

# Multiple Sclerosis Brain Lesions: Is Short Tau Inversion Recovery Sequence Suitable in Magnetic Resonance Imaging Evaluation?

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**Purpose:** To compare the sensitivity of Short Tau Inversion Recovery magnetic resonance sequence with Fast Spin-Echo T2-weighted and Fluid-Attenuated Inversion Recovery magnetic resonance sequences in detection and evaluation of multiple sclerosis brain lesions.

**Material and method:** Fast Spin-Echo T2-weighted, Fluid-Attenuated Inversion Recovery and Short Tau Inversion Recovery sequences were performed in 7 patients with relapsing remitting multiple sclerosis. Qualitative assessment, regarding the number of lesions detected, conspicuity and lesion location was performed on all images in each sequence by two radiologists. Consensus was reached by agreement.

**Results:** When comparing Short Tau Inversion Recovery sequences with Fast Spin-Echo sequences, Short Tau Inversion Recovery showed 51 lesions more than Fast Spin-Echo sequences and increased the number of lesions detected by 38% in posterior fossa and by 27% in juxtacortical locations. When comparing Short Tau Inversion Recovery sequences with Fluid-Attenuated Inversion Recovery sequences, Short Tau Inversion Recovery sequences showed 72 lesions more than Fluid-Attenuated Inversion Recovery sequences and increased the number of lesion detected by 86% in posterior fossa and by 24% in periventricular areas.

**Conclusions:** By increasing the sensitivity Short Tau Inversion Recovery sequence might be suitable as an additional sequence in routine magnetic resonance brain examinations in patients with multiple sclerosis. Although Short Tau Inversion Recovery provides essential supplementary information to conventional imaging for the visualization brain lesions in multiple sclerosis, especially in posterior fossa, it is not a substitute for other sequences.

**Keywords:** Short Tau Inversion Recovery sequence, multiple sclerosis, magnetic resonance imaging, brain

## Introduction

Magnetic resonance (MR) imaging is the most sensitive method for assessing demyelinating brain lesions in patients with multiple sclerosis (MS). At present Fluid-Attenuated Inversion Recovery (FLAIR) images are usually obtained in addition to T2-weighted Fast Spin-Echo (FSE) for detection the MS brain plaques, the usefulness and also the disadvantages of those sequences being both well known. Previous studies pointed out that Short Tau Inversion Recovery (STIR) sequence provides essential supplementary information to conventional imaging for the visualization of spinal cord lesions in MS by improving the lesion-to-cord contrast to noise ratio, even it is more susceptible to flow-related artifacts and offering thus a lower image quality [1]. STIR sequence seemed also to improve high-signal abnormalities detection in optic neuritis [2]. Despite those encouraging results application of STIR sequence in brain pathology was limited to assessing brain maturation [3].

The aim of this study was to compare the sensitivity of STIR sequence with FSE T2-weighted and FLAIR sequences in detection and evaluation of multiple sclerosis brain lesions.

## Material and method

In this study 7 patients (5 female and 2 male; age range: 32-56 years; mean age 43 years) with relapsing-remitting multiple sclerosis underwent brain MR imaging at 1.0T

(General Electric Medical Systems, Milwaukee, USA) with FSE T2-weighted, FLAIR and STIR sequences. All sequences were performed in axial plane with a 192 × 256 matrix over a 25 cm field of view with 3 mm thickness and 3 mm gap. Slice number/sequence: 44. The MR imaging protocol included: FSE T2-weighted (TR/TE = 3000/80 ms); FLAIR (TR/TI/TE = 9000/2000/128 ms) and STIR (TR/TI/TE = 3700/120/47 ms). Each section of STIR sequence had a corresponding section in both FSE T2-weighted and FLAIR sequences.

## Data analysis

For reduction the interobserver variability all analyses were performed by two radiologists who worked together. Consensus was reached by agreement.

Three qualitative evaluations regarding the number of lesions detected, conspicuity (ease of visualization) and lesion location were performed. STIR images of each patient were compared with the corresponding FSE T2 and FLAIR images.

Each lesion detected was assigned to one of the following sites: posterior fossa, periventricular and juxtacortical and recorded as present on both sequences or present on one sequence and absent on the other.

Because the data were not normally distributed the Wilcoxon signed rank test was used to compare the differences in number of lesions between sequences.

