

# Comparison of a 28 Channel Phased-Array Coil and a Circularly Polarized Coil for Morphologic Imaging and T2 Mapping of Knee Cartilage at 7 Tesla

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**Introduction.** Osteoarthritis affects 47 million Americans, resulting in \$127 billion in annual costs [1]. Quantitative magnetic resonance imaging (MRI) assessment of cartilage morphology and biochemical composition has become an important method to assess disease progression in longitudinal studies of osteoarthritis [2]. Ultra high field (UHF, 7T and above) MRI, because of the increased signal-to-noise ratio (SNR) available, allows for imaging with increased spatial resolution and scanning speed compared to imaging at standard field strength (1.5-3 T) [3]. Phased array coils provide the increased sensitivity of individual surface coils with the large field of view coverage of volume coils [4]. The goal of this study was to compare a 28 channel phased-array with a circularly polarized coil for the performance of morphologic and biochemical (T2 mapping) knee cartilage imaging at 7 T.

**Methods.** This study had institutional review board approval. Ten healthy subjects without history of knee pain, trauma, surgery, metabolic, or inflammatory disorder were recruited (7 males, 3 females, mean age  $32.6 \pm 7.8$  years). The right knee of each subject was scanned on a 7 Tesla whole body MR scanner (Siemens, Erlangen, Germany) using a fat-suppressed 3-dimensional fast-low-angle shot sequence (3D-FLASH, TR/TE = 26 ms/5.06 ms, FOV = 14 cm, 512 x 512, 1 mm slice thickness, TA = 11 mins 34 secs) for quantification of cartilage morphology and a multi-echo spin-echo sequence (MESE, TR/TE = 3000 ms/15, 30, 45, 60, 75, 90 ms, FOV = 14 cm, 128 x 256, 2 mm slice thickness, TA = 6 mins 29 secs) for T2 mapping. Each subject was scanned with both sequences utilizing a 28 channel phased-array coil (Quality Electrodynamics, Cleveland, Ohio) and a circularly polarized coil (CP, Rapid MR International, Columbus, Ohio). SNR was calculated as the signal intensity (SI) within a region of interest (ROI) drawn on cartilage divided by the standard deviation of the SI within an ROI drawn on a region of background noise (for the T2 mapping sequence, the SNR was measured from the first echo). Contrast-to-noise ratio (CNR) with adjacent bone was calculated as the SI difference between an ROI drawn on cartilage and an ROI drawn on an adjacent area of subchondral bone, divided by the standard deviation of the noise. Cartilage thickness at the weight-bearing aspect of the medial femoral condyle was measured on 3D-FLASH images. Cartilage T2 maps and mean cartilage T2 values were calculated via the equation  $\ln((S(TE)/S_0) = (-TE/T2) + C$ , where S(TE) is the measured SI of the image at a given TE, S<sub>0</sub> is the signal at the shortest TE, and C is the intercept. Student's t-test was performed to determine if differences between mean SNR, CNR, cartilage thickness, and T2 values were statistically significant (p<0.05).

**Results.** In vivo SNR maps demonstrate greater SNR at the periphery (~300%) and at the center (~20%) of the field of view for the 28 channel coil compared to the CP coil (Figure 1). Representative sagittal images from the same volunteer obtained with the 28 channel coil (top row) and the CP coil (bottom row) are shown in Figure 2. For both the 3D FLASH sequence and the T2 mapping sequence, SNR and CNR were greater in the 28 channel coil compared to the CP coil (Table 1). There was no statistically significant difference in mean cartilage thickness or T2 values obtained with the 28 channel compared to the CP coil (Table 1). Representative T2 maps from the same volunteer are shown in Figure 3.

Table 1. Comparison of SNR, CNR, cartilage thickness, and cartilage T2 value in the 28 channel versus circularly polarized coil.

	SNR (3D-FLASH)	CNR (3D-FLASH)	SNR (MESE)	CNR (MESE)	Thickness (mm)	T2 value (ms)
28 Channel Coil	24.8±7.1	22.3±6.3	152±72.9	117±46.1	0.31±0.08	45.8±4.3
Circularly Polarized Coil	6.9±0.75	6.4±0.8	56.3±29.7	40.1±20.8	0.30±0.08	57.7±1.3
p value	0.004	0.004	0.038	0.016	0.90	0.08

Figure 1. SNR Maps.

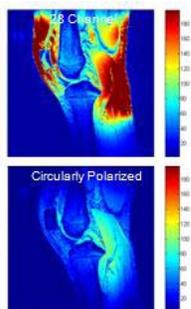


Figure 2. Representative sagittal images.

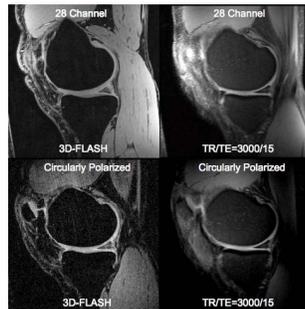
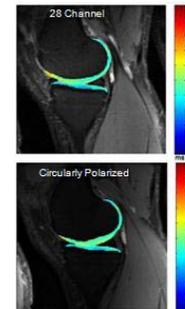


Figure 3. T2 Maps.



**Discussion.** This study demonstrates improved SNR and CNR in a 28 channel coil compared to a circularly polarized coil for 7 Tesla morphologic imaging and T2 mapping of articular cartilage. There was no statistically significant difference in cartilage thickness or T2 values obtained with the different coils. Nevertheless, the greater SNR and CNR of the phased array coil does favor its use in studies of patients with osteoarthritis or knee pathology.

**References.** [1] Yelin E et al. Morbidity and Mortality Weekly Report 2007;56:4-7. [2] Eckstein et al. NMR Bimod 2006;19:822-854. [3] Banerjee S et al. Magn Reson Med 2008; 59:655-660. [4] Roemer PB et al. Magn Reson Med 1990;16:192-225.