

Isotropic MRI of the Upper Extremity with 3D-FSE-Cube

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Introduction

Musculoskeletal MRI is commonly done with two-dimensional fast-spin-echo (2D-FSE) and multiple acquisition planes. This results in anisotropic voxels, partial volume artifact and slice gaps. Three-dimensional fast-spin-echo (3D-FSE-Cube), allows for isotropic voxel acquisition with FSE contrast, diminishing the drawbacks of 2D-FSE while reducing exam time and allowing for image reformation in oblique planes [1-3]. This study compares the image quality of 3D-FSE-Cube to 2D-FSE in evaluation of the healthy shoulder and elbow at 3.0T.

Methods

Eleven shoulders and elbows of healthy subjects were imaged using a GE 750 3.0T MRI scanner (GE Healthcare, Milwaukee, WI). All images of the shoulder were acquired with an 8-channel shoulder coil with TR/TE 2500/35ms, 384 x 288 matrix, 20cm FOV, receiver bandwidth ± 31 kHz. 3D-FSE-Cube image were acquired in the axial plane with an ETL of 60, acceleration factor of 3.65 and auto-calibrated parallel imaging (ARC), 0.6 mm slice thickness, 250 sections, and an imaging time of 5 min 30 sec [4]. 2D-FSE images of the shoulder were obtained in axial and oblique coronal planes with 3mm slices, 0.5mm gaps, ETL 8, and an imaging time of 3mins 20s.

All images of the elbow were acquired using an 8-channel knee coil with TR/TE 3000/35ms, 288 x 256 matrix, 14cm FOV, and receiver bandwidth ± 31 kHz. 3D-FSE-Cube was acquired in the coronal plane with an ETL of 60, acceleration factor of 3.65, 0.6 mm slice thickness, 128 sections, and an imaging time of 5 min 55 sec. 2D-FSE images of the elbow were obtained in axial and coronal planes with 2.5mm slices, 0.5mm gaps, ETL 8, and an imaging time of 4mins 54s.

To allow noise measurements from identical noise images, both methods were also acquired with the RF pulse off. Noise images were processed through the identical linear reconstruction pipeline as the signal data. Regions of interest (ROIs) were placed in fluid, muscle and cartilage for both methods, as well as in identical noise images. Slice averaging to the same slice thickness as the 2D-FSE data was used to normalize the 3D-FSE-Cube SNR and CNR measurements. SNR and CNR were compared with a paired t-test. Two fellowship-trained radiologists compared 3D-FSE-Cube with 2D-FSE for image quality, blurring and artifacts using a seven-point scale (-3 for 3D-FSE-Cube much worse than 2D-FSE; 0 for equal; +3 for 3D-FSE-Cube much better than 2D-FSE). Ratings were analyzed with a Wilcoxon signed rank test.

Results

Normalized muscle and cartilage SNR were similar between 3D-FSE-Cube and 2D-FSE in both the elbow and shoulder. Fluid SNR and fluid-cartilage CNR were significantly higher using 3D-FSE-Cube in both the elbow and shoulder (Figure 1; * = $p < .05$). 3D-FSE-Cube ratings in the shoulder were slightly worse than 2D-FSE in image quality, blurring and artifacts (-0.5 ± 0.2 ; $p < .05$). 3D-FSE-Cube ratings in the elbow were slightly worse than 2D-FSE in image quality and blurring (-0.6 ± 0.2 ; $p < .05$) but not significantly different in artifacts. Due to the reformatting ability of 3D-FSE-Cube images, thin and oblique anatomy can be evaluated in both the shoulder and elbow (Figures 2 and 3).

Conclusion

The ability to acquire thinner slices using 3D-FSE-Cube greatly decreases partial volume artifact and allows images to be viewed in oblique planes and at arbitrary slice thickness, thereby improving anatomic depiction. Further refinement of 3D-FSE-Cube acquisition is needed for image quality to match that of 2D-FSE. With rapid imaging times, 3D-FSE-Cube is well suited for patients who are in pain, claustrophobic, or are pediatric. 3D-FSE-Cube is a promising high-resolution method that may improve depiction of complex shoulder and elbow anatomy.

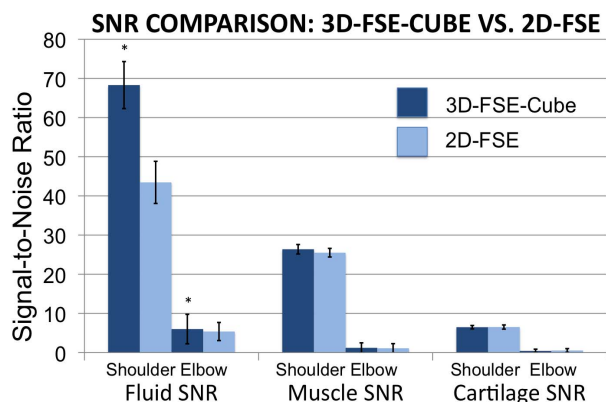


Figure 1. SNR comparison of three tissue types for 3D-FSE-Cube and 2D-FSE in the shoulder and elbow. 3D-FSE-Cube had significantly higher fluid SNR and statistically similar muscle and cartilage SNR in comparison to 2D-FSE (* = $p < .05$).

Acknowledgements

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References

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4. Beatty et al., Proc. ISMRM-ESMRMB p.1749, 2007.

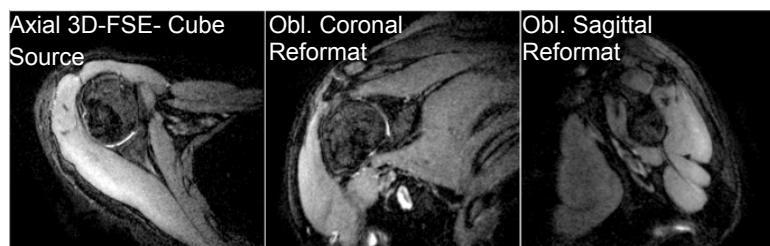


Figure 2. Source and reformatted images of a healthy shoulder using 3D-FSE-Cube. An axial source image (left) can be reformatted into an oblique coronal image (center) or an oblique sagittal image (right). Due to its isotropic nature, 3D-FSE-Cube can be reformatted without loss of image quality.



Figure 3. Images of a healthy elbow acquired and reformatted from a 3D-FSE-Cube scan. A coronal source image (left) is reformatted into a sagittal image (center) and a double-oblique sagittal image (right). The insertion of the biceps tendon into the radial tuberosity and the length of the biceps tendon (arrows) can be visualized in one plane.