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# 3T Double Inversion Recovery Magnetic Resonance Imaging: diagnostic advantages in the evaluation of cortical development anomalies

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ABSTRACT

*Purpose:* The aim of this work was to investigate the diagnostic value of the DIR sequence at 3T MR imaging operating in the evaluation of cortical development anomalies.
*Methods:* We studied 40 patients, with a previous diagnosis of cortical dysplasia, by FLAIR-3D, DIR, FSE T2 and MPR-GE T1 sequences at 3T MRI. Two independent observers evaluated, for each sequence and lesion, some semiological aspects (cortical thickness, cortical signal intensity, white-gray matter blurring, subcortical white matter intensity). We made also a quantitative evaluation of the cortical signal intensity in lesion site, drawing a ROI on each MRI sequences and comparing them to the correspondent normal contralateral cortical area.
*Results:* We identified 44 cortical development anomalies. Qualitative analyses showed a high level of agreement between the observers concerning DIR potentialities in detecting and characterizing the cortical development disorders. Particularly DIR sequence was able to demonstrate the blurring and the subcortical white matter anomalies. The quantitative analyses didn't show a significant difference between DIR and traditional sequences in the evaluation of the cortical signal intensity.
*Conclusion:* 3T MRI-DIR sequence is a useful and better suitable sequence compared to the traditional sequences in the characterization of some semiological aspects of the cortical development disorders, particularly blurring and subcortical white matter hyperintensity.


## 1. Introduction

Double Inversion Recovery (DIR) Magnetic Resonance Imaging (MRI) enables selectively imaging gray matter structures in the human brain by suppressing the signal from both cerebrospinal fluid (CSF) and normal white matter (WM), achieving excellent contrast between gray and white matter and provides high sensitivity to lesions with low T2 contrast [1–3].

Most of the epileptogenic cerebral lesions are adjacent to CSF, generally in mesial temporal lobe or in neocortex. The very thin and highly convoluted structures of the neocortex means that a portion of image voxels contains variable amounts of gray matter (GM), WM and CSF. Subsequently partial volume effect results with inaccuracy of both qualitative and quantitative assessments of the tissue [4–6].

Inversion Recovery (IR) sequences null the signal from a particular tissue type by selecting a specific Inversion Time (TI).

The DIR sequence, previously described by Redpath and Smith [7], extends the commonly used Fluid-Attenuated Inversion Recov-

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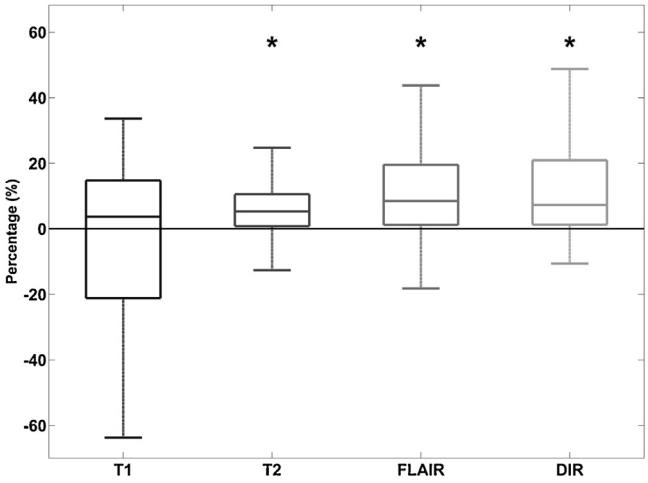


**Fig. 1.** Boxplot. Analysis of the intensity percentage variation for lesions compared to contralateral healthy sides in all sequences.

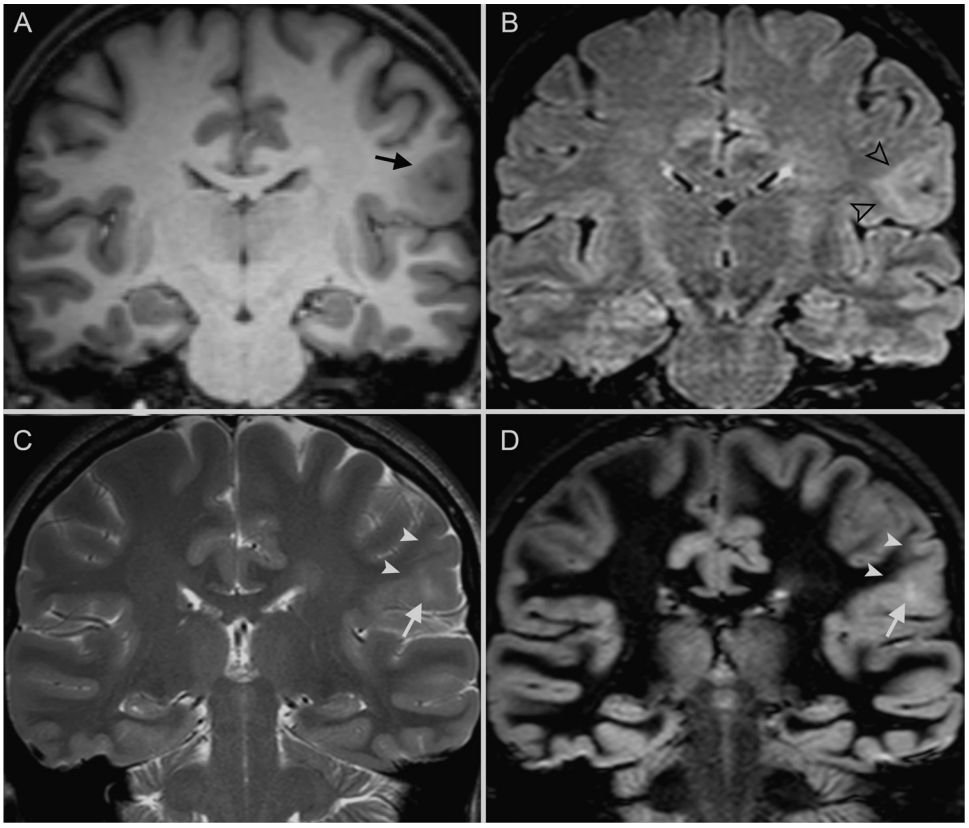


**Fig. 2.** Left parietal Focal Cortical Dysplasia (FCD). Coronal T1-weighted image (A) shows the increased cortical thickness (black arrow). Coronal FLAIR image (B) shows the white matter hyperintensity (empty black arrowhead). Coronal T2 (C) and coronal DIR (D) images show white/gray matter blurring (white arrowhead) and increased cortical signal (white arrows).

ery (FLAIR) sequence for CSF suppression, by adding a second 180° Radio Frequency (RF) pulse, which allows the simultaneous suppression of the signal from the two different tissues with different T1 relaxation time [4–6].

DIR sequence also integrates the utility of FLAIR and Fast Inversion Recovery for Myelin Suppression (FIRMS) sequences [8], in the evaluation of cortical development anomalies.

There are very few reports concerning the application of DIR sequence in the study of epilepsy [1–5,9,10].

The aim of our work was to investigate the diagnostic value, the advantages and the limits, of the DIR sequence at 3T MR imaging operating in the characterization of cortical development disorders, compared to the conventional FSE T1, T2-weighted and FLAIR images.

## 2. Materials and methods

The study protocol was approved by the hospital ethics committee and written informed consent was given from all participants.

From January 2014 to March 2015, we prospectively studied 40 patients, 21 males and 19 females, (mean age of 31,55 years and standard deviation of 14.7) affected by seizures with a pre-