Evaluation the sensitivity of FLAIR and DWI post-inject comparision with delay enhance T1w in detection of active MS lesions

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Aims and objectives

but whether patients don't have MS plaques or MRI images are not enough optimized enough in order to show MS plaques?

The aim of the current study is evaluating the efficiency of different MRI pulse sequences in order to better detection of MS plaques.

The disease usually begins between the ages of 20 and 50 and is twice as common in women as in men.

Our nerve has a protective covering called myelin. In MS, the body's immune system mistakenly attacks myelin, causing inflammation and damage (demyelination).

The resulting scar tissue is called a lesion. Some lesions are inactive and don't cause any symptoms. Active lesions, those that are just forming or expanding, can cause a wide variety of symptoms, depending on where they are located and how big they are.

MS can cause many symptoms, including blurred vision, loss of balance, poor coordination, slurred speech, tremors, numbness, extreme fatigue, problems with memory and concentration, paralysis, and blindness and more. These problems may come and go or persist and worsen over time.

Four disease courses have been identified in multiple sclerosis: Relapsing-Remitting MS (RRMS), Primary-Progressive MS (PPMS), Secondary-Progressive MS (SPMS), and Progressive-Relapsing MS. Each of these courses might be mild, moderate or severe.

While the cause is not clear but proposed causes for this include: Immunologic Factors, Environmental Factors, Infectious Factors, Genetic Factors, Sexuality.

There is no single test that is diagnostic of MS, including MRI. The lesions detected with MRI are pathologically nonspecific.

The principles of MS diagnosis are based on showing dissemination of white matter lesions in space and time.

MRI is the most sensitive method for revealing asymptomatic dissemination of lesions in space and time. The pattern and evolution of MRI lesions, in the appropriate clinical setting, has made MRI abnormalities invaluable criteria for the early diagnosis of MS. The first important role of MRI in the diagnosis of MS allows for an early diagnosis of MS for clinically isolated syndrome (CIS) patients using the international panel (IP) diagnostic criteria, including MRI for dissemination in space (DIS) and time (DIT). The sensitivity of diagnosing MS within the first year after a single attack is 94%, with a specificity of 83%.
The MRI evidence required to support the diagnosis varies, depending on the strength of the clinical findings.

Allowing a new MRI lesion to substitute for a clinical attack doubles the number of CIS patients who can be diagnosed as having MS within 1 year of symptom onset.

Increasing the sensitivity of the test with more lenient criteria, as recommended by the (AAN) subcommittee, can result in decreased specificity.

The second important role for MRI in the diagnostic work-up of suspected MS patients is to rule out alternative diagnoses obvious on MRI, such as spinal stenosis and most brain tumors.

Characteristic lesions that favor MS include Dawson Fingers, ovoid lesions, corpus callosum, and asymptomatic spinal cord lesions. However, other white matter diseases can have similar appearance on MRI.

The problem of identifying lesions in the periventricular region, which is a common site for MS lesions, can also be addressed by suppressing the signal from CSF yet maintaining heavy T2 weighting using a Fluid Attenuated Inversion Recovery (FLAIR) sequence.

This sequence is also superior at detecting cortical/juxtacortical lesions. FLAIR is therefore a commonly used MR sequence on clinical scanners when MS has been raised as a possible clinical diagnosis. The only drawback is inferior quality lesion detection in the posterior fossa and spinal cord where PD and T2 weighting are preferred.

A gadolinium chelates administered intravenously five minutes before T1 weighted imaging detects Blood-Brain Barrier breakdown in association with active inflammation. New lesions appear enhanced and usually persist for a month on average, making them a useful marker for monitoring disease activity. Such lesions play an important role in indicating dissemination in time within the new diagnostic criteria.

Triple dose gadolinium or combination with magnetization transfer imaging can both increase active lesion detection further but are not required in clinical practice.

Despite having normal MRI images, a few patients are believed to suffer from MS. The question that arises here is whether such patients lack MS plaques or MRI scans are not sufficiently optimized to detect MS plaques? The goal of the present study is to investigate the efficiency of various MRI sequences in detecting MS plaques.
Methods and materials

In this cross sectional study 32 patients (male: female = 10:22, age range 18 - 38 years, mean age 27 years) underwent MRI examination between May, 2014 until February, 2015 at Chamran imaging center, Sanandaj, Iran. MRI imaging was performed using a Siemens, Avanto, 1.5 Tesla system equipped with 8 channel head quadrature coil.

