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The role of dual spin echo in increasing resolution in diffusion weighted imaging of brain

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ABSTRACT

The purpose of this study was to increase resolution in DWI of brain by using dual spin echo technique. The study was done on 6patients, they were subject to routine brain MRI examination for different symptoms, the study include patient with normal brain study, post-operative patient and pediatric patient, examination was done on 1.5 T scanner. dual spin echo technique can be used with EPI-DWI to increase resolution as it can reduce blurring of the images and increase contrast between different anatomies tissues (white and gray matter) and between normal and injury tissues, which obtaining a more accurate diagnostic of the studied anatomy. Dual spin echo techniques can be used with EPI-DWI data acquisition to increase resolution.

Keywords: EPI, DWI, T_2* effects, dual spin echo

INTRODUCTION

Diffusion MRI (magnetic resonance imaging) is a non-invasive technique that used to quantify the microstructural characteristics of tissue by in-vivo mapping of diffusion processes [1].MR signals can be made sensitive to diffusion through the use of a pair of sharp magnetic field gradient pulses, the duration and the separation of which can be adjusted[1].

The standard pulse sequence used in diffusion-weighted magnetic resonance imaging is EPI[2].EPI is a popular fast imaging technique, but EPI images are well-known to have localized geometric distortions caused by in homogeneities in the main magnetic field (B0)[3-5].

The basic EPI pulse sequence is based on the spin-warp and Fourier imaging methods used in MRI [6]. Using EPI sequence allow the reconstruction of the image by obtained all the necessary signal in a single shot, thus rapid data acquisition make EPI prone to different artifacts, geometric distortion artifact is most significant near the boundaries separating air, bone, and soft tissues, where there are large differences in magnetic susceptibility [5],[7].

The other artifact caused by field inhomogeneity is the loss of signal due to T2* dephasing. The T2* loss limits the number of echoes that can be acquired and hence the achievable resolution along the phase encode dimension which cause blurring in the image, so the differentiation between normal and injured tissues become difficult.T_2* effects are mainly caused by magnetic susceptibility field gradients because of the heterogeneous brain anatomy (air, bone, and soft tissues) which cause severe distortion at the boundaries of these tissues and even complete loss of signal intensity [6].

The purpose of this study was to decrease blurring in EPI sequence and increase resolution to obtaining a more accurate geometrical representation of the studied anatomy, which provide more differentiation between injured and normal tissues without using extra data acquisition. To achieve this purpose we used dual spin echo technique. In dual spin echo each diffusion gradient can be split, and an additional refocusing RF pulse can be used so that an effective bipolar lobe is created by two smaller sets of bipolar lobes [10].

MATERIALS AND METHODS

1. patients and method

1.1 patients

All patients were referred from Mansoura advanced radiology center, Mansoura city, Egypt. They were subject to routine brain MRI examination for different symptoms.

1.2 MR examination

The MR imaging was performed using a 1.5 tesla general electric health care (GEHC) scanner (signa) using high division neuron vascular (HDNV) array 8 channel coil, firstly routine study was done, T2-FSE (TR/TE,4160/103 ms), the T1- memp/75 (TR/TE,480/12 ms) ,T2 FLAIR (TR/TE/TI, 8002/123/2000 ms), and SE/EPI (DWI) (TR/TE, 11500/123), (b-value 1000s/mm2), diffusion direction all, frequency direction R/L, NEX=1, matrix 128*128 :(voxel size 1.87*1.87*5mm3), (time, 0:58), all sequences with FOV=24cm, thickness= 5mm, spacing=1.5mm . After routine examination we added another DWI with the same parameters and planning used above with adding only dual spin echo.

1.3 Post examination

All images of the interested patients translated via CD disc to a computer have free license of DICOM viewer program (http://www.radiantviewer.com) which was used to compare DW-images acquired with conventional parameters with DW-images acquired with dual spin echo and saving images with jpg format.