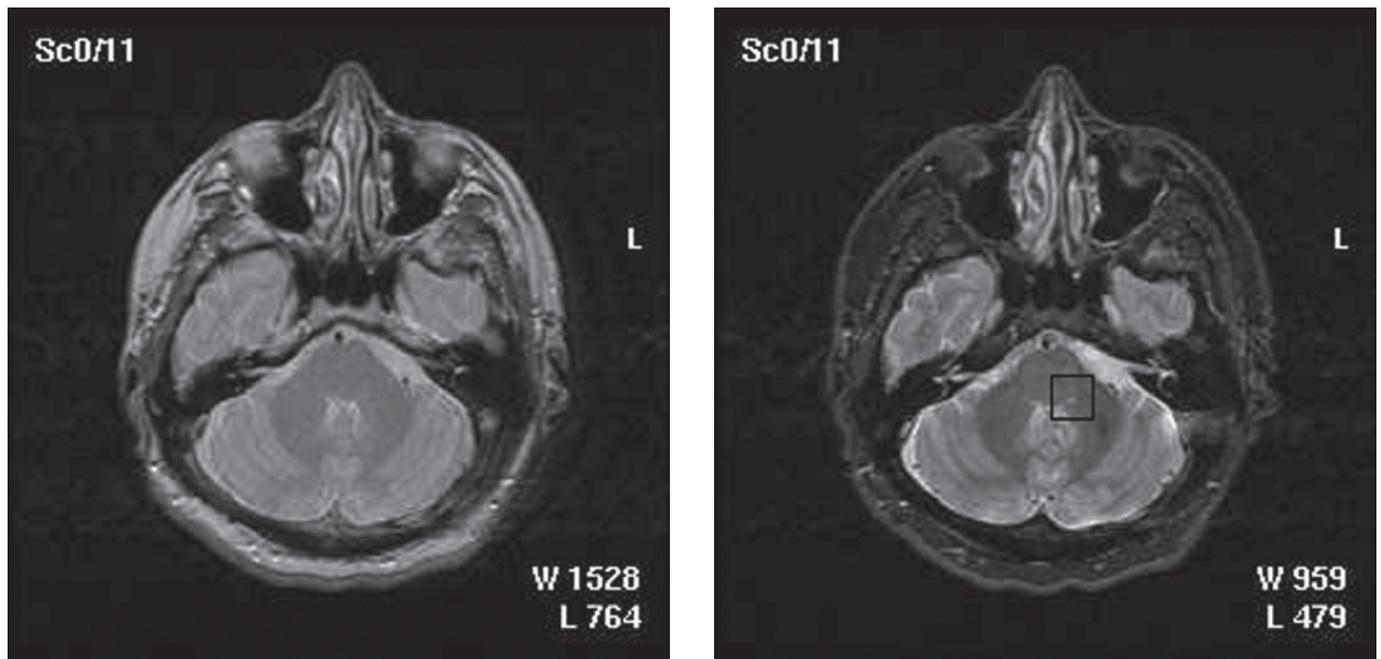


Fig. 1. Comparison of FSE T2 (a) and STIR sequences (b). Axial MR images in a 32-year-old female with MS. MS plaque in the pons which is clearly depicted in b is not seen in a.