First, images without contrast were obtained; including: T2w-FSE, T1w-FSE, FLAIR, SE-EPI (DWI) sequences (see Table 1). Then 0.1 mmol/kg contrast media (Gadolinium based) was injected for each patient and finally, FLAIR and T1w-FSE images (in three planes) were obtained again 30 minutes' delay after injection. The related images to our study were evaluated by two radiologists and the number of the observed active MS plaques in this sequences were noted.

The comparison of observed MS plaques in three different MRI Pulse sequences was done by ANOVA test (P<0.05), and the amount of agreement between two radiologists has been done with Kappa statistic.
Images for this section:

**Fig. 1**: These images show the MS plaque in subcortical white matter in parietal lobe area with four MRI pulse sequences: A) is FLAIR post inject (high signal), B) is T1w post inject (iso intense), C) is ADC map (high signal), D) is DWI with b value 1000 (iso intense to high signal, restricted).

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Fig. 2: These images show the MS plaque in periventricular area with four MRI pulse sequences: A) is FLAIR post inject (high signal), B) is T1w post inject (high signal), C) is ADC map (low signal), D) IS DWI with b value 1000 (high signal).

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Fig. 3: These images show the MS plaque in occipital lobe with four MRI pulse sequence: A) is FLAIR post inject (high signal), B) is T1w post inject (iso intense to high signal), C) is ADC map (low signal), D) is DWI with b value 1000 (low signal).

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Results

This study was performed on 32 patients (male:10; female:22), 110 MS plaques were observed which 16 of them have been active plaques which FLAIR post injection sequences showed them with the most sensitivity and after that, T1W-post injection has the most sensitivity and then, DWI and ADC map sequences. As well as FLAIR pre injection showed 94 inactive MS plaques and another sequences are shown, fewer. These images were evaluated by two Radiologists and results were analyzed by ANOVA tests.

The results showed that in (FLAIR Post Injection) images it has been observed more acute MS plaques at supra tentorial area than (T1W-TSE Post Injection) which is a Gold Standard sequence. As well as, DWI sequences and ADC map displayed active plaques and even some of the inactive plaques which had less specificity than two above sequences.
Conclusion

Multiple sclerosis (MS) is an autoimmune disease of the central nervous system and it is characterized by complex pathophysiological processes including inflammation, demyelination, axonal loss. MRI is the primary imaging modality to diagnose MS and follow up the plaques and has a high sensitivity to detect the plaques. Contrast enhancement in MS plaques indicates activation and is superior to the clinical assessment. Different MRI sequences, such as T$_1$ (with contrast) - and T$_2$-weighted SE, MT-prepared imaging, FLAIR, STIR, and DWI, can be used for the diagnosis of MS.

In some cases, however, the patient has symptoms in which MS is suspected, MRI images are normal; or maybe the patient has symptoms that are related to specific area of the brain but MRI images don't show the MS plaques in the given area; Therefore in this situation we cannot surely say the patient doesn't have MS plaques because in some cases it is due to poor optimization of MRI pulse sequences. So in this investigation we have evaluated some different MRI pulse sequences to assess which of them is the most efficient to detect MS plaques in the brain. For this reason we got additional MRI pulse sequences rather than doing only routine brain MRI.

There were some restrictions in this message data status on the active plaques or not to use the double dose because of special situation of patient like kidney problems and the treatment expenditure. And also not to use the DIR sequence because of the shortage of the treat center.

In this study we investigated the relative contribution of several MRI criteria derived from Gadolinium-enhanced post-contrast FLAIR, DWI and gadolinium-enhanced T1-weighted images in making a diagnosis of multiple sclerosis in MS patients. On FLAIR images, signal from the CSF is nulled, increasing contrast between lesions and adjacent CSF. Our results show that FLAIR sequence was better at lesion visualization than the DWI, T1w, sequences tested herein. (Figs. 1 and 2)

There is another important factor which the importance of these discovery is the more number of active plaques that are found seems more. It means because of high specificity and sensitivity in these message in comparison T1w post injection numbers of real plaques.
DWI is sensitive in detecting lesions where myelin destruction has led to increased apparent diffusion coefficient (ADC) and decreased fractional anisotropy (FA). However, this method lacks specificity because it reflects each demyelination, gliosis, inflammation, axonal contraction, and axonal loss. In this investigation, in some cases, DWI sequence was not able to detect active plaques and as well as DWI sequence detected some non-active plaques as active.
References