High-resolution MRI of the triangular fibrocartilage complex (TFCC) at 3T: comparison of surface coil and volume coil

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INTRODUCTION

Magnetic resonance imaging (MRI) has become a reputable modality in the evaluation of the triangular fibrocartilage ligament complex (TFCC). [1] Due to smallness and complexity of the structures, however, depiction of TFCC lesions is challenging. High-resolution MR imaging has the potential to meet the challenge of generating high sensitivity, contrast and resolution which are essential for accurate imaging. The goal of this study is to compare a 3-inch surface coil and a wrist volume coil to evaluate TFCC at 3T with a two-dimensional (2D) and a three-dimensional (3D) sequence, and investigate the feasibility of scanning the wrist in supine position with a surface coil.

MATERIALS AND METHODS

All MR images were obtained from 9 normal volunteers with a prototype 3-inch receive-only surface coil (SC) and a transmit-receive volume wrist coil (VC) (Figure 1) at a 3T system (GE Healthcare®, Milwaukee, Wisconsin). Each volunteer was placed in prone position with the arm extended over the head using VC, and in supine position with the wrist on the thigh and the SC placed on the ulna side of the wrist. Coronal 2D gradient echo (GRE) images (TR/TE/flip angle = 500/15/40, BW = 31.25 kHz, NEX = 3, 1-mm slice-thickness, 0.5 mm slice- gap, 60-mm FOV, 192×256 matrix, max # of slices = 18), and coronal 3DGRE images (TR/TE/flip angle = 33/15/10, BW = 31.25 kHz, NEX = 1, 0.8-mm slice-thickness, 80-mm FOV, 256x256 matrix, slab = 32) were obtained.

Fig.1 Volume coil (left) and surface coil (right)

Quantitative and qualitative analyses were completed by two radiologists. In quantitative analysis, signal-to-noise-ratios (SNRs) of the disc proper, the lunate cartilage and lunate bone with the 2D-and 3D-sequence using the 2 coils were measured. Contrast to noise ratio (CNR) between lunate cartilage and lunate bone or lunate cartilage and TFCC was also calculated. Qualitative analyses for visualization included 4 structures of the TFCC and 2 intercarpal ligaments: disc proper, triangular ligament with radial and ulnar attachment, ulnotriquetral and ulnolunate ligament, lunate triquetral ligament and scapholunate ligament (Figure 2). A five numerical grading system was used which implied 0 for no visualization, 1 for poor, 2 average, 3 good, and 4 for excellent visualization. Qualitative evaluation was performed independently and blinded to scanning devices and imaging parameters by two radiologists. All measurements were reported as mean (x) and standard deviation (SD) values. To determine the significance of the differences in SNRs and CNRs, the Fisher's PLSD test was used while the Wilcoxon test calculated the significance of difference among the coils in terms of visibility of the anatomic structures.

RESULTS

Each structure was well identified using either surface or volume coil, however, with higher grades when using the surface coil. The visibility of ligaments and the ulnar TFCC attachment on the tip and base of the styloid process were superior to their demonstration on MR images obtained with the volume coil. The difference was most explicit for the ulnotriquetral ligament (UTL) and ulnolunate ligament (ULL), where the mean reader grading was 2.78 (2D-GRE T2*) and 2.89 (3D-GRE T2*), respectively using the surface coil in contrast to mean values of 1.78 (2D-GRE T2*) and 1.89 (3D-GRE T2*) using a volume coil. With regard to the 2D GRE sequence, the Wilcoxon-test revealed statistical significant difference between the grading of surface- and volume coil MR images for the UTL, ULL and the lunotriquetral ligament (LTT). All structures show higher scores on surface coil MR images with 3D-GRE imaging resulting in more statistical difference between the two coils. On 3DGRE T2* weighted images, the Wilcoxon-test found significant difference between the surface and volume coil for the grading of all structures besides for the TFCC attachment on radius and ulnar styloid process. Inter-observer analysis proved high exact agreement on surface coil MR images ranging from 77.8 % to 100% (2D-GRE T2*), and 66.7 % to 100 % (3D-GRE T2*). Except for disc evaluation (100 % agreement), the inter-reader agreement was inferior on MR images with a volume coil, with values ranging from 33.3 % to 88.9 %. Intra-reader analysis revealed no explicit difference between the two coils. In quantitative analysis, only slight, non-significant difference in SNR between the surface and volume coil was found. The SNR was highest in the cartilage with both coils. The cartilage-TFCC CNR (2DGRE: 11.07; 3DGRE: 14.11) and cartilage-bone marrow CNR (2D GRE: 12.75; 3DGRE: 15.51) using the surface coil were slightly superior to cartilage-TFCC CNR (2DGRE: 8.75; 3GRE: 11.91) and cartilage-bone marrow CNR (2DGRE: 10.51; 3DGRE: 15.02) using the volume coil.

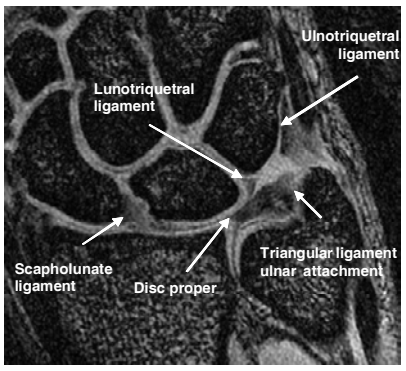

Fig.2 TFCC structures and intercarpal ligaments

CONCLUSION

MRI of the TFCC and surrounding structures at 3T showed similar results, quantitatively and qualitatively, using either the surface coil in supine position or the volume coil in prone position. If difficulties with the prone position occur, the surface coil can be an optional technique for more patient comfort while upholding image quality.

REFERRENCES

1. Potter HG, Asnis-Ernberg L, Weiland AJ, Hotchkiss RN, Peterson MG, McCormack RR, Jr. The utility of high-resolution magnetic resonance imaging in the evaluation of the triangular fibrocartilage complex of the wrist. J Bone Joint Surg Am 1997;79(11):1675-1684