



ORIGINAL RESEARCH PAPER

Medical Science

EVALUATION OF 3D VOLUME FLAIR MAGNETIC RESONANCE IMAGING (MRI) PROTOCOL FOR THE VISUALIZATION OF MULTIPLE SCLEROSES (MS)

KEY WORDS: Multiple Scleroses, 3d, Ms, Mri, Protocol,Flair

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ABSTRACT

This study was done in two hospitals in Sudan in Khartoum state .The objective of the *study was* to add MRI Protocol for the Visualization of Multiple Scleroses MS by Comparing between 3D volume Flair, Flair thin slice & gap and routine protocol in detecting of MS lesion . A total of 60 patients undergoing brain MRI were involved. Data were collected from findings which appeared in different MRI cuts and the data were represented in tables and graphs. The results of the study showed that : the mean MS findings in protocol 1 was 38.41, in protocol 2 was 52.14 and in protocol 3 was 69.00.In conclusion the most sensitive and efficient protocol in the detection of MS plaque was protocol 3.

1. Introduction:

Multiple sclerosis is a chronic, progressive, degenerative disorder of the central nervous system (CNS) characterized by disseminated demyelination of nerve fibers of the brain and spinal cord. MS usually affects young to middle- aged adults, with onset between 15 and 50 years of age. Women are affected more than men, it's unknown etiological cause may be related to infectious, immunologic, and genetic factors, possible precipitating factors include (physical injury, emotional stress, pregnancy, poor state of health. Pathophysiology of myelin sheath affected by segmented lamination that wraps axons of many nerve cells increases velocity of nerve impulse conduction in the axons, composed of myelin, a substance with high lipid content (Kalb & P. D.R.C 2008). Characterized by chronic inflammation, demyelination, and gliosis (scarring) in the CNS, initially triggered by a virus in genetically susceptible individuals subsequent antigen-antibody reaction leads to demyelination of axons .Disease process consists of loss of myelin, disappearance of oligodendrocytes, and proliferation of astrocytes changes result in plaque formation with plaques scattered throughout the CNS.Initially the myelin sheaths of the neurons in the brain and spinal cord are attacked, but the nerve fiber is not affected. Patient may complain of noticeable impairment of function, myelin can regenerate, and symptoms disappear, resulting in a remission (Kalb & P. D.R.C 2008).The characteristic abnormalities of MS in the brain consist of multiple white matter lesions with a high signal intensity (SI) on fluid attenuation inversion recovery (FLAIR), proton density (PD)-weighted image (WI), and T2-WI and low signal intensity (SI) on T1-WI. Lesions are found predominantly in a periventricular distribution, centrum semiovale, and the calloseseptal interface. Additional sites of involvement include other parts of the cerebral

white matter such as the sub cortical a penetrating medullary vein. Atypical lesions and mass-like lesions occur with sufficient frequency to cause diagnostic errors. MS lesions may enhance after contrast administration on T1-WI, depending on the age and activity of the lesion. New and active lesions commonly show contrast enhancement, due to BBB breakdown. New lesions tend to show solid enhancement, whereas reactivated lesions enhance in a ring-like fashion (Fazekas et al., 1999).After 2 months, the integrity of the BBB is restored, and the majority of lesions no longer show contrast enhancement. As with unenhanced lesions, the contrast-enhancing lesions are smaller than the corresponding lesions on the T2-W scan. The discrepancy between the size of the lesion on T1-WI and T2-WI reflects the different components of the local process: edema, inflammation, and demyelization. The poor correlation between the MRI findings and the clinical events was demonstrated by the frequent finding of enhancing lesions in clinically stable patients.White matter, optic nerves, corpus callosum, internal capsule, cerebellar peduncles, brainstem, and spinal cord. Demyelinating lesions appear smaller on T1-WI than on T2-WI. Occasionally, they show a hyper intense border on T1-WI (Fazekas et al 1999).Lesions in MS can be small, large, or confluent the typical configuration is that of an ovoid lesion extending perpendicularly from the ventricular surface (Dawson's finger).This probably reflects the perivascular inflammation along found in the corpus callosum. Typically, these lesions occur along the inner callosal-ventricular margin, creating an irregular ventricular surface of the corpus callosum. This aspect can be differentiated from callosal atrophy due to the lobar white-matter lesions. The existence of callosal lesions improves both the sensitivity and the specificity of MRI for the diagnosis of MS. The absence of callosal lesions renders the diagnosis of MS less likely,

