

# A primary study of in vivo morphological semi-quantitative assessment of knee osteoarthritis using dual-echo 3D UTE imaging: compared with traditional sequences

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**Introduction:** Knee osteoarthritis (KOA) is very common in the world. A large portion of aged people, especially postmenopausal women over 60 years old, often suffer from KOA which causes pain, stiffness, disability, and diminished quality of life. Knee MR imaging with ultrashort-echo-time (UTE) sequence can detect more signals from the short T2/T2\* tissues such as cartilage, ligament, and meniscus than traditional sequences with longer TEs. In theory, UTE imaging can provide more information on finding the lesions and potentially be an important noninvasive method for detecting the biochemical changes during the KOA pathological process<sup>[1,2]</sup>.

In this study we aimed to use dual-echo 3D UTE and traditional sequences to image the KOA, using the MRI Osteoarthritis Knee Score (MOAKS) system<sup>[3]</sup> to semi-quantitatively assess the morphological changes of KOA, in order to find some characteristics and differences of this new technique compared to the routine methods.

**Methods:** With the permission of the Ethics Review Board of Huadong Hospital, 15 KOA patients were recruited to undergo the unilateral knee joint MRI scanning on a clinical wide-bore system (MAGNETOM Skyra 3.0T, Siemens Healthcare, Erlangen, Germany) with a dedicated 15-channel TX/RX knee coil. Two groups of series were prescribed for this study. The first one was the experimental group: A 3D radial dual-echo UTE sequence prepared with fat saturation (TE1=0.1ms, TE2=3.9ms) was used. Imaging parameters were TR= 90 ms, FA=45°, FOV=270x270x270 mm<sup>3</sup>, resolution 0.8x0.8x0.8mm<sup>3</sup>, scan time 6'42". The two original axial images and subtracted images were reconstructed to sagittal and coronal images after scanning. The second one was the control group, which included sagittal 2D fat-saturated proton density (PD)-weighted fast spin-echo sequence (TR/TE, 3500/35 ms; thickness, 3.0 mm), sagittal 3D dual-echo-in-steady-state (DESS) sequence (16.3/4.7 ms; thickness, 0.7 mm), coronal 2D fat-saturated PD fast spin-echo sequence (3500/35 ms; thickness, 3.0 mm), and a 3D fast low-angle-shot (FLASH) sequence with selective water excitation (20/7.57 ms; thickness, 1.5 mm).

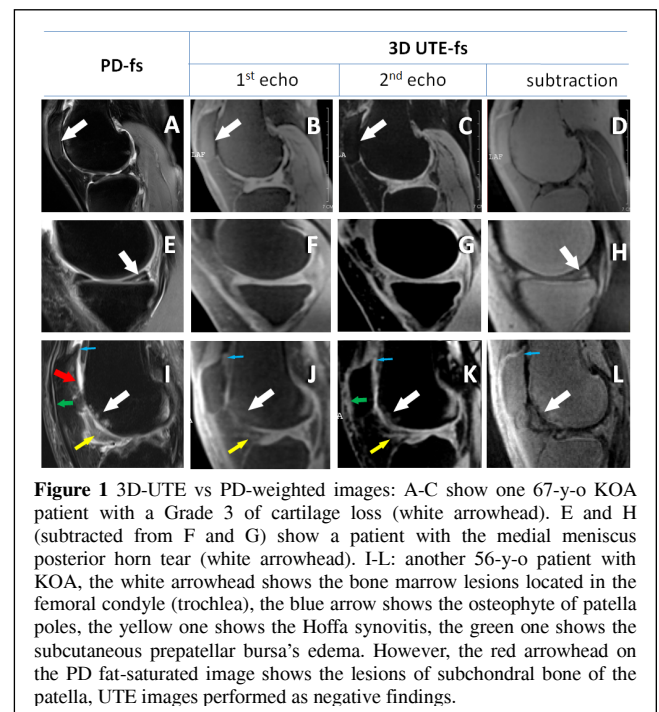
All the images from both groups were assigned to 2 experienced doctors who specialized in MSK disease for 10-12 years. After their professional analysis, the MOAKS score of each group were obtained, and the lesion visualization rate of 3D UTE compared to PD images were statistically recorded.

**Results:** KOA with bone marrow lesions (visualization rate: 22/32), osteophyte (147/147), cartilage loss (29/36), meniscal lesions (49/60) and synovitis (13/15) can be displayed on UTE images (first echo, second echo, or subtracted images) (Figure 1). The MOAKS scores of 15 patients from the two doctors achieved a general coherence (kappa=0.63), however, in assessment of the BMLs, osteophyte, cartilage loss, they reached a relatively high coherence (kappa=0.79).

## Conclusion:

Good *in vivo* results of KOA imaging were obtained over a large FOV using a fat-saturation-prepared dual-echo 3D UTE sequence. KOA semi-quantitative evaluation based on 3D UTE images achieved a general coherence and in the assessment of some lesions, they acquired a relative high-level coherence. But the image quality and the lesion visualization rate of 3D UTE should be improved and further investigated in the future.

[1].X. Li, E. T. Han, B. Ma, R. F. Busse, and S. Majumdar, Magn. Reson. Med., 2008, 59, 298–307. [2].J. Du, M. Carl, E. Diaz, A. Takahashi, E. Han, N. Szeverenyi, C. B. Chung, and G. M. Bydder, Magn. Reson. Med., 2010, 64, 834–842. [3].Hunter et al. Osteoarthritis Cartilage, 2011 August ; 19(8): 990–1002.



**Figure 1** 3D-UTE vs PD-weighted images: A-C show one 67-y-o KOA patient with a Grade 3 of cartilage loss (white arrowhead). E and H (subtracted from F and G) show a patient with the medial meniscus posterior horn tear (white arrowhead). I-L: another 56-y-o patient with KOA, the white arrowhead shows the bone marrow lesions located in the femoral condyle (trochlea), the blue arrow shows the osteophyte of patella poles, the yellow one shows the Hoffa synovitis, the green one shows the subcutaneous prepatellar bursa's edema. However, the red arrowhead on the PD fat-saturated image shows the lesions of subchondral bone of the patella, UTE images performed as negative findings.