Fast 3D UTE Imaging of Knee Connective Tissues on a Clinical 3T Scanner

Y. Qian[1], A. A. Williams[2], C. R. Chu[2], and F. E. Boada[1]

[1]Department of Radiology, University of Pittsburgh, Pittsburgh, PA, United States, [2]Department of Orthopaedic Surgery, University of Pittsburgh, Pittsburgh, PA, United States

INTRODUCTION

Connective tissues in human knee joint, such as articular cartilage, menisci, or ligaments, have short transverse relaxation time components (T_2 ~5ms) due to their collagen-rich micro-structures (1). To image those short-T_2 components with minimum signal loss, special pulse sequences capable of ultra-short echo time (UTE) are desired. A number of UTE sequences have been developed in recent years, such as the half-sinc RF excitations with radial or spiral acquisitions for two-dimensional (2D) imaging, the non-selective RF excitations with radial acquisitions for three-dimensional (3D) imaging, the selective RF excitations with variable-duration slice-encodings plus Cartesian, radial, or spiral in-plane acquisitions for 3D imaging, the discrete (gapped) RF excitations with radial acquisitions for 3D imaging. For *in vivo* knee imaging on clinical scanners, however, selective RF excitation is a desirable choice to avoid wrap-around artifacts from the leg. This abstract introduces a new, volume selective, fast 3D UTE sequence and demonstrates its performance during knee imaging.

METHODS AND MATERIALS

Methods: The sequence used in this study was the acquisition-weighted stack-of-spirals (AWSOS) (Fig. 1), in which a selective RF pulse was used to excite a slab covering the whole knee joint and variable-duration slice encodings were employed to partition the slab and minimize the data acquisition delay before spirals were played out (2). An ultra-short echo time was then achieved in the AWSOS through short RF duration (<1ms), minimized ADC delay (40µs), and FID acquisition (rather than gradient-/spin-echo). The spiral trajectory rendered a fast k-space sampling. *Experiments* Healthy volunteers were scanned on a clinical 3T scanner (Magnetom Trio Tim 3T, Siemens Medical Solutions, Erlangen, Germany) with an 8-channel knee coil (Invivo Inc., Gainesville, Florida, USA), using a home-developed AWSOS sequence with parameters: TR= 100ms, flip angle θ=30°, FOV=140×140mm^2, matrix size=512×512, partitions=60 at 2mm in thickness, in-plane spirals=64 at 16.8ms in readout, fat saturation, and total acquisition time=6.4 min. The human studies were approved by the Institutional Review Board (IRB) of the University of Pittsburgh.

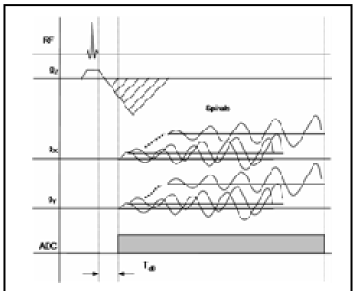

Fig. 1. Conceptual diagram of the AWSOS pulse sequence (Ref.2).

RESULTS AND DISCUSSION

Figure 2 shows coronal images of a human knee acquired at TE=0.6 and 10ms. These images demonstrate significant signal loss from the ligament as TE increases. In Figure 3, transverse slices show enhanced depiction of the patellar cartilage (Fig. 3, top row) and menisci (Fig. 3, bottom row) on the UTE images. The sagittal slices are presented in Figure 4, and highlight the articular cartilage, patellar ligament, and menisci on the UTE images. The difference images in Figures 2-4 (right column) show the changes in signal intensity for the tissues of interest (arrows). These connective tissues were otherwise partial- or full-hypointensity in the conventional long-TE (10ms) images (Figures 2-4, left column) and, consequently, were difficult to track/differentiate. *In conclusion:* We have shown that the AWSOS data acquisition scheme is an effective means for fast, high-resolution (274 µm) anatomic imaging of the knee *in vivo*.

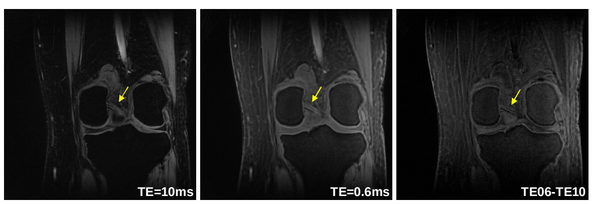

Fig. 2. Coronal knee images at UTE (middle) and long-TE (left), and their difference (right). The ligament (arrow) was highlighted on the UTE image and detailed on the difference image. (Parameters: 3T, 8-ch knee coil, TR=100ms, θ=30°, fatsat, FOV=140mm, matrix=512, slice thickness=2mm)

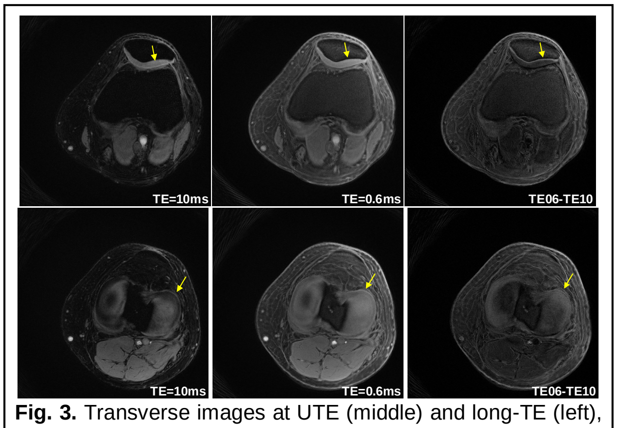

Fig. 3. Transverse images at UTE (middle) and long-TE (left), and their difference (right). The patellar cartilage (arrow, top) and the meniscus (arrow, bottom) were brighter on the UTE images and the intensity changes were detailed on the difference images. (Parameters: the same as in Fig. 2).

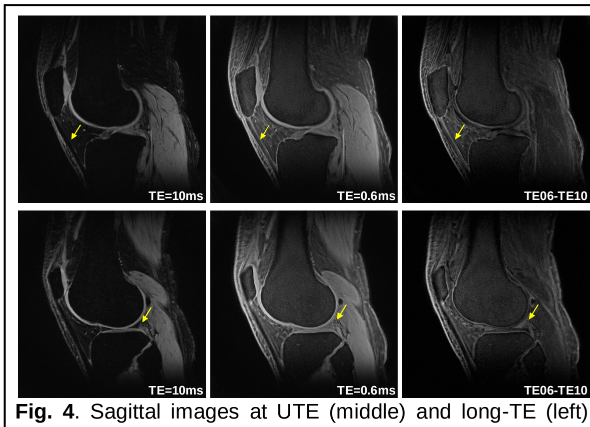

Fig. 4. Sagittal images at UTE (middle) and long-TE (left), and their difference (right). The patellar ligament (arrow, top) and meniscus (arrow, bottom) became hyperintensity on the UTE images. The detailed changes were shown on the difference image. (Parameters: the same as in Fig. 2).

REFERENCES

[1] Gay S, etc. Gustav Fischer Verlag, Germany; 1978.

[2] Qian Y, etc. MRM 2008; 60: 135 - 145.