RESULTS AND DISCUSSION

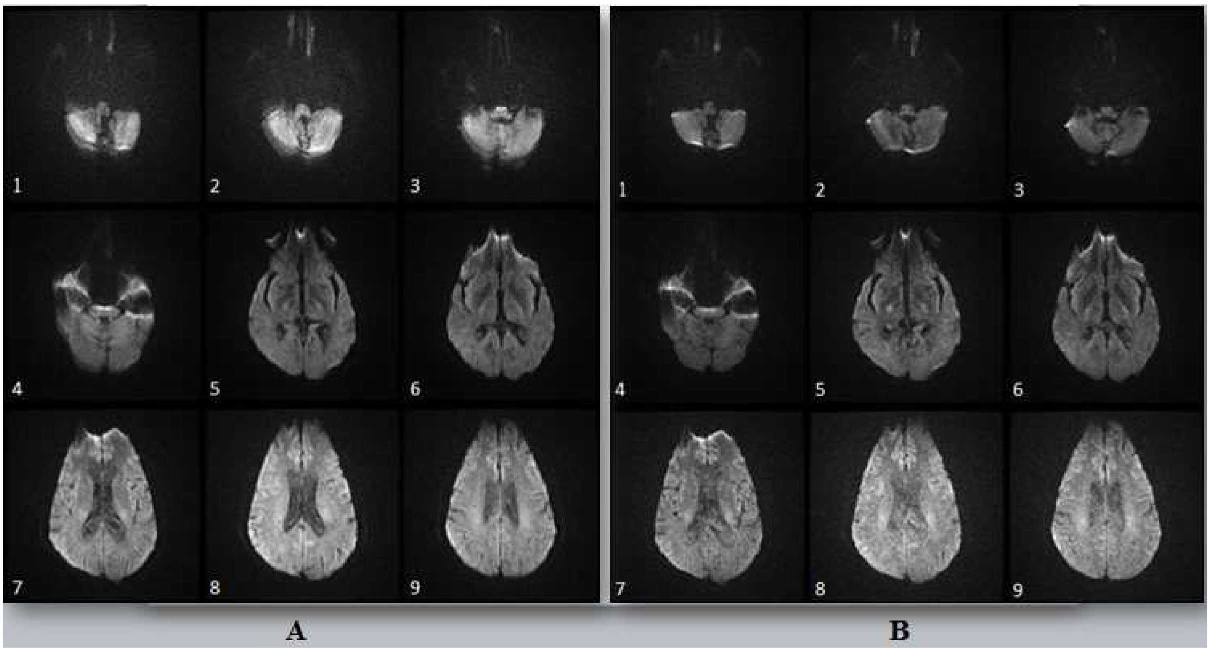

Figure (1) two series of the same slices of DWI series (A) acquired with conventional parameters and series (B) acquired in addition to dual spin echo

Effect of dual spin echo
Figure (1) shows effect of dual spin echo on DWI, series (B) acquired with dual spin echo compared with the same slices acquired without dual spin echo series (A), the effect of dual spin echo clearly detected in cerebellum region images (1, 2, 3) by reducing blurring and the other artifact appeared in the right lobe of the cerebellum. Using dual spin echo has no effect on susceptibility artifact (5, 6, and 7) and geometric distortion artifact(8, 9).

Second case
Figure (2) shows effect of dual spin echo on DWI, series (B) acquired with dual spin echo compared with the same slices acquired without dual spin echo series (A), Dual spin echo reduce the artifacts in cerebellum region images (1 to 4) series (B) compared with images (1 to 4) series (A). Using dual spin echo has no effect on susceptibility artifact and geometric distortion artifact in the rest of slices. Dual spin echo increase contrast between different tissues as images (7, 8, 9) show high contrast between white and gray matter.