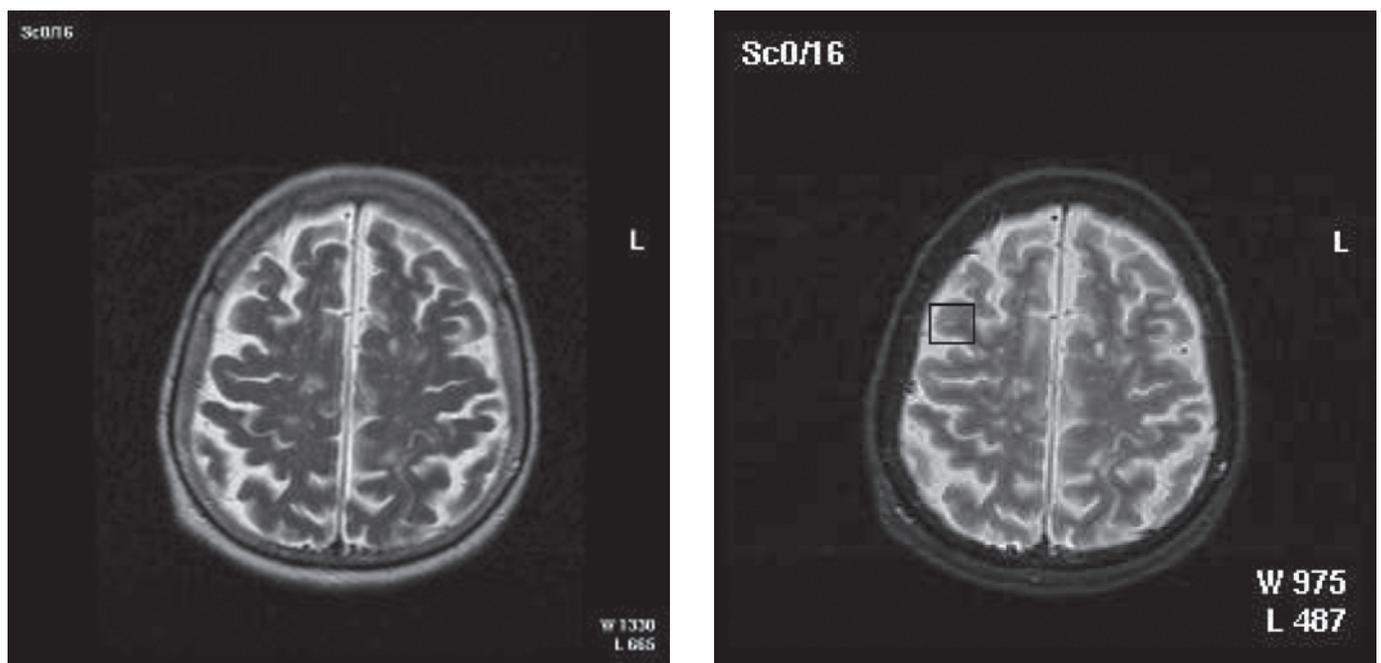


Fig. 2. Comparison of FSE T2 (a) and STIR sequences (b). Juxtacortical MS lesion not detected in a but evident in b in a 45-year-old woman.

## Results

### STIR versus FSE T2 sequences

#### *Lesion detection and conspicuity*

361 lesions were present on both sequences. 55 additional lesions were seen on STIR images only and 4 on FSE T2-weighted images only. For overall multiple sclerosis brain lesions STIR sequences showed 51 (13%,  $p = 0.015$ ) lesions more than FSE T2-weighted sequences.

#### *Location*

STIR sequences increased the number of lesions detected in posterior fossa by 38% (from 39 lesions to 54 lesions) and

by 27% (from 118 to 151 lesions) in juxtacortical locations. Periventricular, STIR images showed only 3 (1%, not significant) lesions more than FSE T2-weighted images.

### STIR versus FLAIR sequences

#### *Lesion detection and conspicuity*

344 lesions were seen on both sequences. 75 additional lesions were detected on STIR images only and 3 lesions on FLAIR images only.

For overall multiple sclerosis brain lesions STIR sequences showed 72 (20%,  $p = 0.015$ ) lesions more than FLAIR sequences.

