Subcallosal Striations: the Role of FLAIR MR Imaging in Detecting these lesions in Patients with Multiple Sclerosis

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Abstract

Objective: To evaluate the reliability of Fluid Attenuation Inversion Recovery (FLAIR) in detection of subcallosal striations in clinical Multiple sclerosis (MS) patients and determine its role as a good noninvasive tool for the diagnosis of this disease.

Material and Method: Forty patients with clinically proved MS were examined along with 40 control patients well matched for age who presented with other indications for MRI study. Two mm Sagittal FLAIR sequence was added to the routine MRI studies of the brain. The images were reviewed for the presence of subcallosal striations. The study was conducted at King Hussein Medical Centre, Amman-Jordan from January 2005 to July 2007.

Result: All the 40 patients with clinical MS had subcallosal striations. Of the 40 without MS only four had subcallosal striations. Subcallosal striations were highly associated \((P < .001)\) with clinical MS.

Conclusions: FLAIR is a reliable tool for detection of subcallosal striations in MS which are not seen on routine axial MR images. However, these striations later produce the ovoid lesions visible on routine MR imaging.

Keywords: Multiple sclerosis; Magnetic resonance imaging; Subcallosal Striations.

Introduction

Multiple sclerosis (MS) is an autoimmune inflammatory demyelinating disease of the central nervous system. The white matter lesions appear to be well-defined high water content lesions which involve the cerebrum, cerebellum, brain stem and spinal cord1. MS diagnosis is based on clinical criteria stating that patients should experience at least two attacks of neurological dysfunction, such as optic neuritis, transverse myelitis, double vision, or numbness of the leg, where signs or symptoms cannot be attributable to a single brain or nerve lesions1,3. MS lesions are characterized by heterogeneous pathologic features in MRI study, all resulting in increased water mobility and consequently increased T2 signal, hence T2 weighted images are traditionally used for diagnosis of MS and for monitoring its natural course and progression5.

Pathologic studies have shown that small cortical and subcortical lesions are common in MS, although they may be under estimated on T2 weighted MR images [Fig 1], so the sagittal Fast fluid-attenuated inversion recovery (FLAIR) sequence was introduced to the routine brain MRI in an attempt to see more subtle lesions in MS patients.

FLAIR sequences produce heavily T2 weighted images with suppression of CSF signal and hence the water content lesions appear more clearly [Fig1, 2]2,4. The sagittal plane is the optimal plane of imaging for the evaluation of MS. The two distinct advantages of sagittal imaging are direct visualization of the undersurface of the corpus callosum and decreased number of sections required to cover the brain from side to side6.

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253
In our study, sagittal fast FLAIR technique was used to compare the prevalence of subcallosal striations in patients with clinical MS comparing with non MS patients.

**Fig 2.** Fast FLAIR images in a 22-year-old woman show subtle subcallosal striations (arrow) adjacent to the body of the corpus callosum. This patient clinically had MS but had negative findings on conventional 5-mm-thick T2-weighted images.

**Material and method**

This study was conducted at King Hussein Medical Centre, Amman-Jordan from January 2005 to July 2007. We studied 40 patients with clinically proved MS (21 women and 19 men). Their ages ranged between 16 and 60 years with a mean of 33 years. Additional 40 patients (25 women and 15 men with age group 19-68 mean 39 years) underwent MR imaging for indications other than MS. All imaging was performed on the same scanner 3T (Trio; Siemens Medical Systems, Germany). Thin-section, sagittal, fast FLAIR imaging was added to the routine MR examinations of the brain. The routine MR imaging of the brain included: T1 weighted sagittal imaging, proton density and T2 weighted axial imaging. Potential pitfalls in the evaluation of subcallosal striations were found; including gray matter bridges that traverse the corona radiata white matter so we used only sagittal and parasagittal sections that included CSF in the lateral ventricle.

All studies were performed with a 256 x 256 matrix over a 20-cm field of view with 5-mm-thick sections and a 1-mm gap. The fast FLAIR parameters were FSE, 10,000/2,500/112 (TR msec/echo time msec/inversion time msec).