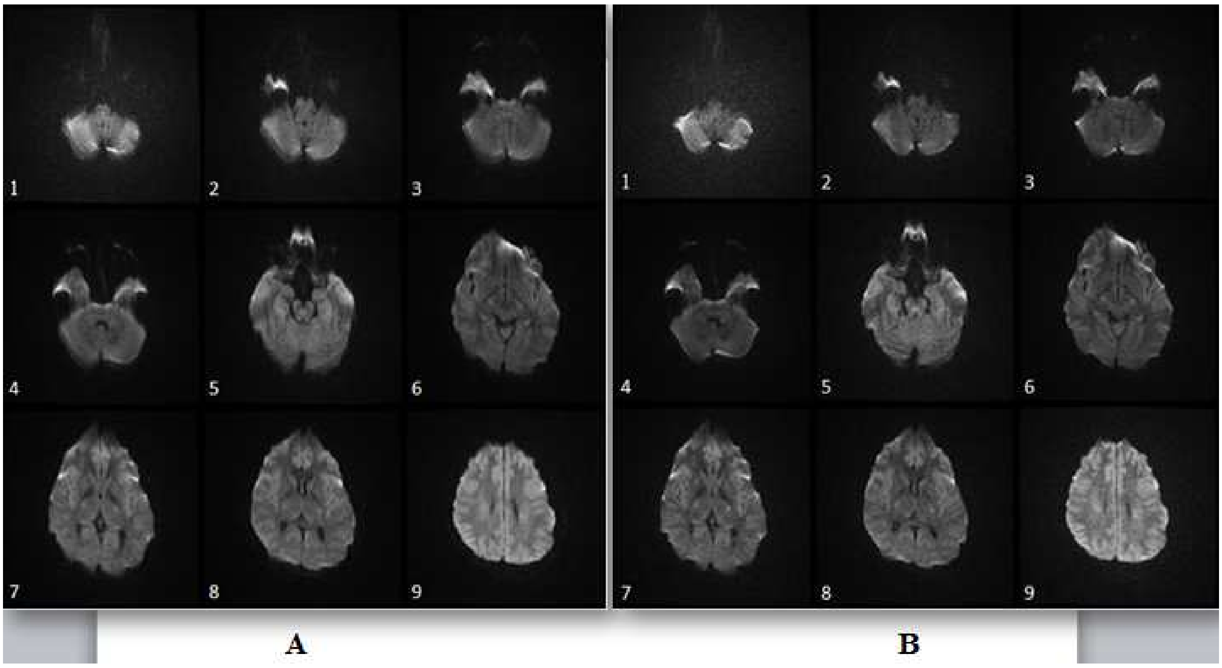

Figure (2) two series of the same slices of DWI series (A) acquired with conventional parameters and series (B) acquired in addition to dual spin echo

Third case
Figure (3) shows the third case where series (B) acquired with dual spin echo compared with the same slices acquired without dual spin echo series (A), Dual spin echo reduce the artifacts in cerebellum region images (1, 2, 3) series (B) compared with images (1, 2, 3) series (A). Using dual spin echo has no effect on susceptibility artifact (4, 5, and 6) and geometric distortion artifact in the slices (7, 8). Images acquired with Dual spin echo showed less blurring which increase the contrast between different tissues (white and gray matter).