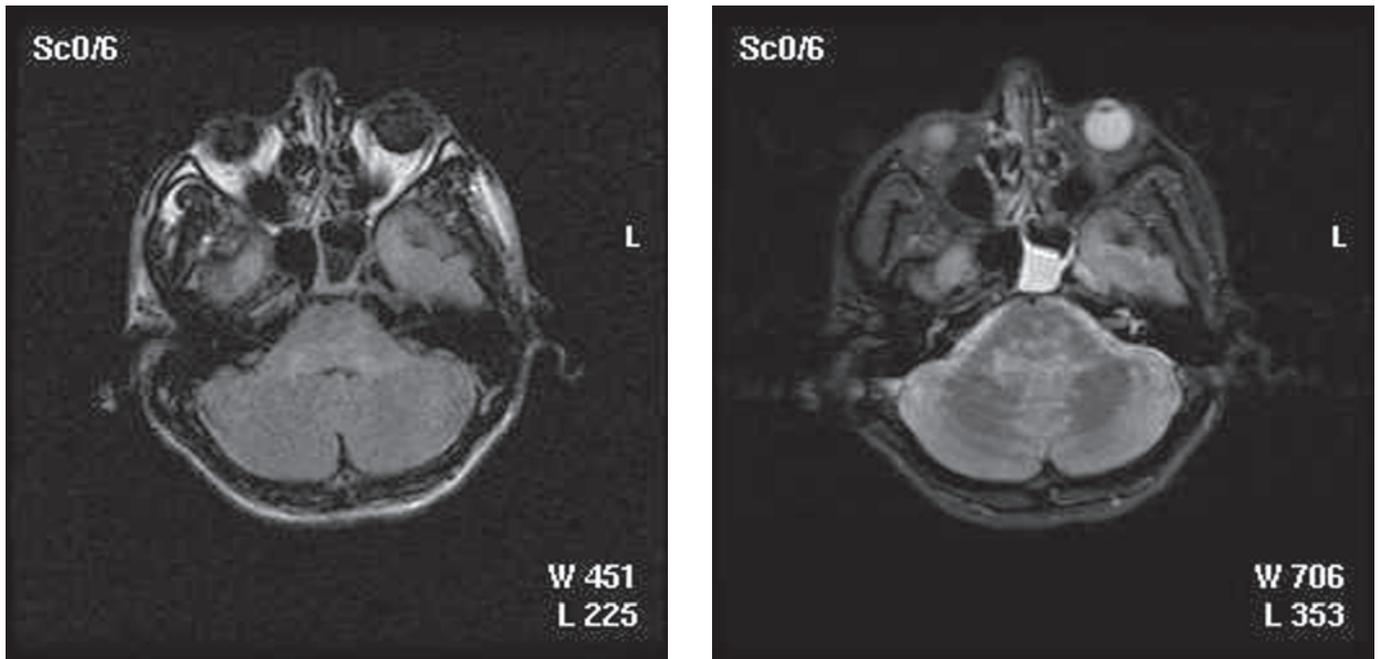


Fig. 3. Comparison of FLAIR (a) and STIR (b) sequences. Axial MR images in a 37- year-old man with MS. Pontine lesions are clearly depicted in b but have insufficient contrast in a.

