

Double Inversion Recovery (DIR) MR Imaging in Detections of Acute Stroke Lesions

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Introduction

The use of a double inversion pulse with double inversion delay times allows signals from two different tissues to be voided simultaneously, and is termed a double inversion recovery (DIR) sequence (1,2,3). A DIR MR sequence manipulates the difference of T1 relaxation times between gray matter and CSF, or gray and white matter by selecting an appropriate inversion times which can suppress signals from both CSF and normal white matter. Thus, this can produce a superior delineation of gray matter lesions such as infratentorial or cortical lesions. Although the DIR MR sequence has been used as an effective tool to detect diseases such as multiple sclerosis (4) or epilepsy (5), there has been no study reported about the effectiveness of DIR imaging in detections of brain stroke lesions. The purposes of this study, therefore, were to evaluate the depiction of brain ischemic stroke by using DIR and to compare the contrast-normal ratio (CNR) of DIR with that of DWI and FLAIR images.

Materials and Methods

Fifty-five patients were enrolled in this study. All of them had symptoms of acute ischemic stroke and also underwent the imaging workups with DIR-, FLAIR-, and DWI-MRI sequences. These imaging workups were all performed within 120 hours of the onset time and all patients had the diffusion-restrictive lesions. For the DIR protocol, we used two inversion times of TI1=3200 msec and TI2=800 msec to suppress CSF and WM. For the FLAIR protocol, we used the inversion time of TI=3400 msec to suppress CSF. For the DWI protocol, we used two b-values of zero and 1000 sec/mm². Regions of interest (ROI) of the infarction area (L) and its contralateral normal (N) brain lesions were drawn using the DWI b1000 image as a golden standard image. DWI b0 was regarded as a T2 weighted image. The contrast-normal ratio (CNR) was obtained by using $CNR=(L-N)/N$ for DIR, FLAIR, DWI b1000, and DWI b0 images and $CNR=(N-L)/N$ for ADC maps. For the statistical analyses, the ANOVA test was performed to find effects of CNRs among imaging sequences. The Turkey's post hoc tests were applied to find significant differences between sequences ($p<0.012=0.05/4$). In addition, the correlation analysis was performed to find the relationship between the CNR values and the onset time.

Results

Figure 1 shows a case obtained from the patient of 54 years old female after 48 hours symptom onset. We can easily find the ischemic lesion in left pons. Table 1 lists the CNR values for different imaging protocols. The CNR value of DIR has the highest. The difference of mean CNR values among imaging protocols has statistically significant (Df=4, F=35.32546, $p<0.000001$) shown in Figure 2. According to the Turkey's multiple comparison test, differences of mean CNR values between DIR and other sequences except DWI b1000 are statistically significant ($p<0.00001$). The CNR value of the DWI b1000 is also significantly different to that of other sequences, except DIR ($p<0.00001$). There is no statistically significant difference of CNR values between DIR and DWI b1000 ($p=0.046$). Although the mean CNR values of FLAIR, b0 and b1000 sequences are significantly correlated with the onset time, the CNR value of DIR is not.

Discussions and Conclusion

The mean CNR value of DIR images is higher than that of ADC, DWI and FLAIR images. In addition, the CNR value of DIR overall ranges of onset times is higher than that of other protocols.

The difference of CNR value in DIR with other sequences is especially high in subacute stroke lesions. The CNR value of DIR is higher than that of DWI b1000. This may be related to suppressions of the contra-lateral normal regions of white matter in DIR protocol. We usually find that signals from white matter in DIR are much less than that from white matter in DWI b1000.

In conclusion, MR imaging with the DIR may be helpful for the detection of acute infarctions. This would be more effective in lesions such as brain stem where the diagnosis could be limited due to the image distortion in DWI.

Acknowledges:

This research was supported by the Program of Kyung Hee University for the Young Researcher of Medical Science in 2008 (20081229) and the grant of the Korean Health 21 R&D Project, Ministry of Health & Welfare, Republic of Korea (A062284).

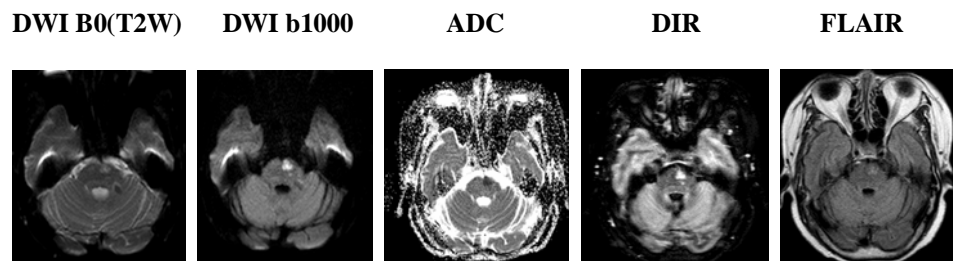
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CNR	ADC	FLAIR	b0T2	b1000	DIR
Mean	0.357	0.362	0.386	0.777	0.972
± STD	±0.144	± 0.207	±0.237	±0.291	±0.656

Table 1. CNR values for different imaging protocols.

Fig. 1 A case obtained from 54 year old female taken 48 hours after the symptom was onset.



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Fig. 2 The graphical demonstration of CNR values of the five imaging protocols.