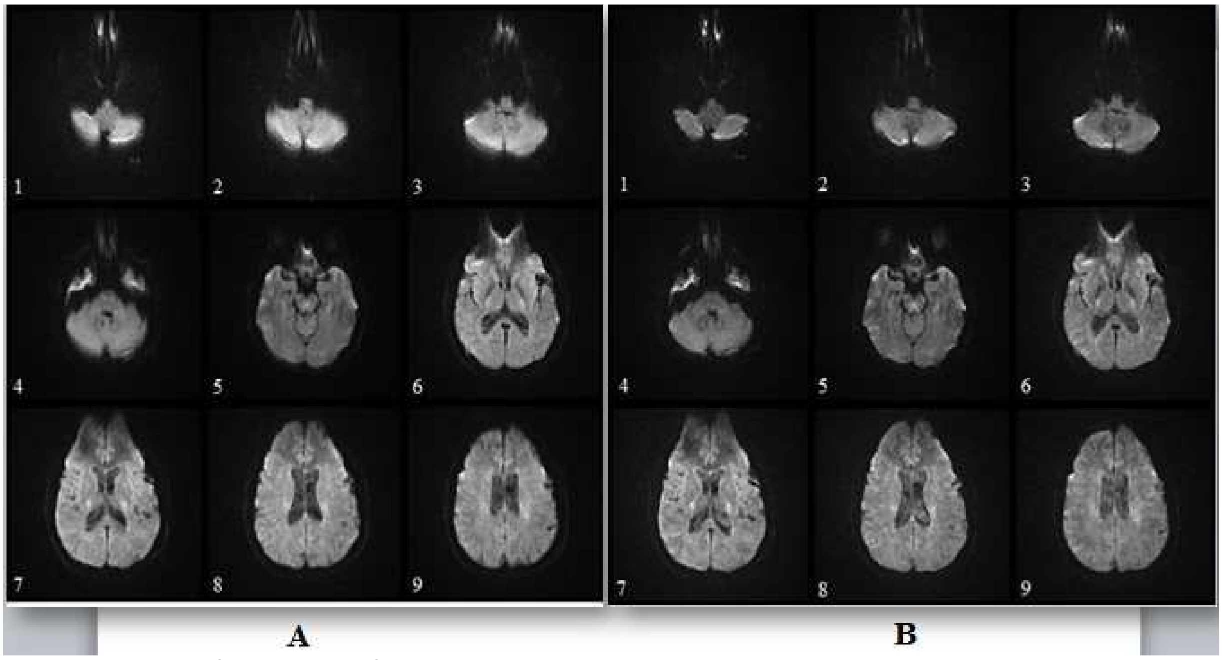

Figure (3) two series of the same slices of DWI series (A) acquired with conventional parameters and series (B) acquired in addition to dual spin echo

Fourth case

Figure (4) shows the fourth case where series (B) acquired with dual spin echo compared with the same slices acquired without dual spin echo series (A), Dual spin echo reduce the artifacts in cerebellum region as blue arrow shows in image images (1) in series (B) compared with images (1) in series (A).

High resolution and contrast after using dual spin echo more helpful in clarifying any injury no matter how a small, black arrow shows the clearly appearance of small lesion in image (5- B) compared with lower appearance of the lesion in DWI acquired without dual spin echo image (5- A) because of low contrast and signal between different tissue types.