Image review was performed by two experienced radiologists who examined the hard copies side-by-side searching for the presence of lesions perpendicular to the corpus callosum (subcallosal striation). The observation was done without knowledge of age of the patients or the clinical presentation.

**Results**

In our series of 80 patients, 40 have clinically proven MS, while the other 40 have other diseases. All the patients with MS had subcallosal striations. Of the patients without clinical MS only four (10%) had subcallosal striations with significant statistical difference between the two groups (p <0.001).

**Discussion**

MS is a multifocal disease affecting the white matter of the central nervous system. It is diagnosed on the basis of its clinical course and presentation. It is an inflammatory autoimmune demyelinating disease that affects genetically susceptible individuals. It manifests as recurrent attacks of focal neurologic disorders with a predilection for the brain, spinal cord, and optic nerves. Tissue destruction and brain degeneration, which may be irreversible, appear to be an integral part of the MS disease process. The usual course of the attacks is to occur, remit, and re-occur randomly over many years.

Interferon β1a is approved by Food and Drug Administration (FDA) for treatment of patients with MS. Early and accurate diagnosis of the disease is mandatory to initiate treatment in order to halt the disease progression.

Because of its high sensitivity and excellent gray-white matter resolution with the advantage of simultaneous imaging of spinal cord and orbits, MRI has virtually replaced all other imaging modalities including CT in the evaluation of white matter diseases.

There are two patterns of white matter changes which are relatively specific for MS: the ovoid lesions and the lesions on the undersurface of the corpus callosum. The finding of subcallosal striations is an earlier manifestation of the inner callosal–subcallosal and callosal–septal interface lesions. Given their perpendicular orientation to the ependymal tissue, subcallosal striations mostly represent some sort of perivenular inflammation. Subcallosal striations are generally not visible on routine brain MRI (Sagittal T1 weighted axial proton-density weighted and Axial T2-weighted images) which reflects the great importance of the FLAIR sagittal images in MS suspected patients. In our study the subcallosal striations were detected in the majority of MS patients (about 85%) using conventional MR imaging techniques while all the patients (100%) showed the lesions when using the FLAIR imaging [Fig 2-
This data were consistent with those obtained by Marco et al9 and Jeroen et al10. We noticed that the use of thin section FLAIR resulted in lowering of the partial volume averaging artifacts from unaffected normal tissues on the undersurface of the corpus callosum.

Fig 3. Fast FLAIR images obtained in a 40-year-old woman shows subcallosal striation (arrow).

Fig 4. fast FLAIR images for a 33 years man with MS. a cluster of subcallosal striations noted around the corpus callosum.

Fig 5: A fast FLAIR image for a 28 year female patient with chronic headache. The patients was investigated for MS and it was negative. The MRI did not show any evidence of subcallosal striations.

FLAIR imaging in patients with MS is not without problems! It has a relatively low sensitivity for detecting lesions in the posterior fossa and in the thoracic spinal cord. It also prolongs the examination time of the patient by 5-9 minutes.

Also the clinical overlap between early MS and acute disseminated encephalomyelitis (ADEM) may cause some difficulties in using the subcallosal striations sign as both conditions may result in perivenular demyelinating changes; it is likely that subcallosal striations might be noted in (ADEM) as well as MS10.

As there may be an overlap between different varieties of demyelinating diseases, the subcallosal striations sign should not be confused with white matter ischemic changes, ependymitis granularis or gray matter bridges. In old patients with deep white matter ischemia, the gliosis found to be parallel to the ependyma rather than perpendicular to it11. On the other hand, in ependymitis granularis, the findings tend to be more globular and parallel to the frontal ependyma6,7. Gray matter bridges may be avoided by choosing the appropriate section for evaluation7,9,11.

**Conclusion**

FLAIR is a sensitive way to detect subcallosal striations in MS which represent the early privenular demyelination that later progress to the ovoid lesions visible on routine MR imaging. This may have a good impact on early initiation of therapy in these patients. However, further evaluation and follow up may be necessary before the sign of subcallosal striations can be used to as definite diagnostic sign of MS.

**References**


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