but does not exclude it. A frequent initial presentation of MS is optic neuritis, although there is controversy regarding the likelihood of definitive MS developing in patients who have had an optic neuritis. Brainstem lesions are common, and a lesion in the medial longitudinal bundle affects approximately one-third of MS patients. In patients with clinically possible MS and a normal MRI study of the brain, a spinal MRI study should be performed. MS is an inflammatory demyelinating disease of the CNS. It is the most common demyelinating disease after vascular- and age-related demyelination. MS is characterized by multiple "plaques" of demyelination in the white matter of the brain and spinal cord. The primary lesions are found in the perivascular spaces along penetrating veins. Though the etiology of MS is not fully understood, the destruction of myelin is most likely caused by an autoimmune process. Initial symptoms can sometimes be triggered by trauma or a viral infection, but a convincing link to the disease has not been made. (Gray, et al., 2004). The clinical course of MS is highly variable. The age of symptom onset in MS is usually between 18 and 40 years; onset is uncommon in childhood and after the age of 50 years. Initial symptoms may include numbness, dysesthesia, double vision, or problems with balance and coordination. Loss of motor function is also a frequent initial presentation. Less commonly, spinal-cord-related symptoms constitute the initial presentation of MS. There is a female: male ratio of 3:2. The most common clinical presentation is "relapsing-remitting" MS (70% of cases) (Rae-Grant et al., 1999). Patients experience symptomatic episodes (known as "attack"), which can last from 24 h to several weeks, followed by complete or partial disappearance of symptoms (remission). The interval between relapses may be weeks to years (and even decades). As white-matter lesions increase over time, and neurologic disabilities increase, the disease frequently becomes "secondary progressive." Accumulating neurological deficits eventually lead to permanent disability. The evolution from relapsing-remitting to secondary-progressive MS occurs in approximately half of patients within 10 years after onset. Alternatively, in 10–20% of cases, MS can follow a "primary progressive" course; in this type of disease, there is a continuous, gradual evolution from the beginning, rather than relapses (Rae-Grant et al., 1999). The common brain MRI protocols, Axial T1, T2 and Flair. Sagittal T1. Coronal :T2. Slice gap: 1mm. Slice thickness: 5mm Asma et al 2015.

2. Materials and Methods

2.1 Materials:

2.1.1 Patients (Study sample): This study was conducted in period from May 2015 to February 2018, which included 64 patients (18 male and 46 female) under went brain MRI of known case of MS disease in different genders and age groups. Who were referred to the radiology department in Modern Medical Centers in Khartoum, to add and standardize protocol to diagnose MS, children and patients with brain tumor were excluded from the study. All patients were informed to obtain their consent before the exam and their information were used in this study. The data were collected and interpreted by radiologist reports.

2.1.2 Machines used: Machines used in this study included MRI scanner TOSHIBA, ALLTECH (1.5 Tesla), and GE. TOSHIBA machine in Almoalem Medical City, ALLTECH machine in Sharg Alneel Hospitals, and GE machine in Asia hospital. Coil used was neurovascular head coil, ear plug, and immobilization band.

2.2 Methods

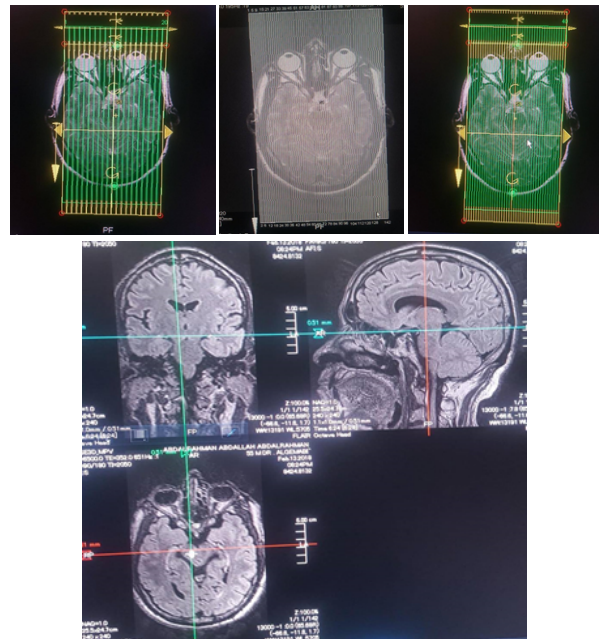
2.2.1. Technique used

The following MRI technique was used: Field Strength: 1.5 T. Sequences: 1st: 3Dvolume FLAIR, 2nd: Axial T2 – Sagittal T2. 3rd: Gadolinium enhanced in 3Dvolume T1 fat saturation and T1 sequence.

2.2.2. Data collection: The data included the general patients data (Age, gender, weight clinical diagnosis and signal intensity) and were accompanied by the relevant Symptoms and clinical information such as clinical signs (A numb or weak feeling in the face, trouble speaking, blurred or poor vision, loss of balance, headache, The risk factors and patients history were (hypertension, D.M, heart disease). The study variables consisted

of parameters related to the MS in which the data were categorized into two main groups such as (patient disease and demographic data and images containing the pathology for further evaluation using CAD programs).