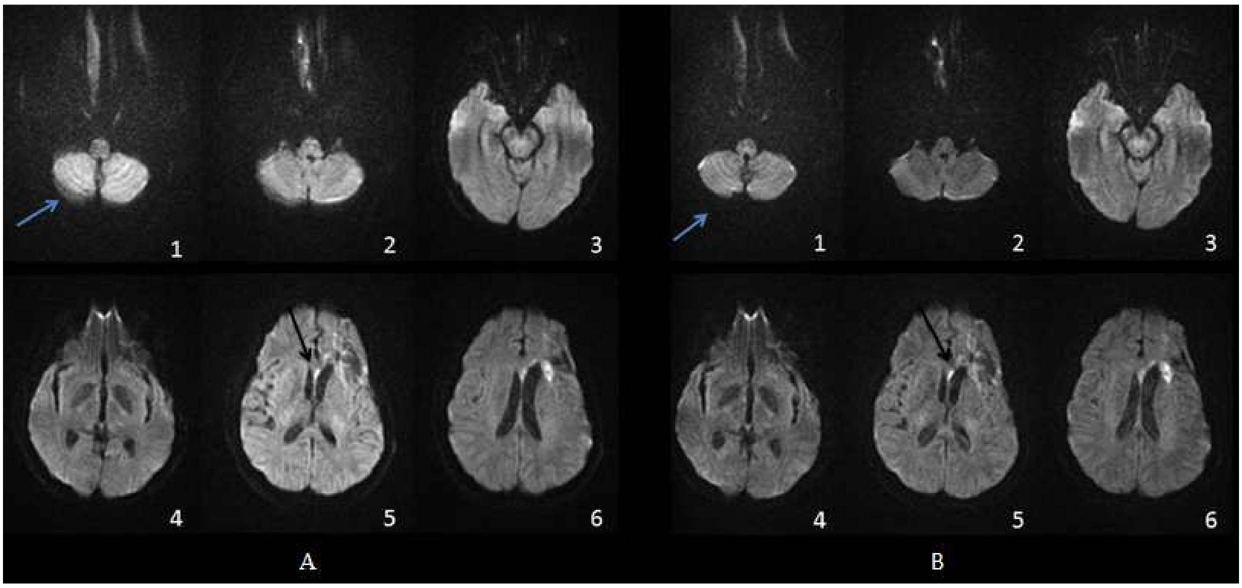

Figure (4) two series of the same slices of DWI series (A) acquired with conventional parameters and series (B) acquired in addition to dual spin echo

Fifth case
Figure (5) shows the fifth case where series (B) acquired with dual spin echo compared with the same slices acquired without dual spin echo series (A). black arrow shows the clearly appearance of small lesion in image (5- B) compared with lower appearance of the lesion in DWI acquired without dual spin echo image (5- A) because of signal loss and low contrast between different tissue.

High resolution and contrast after in DWI acquired with dual spin echo technique clearly appeared in the rest of images in series (B) compared with low resolution, contrast and blurring in the same DWI images acquired without dual spin echo technique as showed in series (A).

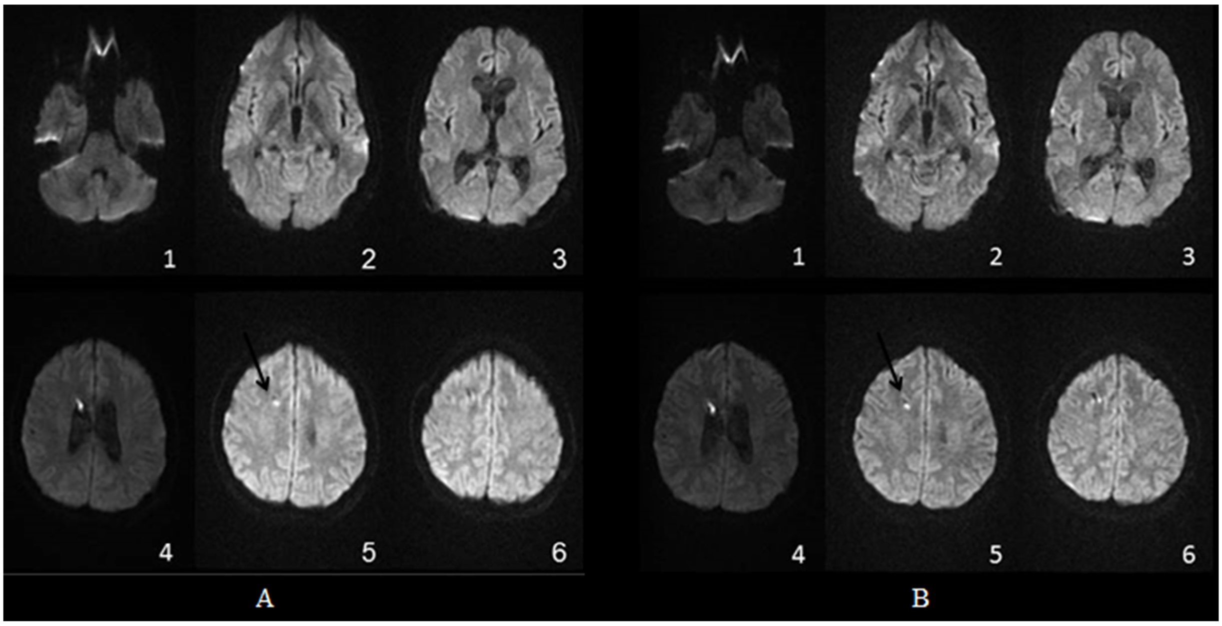

Figure (5) two series of the same slices of DWI series (A) acquired with conventional parameters and series (B) acquired in addition to dual spin echo

