

OPTIMIZATION STUDY FOR HIGH-RESOLUTION 3D ISOTROPIC FAT-SUPPRESSED FAST SPIN ECHO MR IMAGING OF THE WRIST

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INTRODUCTION

Because the wrist structures are small and complicated, high signal to noise ratio (S/N), high spatial resolution, and high contrast resolution are crucial for magnetic resonance imaging (MRI) of the wrist. 3D isotropic MRI holds promise for accurate and detailed assessment of musculoskeletal lesions^{1,2}. Fast spin echo (FSE) images, especially when combined with fat suppression, can provide excellent contrast between ligamentous/bony injuries and normal structures. However, 3D FSE imaging requires longer scan time, and the image blur on FSE with long echo train length (ETL) is a significant problem due to a widened point spread function. Accordingly, the purpose of the present study is to optimize parameters of high-resolution 3D isotropic FSE fat-suppressed proton density weighted images (FS PDWI) of the wrist in clinical settings within approximately 5 minute scan time.

MATERIALS AND METHODS

All MR images were performed on seven normal volunteers (5 males and 2 females, ages ranging from 31 to 58 years (mean age 44.1 years)) using an 8 channel wrist coil at a 3T system (Achieva TX, Philips Healthcare®, Best, The Netherlands). Each volunteer was placed in supine position with the wrist at side of the body and neutral forearm position. Coronal 3D isotropic FSE combined with Sensitivity Encoding (SENSE) and Driven equilibrium (DRIVE) (TR/TE = 1400/28-29 ms, NSA = 2, 70 mm FOV) were obtained with spectrally adiabatic inversion recovery (SPAIR) fat suppression technique. To optimize imaging parameters in 3D isotropic MRI, we evaluated 1) slice thickness (0.3 – 0.6 mm) or voxel size (0.3 x 0.3 x 0.3 – 0.6 x 0.6 x 0.6 mm), 2) ETL (31 - 117) and 3) inversion time (TI) (60 – 240 ms).

RESULTS

Increase in slice thickness/voxel size decreased scan time. However, it resulted in significant increase in image blur (Figure 1). Therefore, it is considered that slice thickness/voxel size should be less than or equal to 0.4 mm when ETL is constant. Compared the effect of thinner slice/smaller voxel with that of decreasing in number of ETL in order to improve image blur, the former is more effective in decreasing image blur at a given scan time. With thinner slice thickness/smaller voxel, long ETL images resulted in incomplete fat suppression and shorter TI suppressed fat better (Figure 2). The reason for shorter optimal TI on thin slice thickness/small voxel combined with long ETL might be due to incomplete 180 degrees inversion pulse for fat suppression and more magnetization transfer contrast (MTC) effect. Optimal high-resolution 3D isotropic FS PDWI of the wrist can be obtained with either 0.3 mm slice thickness/voxel size, 117 ETL, and 140-160 TI or 0.35 mm slice thickness/voxel size, 88 ETL, and 160-180 TI with approximately 5 minute scan time, less blurring, and acceptable S/N. 3D isotropic MRI with 0.3 mm slice thickness demonstrated less image blur, while that with 0.35 mm slice thickness did higher S/N. Shorter TI can produce strong fat suppression effect (darker fat) on long ETL images.

DISCUSSION

High-resolution 3D isotropic FS PDWI of the wrist is feasible within a clinically reasonable scan time (~ 5 minutes). Additional axial and sagittal images with thin slice thickness can be reformatted with no extra scan time or degradation of image quality for a more complete assessment of the wrist ligaments and triangular fibrocartilage complex (Figure 3). It would be possible to crosslink even very small lesions between multiple planes for a more complete evaluation without risk of misregistration. Additionally, the 3D isotropic MRI can decrease acquisition time as a function of a single isotropic 3D sequence versus three (axial, coronal, and sagittal) 2D sequences.

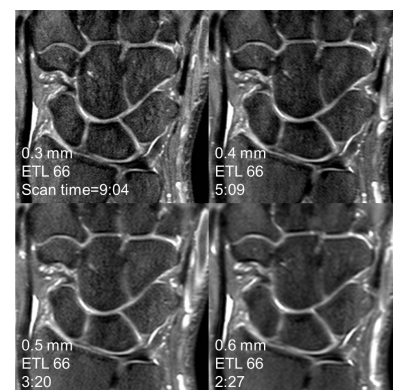


Fig 1. Effect of slice thickness/voxel size

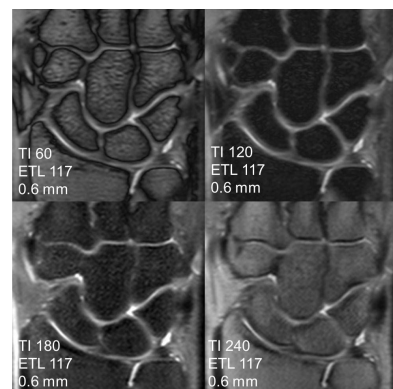


Fig 2. Effect of TI

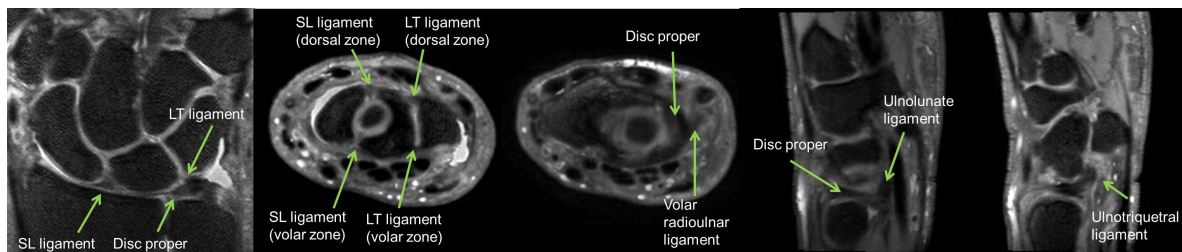


Fig 3. 3D isotropic coronal FS PDWI and reformatted axial and sagittal images with 0.35 mm slice thickness, 88 ETL, 180 TI, and 5 minutes scan time.

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