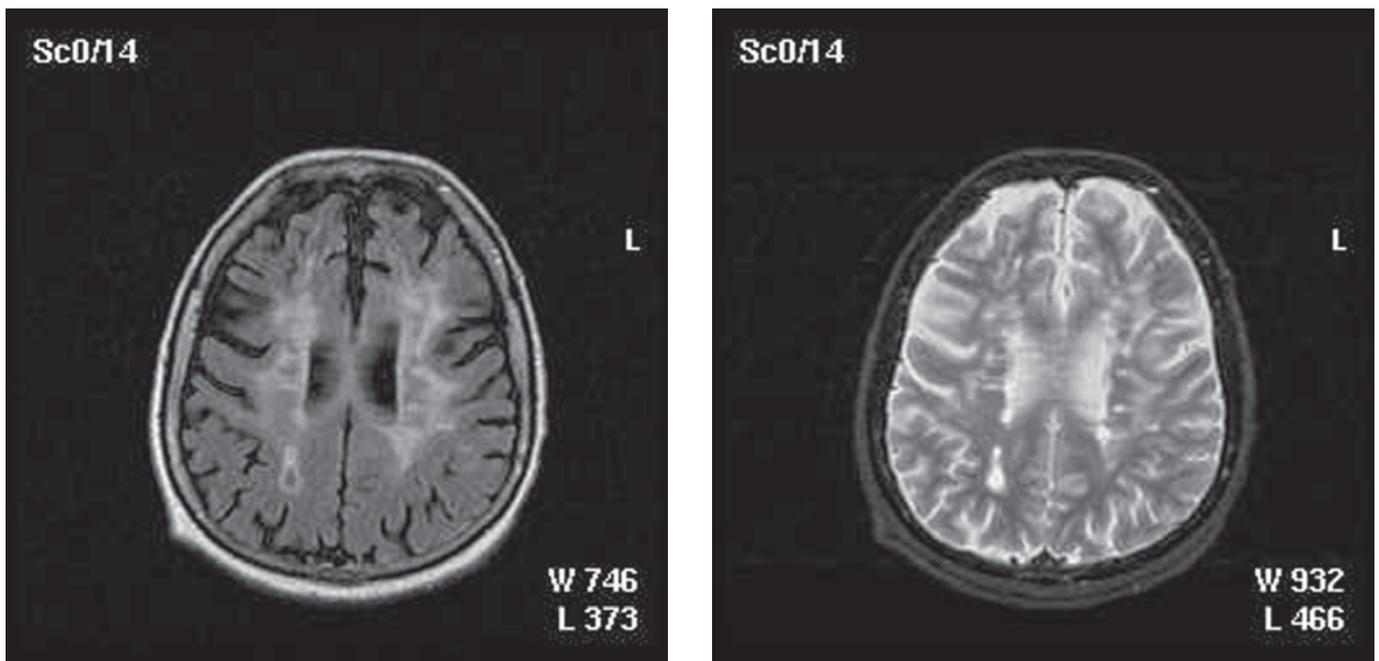


Fig. 4. Comparison of FLAIR (a) and STIR sequences (b). Axial MR images in a 56- year-old woman with MS. Periventricular MS plaques are demonstrated less clearly in a than in b because of confluency.

#### Location

STIR sequences increased the number of lesion detected in posterior fossa by 86% (from 29 to 54 lesions) and by 24% (from 170 to 211 lesions) in periventricular sites. At juxtacortical level STIR images showed only 6 (4%, not significant) lesions more than FLAIR images.

#### Discussions

STIR sequences appear to be significantly more sensitive than FSE T2-weighted and FLAIR sequences in detection of MS lesions especially in particular anatomical regions (posterior fossa).

#### STIR versus FSE T2 sequences

The STIR sequence having a short inversion time facilitates the suppression of the signal stemming from fat and shows a high contrast between neighboring tissues [4].

Compared with FSE T2-weighted sequences, STIR sequences detected 51 more lesions, the majority located in juxtacortical and posterior fossa areas. With STIR sequence the number of detected lesions in posterior fossa increased greater than the number of detected lesions in juxtacortical locations. This might be explained by the fact that on FSE T2-weighted sequences the cerebrospinal fluid (CSF) appeared very bright and thus masking adja-

**Table I. Comparison of FSE T2 and STIR sequences**

	Lesions on both	Lesions only on FSE T2	Lesions on FSE T2	Lesions only on STIR	Lesions on STIR
Posterior fossa	39	0	39	15	54
Periventricular	204	4	208	7	211
Juxtacortical	118	0	118	33	151
<b>Total</b>	<b>361</b>	<b>4</b>	<b>365</b>	<b>55</b>	<b>416</b>

cent lesions (in the vicinity of ventricles and external CSF spaces). However at periventricular level FSE T2-weighted and STIR studies were pretty similar although on STIR some lesions appeared with blurred edges. This effect was possibly caused by the presence of diffuse white matter demyelination which appeared more evident on STIR images as a result of fat suppression [5].

### STIR versus FLAIR sequences

When compared with FLAIR sequences, STIR sequences showed an increase in sensitivity at periventricular level and especially in posterior fossa location. In FLAIR sequences the CSF signal is suppressed allowing a heavier T2 weighting and an increase in lesion confluence [6]. It is possible that some of the lesions seen on STIR images were present but not counted as independent lesions on FLAIR images. Posterior fossa decreased conspicuity on FLAIR images compared with STIR images might be linked to presence of more CSF pulsatility related artifacts degrading the diagnostic value of the FLAIR scans. Also, the contrast between lesions and neighboring tissues appeared as low on FLAIR in posterior fossa location.

At juxtacortical level, by suppressing the fat from skull, demyelinating lesions were more evident (although not significant) on STIR images.

### Conclusions

By increasing the sensitivity STIR sequence might be suit-

**Table II. Comparison of FLAIR and STIR sequences**

	Lesions on both	Lesions only on FLAIR	Lesions on FLAIR	Lesions only on STIR	Lesions on STIR
Posterior fossa	29	0	29	25	54
Periventricular	170	0	170	41	211
Juxtacortical	142	3	145	9	151
<b>Total</b>	<b>341</b>	<b>3</b>	<b>344</b>	<b>75</b>	<b>416</b>

able as an additional sequence in routine MR brain examinations in patients with multiple sclerosis.

Although STIR provides essential supplementary information to conventional imaging for the visualization of brain lesions in MS, especially in posterior fossa, it is not a substitute for other sequences.

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