Sixth case
Figure (6) shows the DWI for a pediatric patient where series (B) acquired with dual spin echo and series (A) slices acquired without dual spin echo technique.

Using the naked eye could notice the difference in image quality and clarity after using dual spin echo technique as series (B) shows.

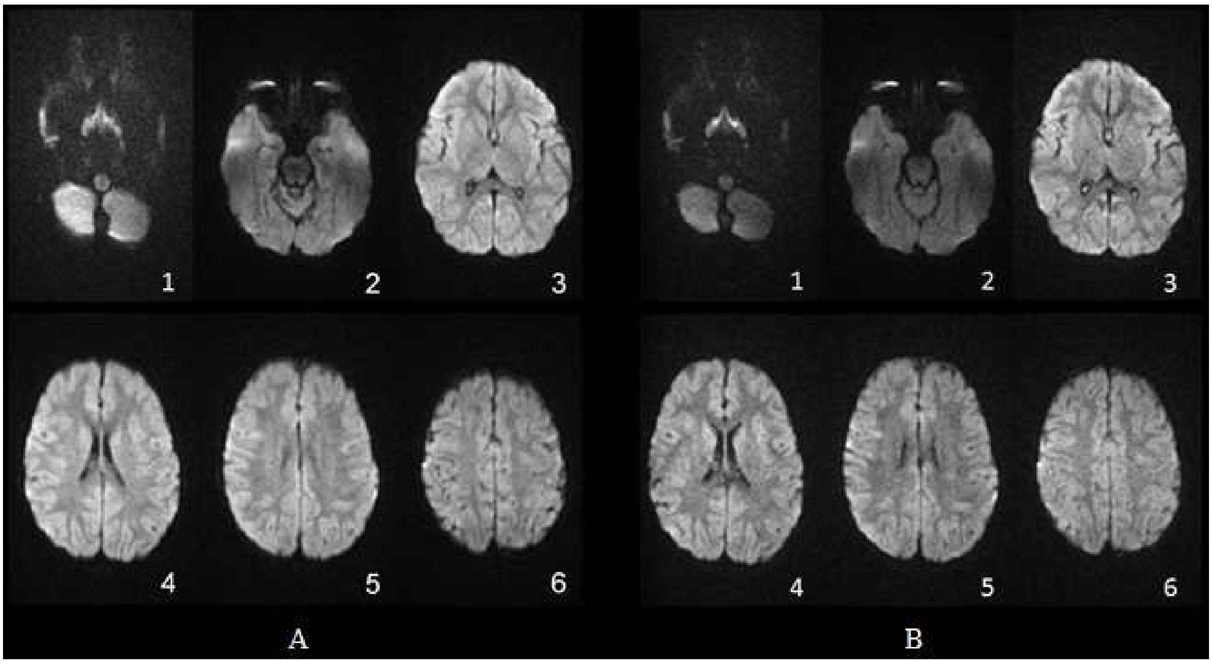

Figure (6) two series of the same slices of DWI series (A) acquired with conventional parameters and series (B) acquired in addition to dual spin echo

CONCLUSION

Different techniques affecting image resolution, artifacts and signal strength in EPI-DWI. We showed that dual spin echo technique can be used to decrease blurring and increase resolution in DWI of the brain, which provide more contrast between different tissues resulting in obtaining a more accurate geometrical representation of the studied anatomy.

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