logical methods. [13] MRI has moreover emerged as main supportive consequences evaluations in MS medical trials, and is repeatedly employed for longitudinal medical monitor. MRI has an important function in make the MS diagnosing; the disorder can now be

approved with a single time point MRI scans through the latest Universal Panel on MS Diagnosing criteria .[14]

MS is the commonest chronic inflammation and demyelinating disorder of the CNS that led to stated neurological dis-ability in young adults and results in longterm dis-ability. The pathological stamp of MS is the buildup of demyelinating lesions that arise in the grey and white matter of the brain and additionally diffuse neuro-degeneration in the whole brain, even in NAWM. [15]

The present work aimed to identify the function of MRI in in the characterizations of MS-correlated brain and spinal cord involvements.

This was an observational investigation of 30 cases with RRMS, the mean of patients age was 45.00±10.498 years and more than half of them were male (53.3%). Patients' co-morbidity shows that 10(33.3%) had DM while 9(30%) had hypertension and only 2 patients had dyslipidemia. The mean of disorder duration of patients was 16.00±7.661 years and the majority of them had previous MS treatment exposure (86.7%); 12 out of them (40%) had a history of Disorder-modifying drugs (DMDs) intake while the rest of them (14 cases) had a history of immunosuppressive therapy. The mean of patients EDSS Score was 3.32±0.978 while the mean of patients MS-Severity Scoring (MSSS) was 3.10±0.923.

This is in accordance with an observational report of Yamout et al., [16] in which a number of 207 cases with RRMS, the mean of cases age was 40.5 ± 12.3-yrs and male (34.8%). The mean of disorder period of patients was 7.9 ± 6.2-yrs, The mean of patients EDSS Score was 2.25 ± 1.2 (0–6.5).

In comparison with the study of Bertado-Cortés et al., [17] which was conducted on 313 cases, out of which 65.5 percent were females. Age's mean was 41-yrs (SD 11.22). youngest aging of the diagnosed cases was 12-yrs and the oldest, 66-yrs; ages mean was 32-yrs (SD:9.72). Regarding to clinical variables, 3.4 % existing radiologically isolated syndromes (RIS), 82 % RRMS, 13.9 % secondary-progressive MS (SPMS), and 0.8 % primary-progressive MS (PPMS). Of all the cases, 10 percent had relatives of 1st- or 2nd-degree with diagnosing of this disorder; foreign ancestors where 16 percent smokers were 27 percent

Also, a report of Minneboo et al., [18] revealed that the aging at base-line 38 (33; 44) yrs., Disorder period at base-line was 5.0 (2.4; 7.3) yrs., Gender (females; males) was 27; 16, EDSS at base-line was 2.5 (2.0; 3.5), and MSSS (built on data from following-up 2) 4.3 (2.2; 6.9).

MRI is sensitive to focal MS lesions. For this cause, conservative MRI assessments of the load of disorder resulting from dualecho, fluid-weakened inversions recoveries and post-contrast T1W sequence is repeatedly employed to monitor disorder course in cases with MS confirmed and were involved in the

diagnosing work-up of cases in whom MS is assumed. [19]

In most cases, standard MS lesions are found on T2W image and MRI aids to expect conversion to clinical definite MS (CDMS). Reports that following cases with a clinically isolated syndromes (CIS) from start define significant correlations among lesion load and dis-ability at FU. In the progressive disorder stage of CDMS, cross-sectional as well as longitudinal investigations revealed a reasonable correlation among lesion load on T2W or T1W scans and EDSS. [20]

In the current study, MRI finding showed that the majority of case's lesions were detecting by T2W imaging with a mean value of Number of lesions detected of 4.43±3.329.

Almutairi et al., [21] reported that the entire lesion amount was lastly determined and matched between 3 sequences. The average entire lesion number amongst cases in all area built on DIR was M = 37.67, FLAIR was M = 29.57, and for T2WI was M = 27.47 (ranging between 2 and 101).