2.2.3 Data Interpretation: The data were collected from the results of MRI scan findings and supported by radiologist reports, Determined by SI as hyper, hypo and iso as compared with normal brain area by observation and by measuring SI of affected area.



2.2.4. Method of data analysis and presentation: The data were stored in computer programs than containing all parameters related to the MS in which the data were categorized into two main groups (patient disease ,demographic data and images contacting the pathology for further evaluation, using computer aided diagnosis programs. IDL). After that MRI images were stored in computer disk were viewed by the Radiant, Ant DICOM viewer in computer to select the axial images that suit the criteria of research population then uploaded into the computer based software Interactive Data Language (IDL) where the DICOM image converted to JPEG format to suit IDL platform in order to preserve the quality of the image. Then the image were read by IDL in JPEG format and the user clicked on areas representing the background, grey matter, white matter, CSF and MS plaques in case of test group; in these areas a window of 3x3 pixel was generated and textural feature for the classes center were generated. These textural features includes FOS; (coefficient of variation, stander deviation, variance, signal, energy, and entropy), and were assigned as classification center used by the Euclidian distances to classify the whole image. The algorithm scanned the whole image using a window; 3x3 pixels and computed the above mentioned textural features and then computed the distance (the Euclidean distance) between the calculated features during the scanning and the class's centers and assigned the window to the class with the lowest distance. Then the window interlaced one pixel and the same processes started over again till the entire images were classified and classification maps were generated. After all images were classified the data concerning the brain

tissues (CSF, grey, and white matter) and MS plaques were entered into SPSS with its classes to generate a classification score using stepwise linear discriminate analysis; to select the most discriminate features that can be used in the classification of brain tissues in MRI images. scattered plots using discriminate function were generated as well as classification accuracy and linear discriminate function equations to classify the brain tissues into the previous classes without segmentation process for unseen images in routine work.

3,Results:

Table 1. Illustrates the MS findings in protocol 1 (routine protocol 2d flair slice thickness 5mm gap 1mm), protocol 2 (modify protocol 2d flair slice thickness 3mm and slice gap 0mm) and advanced protocol 3 (3Dvolume flair).

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
age	64	17	52	35.89	9.5
Protocol 1 finding	64	8	100	38.41	22.860
Protocol 2 finding	64	19	120	52.14	26.030
Protocol 3 finding	64	25	145	69.00	31.316

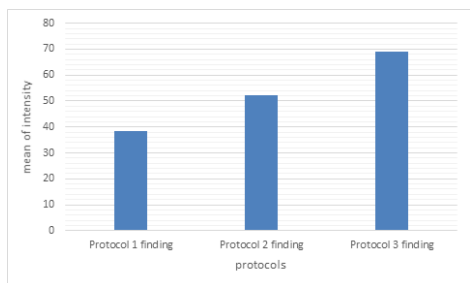


Figure 1. Illustrates the MS finding in protocol 1 (routine protocol 2d flair slice thickness 5mm gap 1mm), protocol 2 (modify protocol 2d flair slice thickness 3mm and slice gap 0mm) and advanced protocol 3 (3Dvolume flair).

4. Discussion: In this study the most sensitive and efficient protocol in the detection of MS plaque was protocol 3. protocol 3 1st: 3Dvolume FLAIR, 2nd: Axial T2 – Sagittal T2. 3rd: Gadolinium enhanced in 3Dvolume T1 fat saturation and T1 sequence. The modified protocol applied in this study represented by protocol 2 and this protocol was less efficient than protocol 3 in the detection of MS lesion, but can be applied in the absence of protocol 3 in the MRI machine used in hospitals.

Protocol 2: 1st FLAIR slice thickness 3mm slice gap 0 mm, 2nd: Axial T2 – Sagittal 3rd: Gadolinium enhanced in T1 slice thickness 3mm slice gap 0mm. The routine protocol common applied in hospitals and radiological centers to detect MS was represented by protocol 1. This protocol in this study showed a weak detection of MS lesion and active MS, but it is good in brain survey although it cannot cover all MS in the brain.

Protocol 1 : 1st Sagittal FLAIR slice thickness 5mm slice gap 1 mm, 2nd: 2DAxial T2 -sagittal T2, 3rd: Gadolinium enhanced in T1 slice thickness 5mm slice gap 1mm. The recent results of this study agreed with the results of (Wolter L. de Graaf&Jaco J. M. Zwaneburg&Fredy Visser& Mike P. Wattjes& Petra J. W. Pouwels. et al 2011) and (Bink, A., Schmitt, M., Gaa, J. et al Eur Radiol 2006). According to the results, obtained by the analysis the mean MS findings in protocol 1 was 38.41, in protocol 2 was 52.14 and in protocol 3 was 69.00.

5. Conclusion: The study concluded that: The most sensitive and efficient protocol in the detection of MS plaque was protocol 3.

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