Many pulse sequences could enhance contrasting for recognizing small T2 hyper-intense MS lesions dependent on site. Conventional T2W sequence still has the highest sensitivity for detecting lesions in the brain-stem and cerebellum owing to flexibility to flow-connected artifacts, while FLAIR is more sensitive for detecting of peri-ventricular and cortical/juxta-cortical lesions. Generally, the field strength of the MRI is proportional to the signal-to-noise and then the sensitivities of the scans for detecting lesions. [22]

As an indicator of the activity of disorder, MRI lesions could be utilized as outcomes in clinical trials as well as traditional outcomes like dis-ability. A metanalysis that comprise 18,901 RRMS-cases established that MRI lesions within a quick following-up (6 to 9-mths) may be employed to expect following rate of relapse, giving strong supporting for considering MRI as a measure of clinical outcomes. [23]

In the present study, MRI confirms that three cases with probable MS and five cases with possible MS. Of 17 patients with definite MS, five had acute MS, 9 had Chronic with acute exacerbation MS and 3 had Chronic progressive MS.

Early research on T2-hyper-intense lesions revealed minimum clinical associations with disorder load, fond on MRI, causing the term 'clinico-radiological paradox'. High lesions loads were related to neither disorder period nor functionally state. Longitudinal research, but, were capable to show that an elevated number of T2-hyper-intense lesions and the elevated lesion size had been related to elevated dis-ability.44 The quantity of recent T2-hyper-intense lesions in the initial 5-yrs was the most powerful predictor of elevated EDSS at 14-yrs and the following-up report showed an affiliation among early lesion buildup and next 20-yrs dis-ability.45 Besides, T2-hyper-intense lesions also can be employed to expect short-term dis-ability,46 where base-line T2-hyper-intense lesion size is prognostic for falling EDSS.47,48 Although the typically found decreased lesions loads of cases with PPMS, the variety of latest T2-hyper-intense lesions is as well modestly prognostic for the disorder outcomes in those cases

MRI has evolved into the best essential tool for the analysis and tracking of MS. Its excessive sensitivities for the assessment of inflammation and neuro-degenerative procedures in the brain and spinal cord has make it the commonest employed method for the assessment of cases with MS. Furthermore, MRI has come to be an effective tool for treating monitoring, safety evaluation in addition to for the prognostication of disorder progressions. Clinically, using MRI has elevated in the preceding 20 years due to new technologies and elevated obtainability that now spreads well beyond educational centers. Subsequently, there are various research confirming the roles of MRI in managing the MS cases. [24]

Studies of Fisniku et al. [25], Tintore et al. [26] have established that an excessive lesions load and the region of MS lesion at the starting of the disorder is prognostic for the improvement of clinical dis-ability. It is moreover well known that disorder activity as evaluated via MRI has greater sensitive than the clinical disorder activity as assessed, for instance, by the rate of relapse. Thus, repetitive MRI surveys are a known tool to discover and screen sub-clinical disorder activities.

In addition to above findings, we found that MRI accuracy to predict MS was 86.67% with sensitivity and specificity 88.9 and 66.7 correspondingly.

In accordance to the report of Narayana et al., [27] which reported that the sensitivity and specificity averaged through the 5 testing sets were 78% ± 4.3 and 73% ± 2.7, correspondingly, for slice-wise predictions. The matching contributor-wise values were 72% ± 9.0 and 70% ± 6.3. The diagnosing presentations (AUCs) were 0.82 ± 0.02 and 0.75 ± 0.03 for slicewise and contributor-wise improvement predictions, correspondingly.

In another study done by Cetina et al., [28] aimed to improve a new, robust, and simplified images dividing technique to make MS-lesions quantitative analysis from multi-modal MRI data, stated that the advanced method categorizes several brain tissues and recolonizes MS lesion with over 90 percent specificity& accuracy, and average sensitivity ranging between 62–65 %.

CONCLUSION

MRI still the most significant para-clinical tool obtainable to confirm diagnosing and screening of MS-cases. Furthermore, MRI-derived metrics are communal secondary measure of the outcomes in clinical trials of phase-III. Conventional MRI sequences remain providing elevated sensitivity in the MS diagnosing, but absence specificity to recognize precise pathologies. Ultra-high field and advanced MRI systems delivers exclusive insight into the MS patho-physiology together with elevated specificity, but are restricted in wide-spread acceptance because of the deficiency of standard protocols and big, well-controlled studies.

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