Multiecho Ultrashort TE (UTE) Imaging and T2* Mapping of Knee Cartilage

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INTRODUCTION

Magnetic resonance imaging has been used widely for the detection of cartilage lesions (1, 2). In addition to quantifying changes in cartilage morphology, such as thickness and volume, extensive studies have been performed on T1 and T2 quantification which reflect changes in biochemical composition of cartilage with early osteoarthritis (OA) (3-5). Short TE projection reconstruction MR imaging (TE = 150 µsec) has been shown to provide superior delineation of cartilage lesions when compared with conventional spoiled gradient-recalled acquisition (SPGR) and magnetization transfer contrast (MTC) (6). Recently ultrashort TE sequences (UTE, TE < 100 µsec) have been investigated (7-9). Here we present multislice multiecho UTE imaging of the cartilage with an initial echo time of 8 µsec, followed by 11 echoes with an echo space of 5 msec. T2* maps were generated from the multiecho images using exponential fitting.

MATERIALS AND METHODS

A multiecho UTE sequence (Figure 1) was implemented on a 1.5 T Signa TwinSpeed scanner (GE Healthcare Technologies, Milwaukee, WI) with a maximum gradient performance of 40 mT/m and 150 mT/m/ms. A slice selective half pulse was followed by a 2D center-out radial acquisition. A complete slice profile was generated by collecting data with the slice selection gradient in one direction and adding this to data collected in the same way with the slice selection gradient reversed. A hysteresis gradient was played between each echo to reduce the eddy current effect. A 3-inch coil was used for signal reception. A fat saturation pulse was played to suppress fat signal for better delineation of cartilage. A T2* map was generated using a Levenberg-Marquardt mono-exponential fitting algorithm. The acquisition parameters were: FOV = 12 cm, TR = 300 ms, TE = 8 µsec, 12 echoes, echo spacing = 5 msec, flip angle = 80°, BW = 41.67 kHz, readout = 512, number of projections = 355, number of slices = 8, slice thickness = 5 mm, scan time = 3 min 30 sec.

Figure 1. Pulse sequence diagram for multislice multiecho UTE sequence. Half pulse was applied with the slice selection gradient positive and negative, respectively, to form a complete slice profile. A hysteresis gradient was played between each echo to reduce eddy current effect.

RESULTS AND DISCUSSION

Figure 2 shows multiecho images of cartilage with 8 echo images displayed. The cartilage was depicted with high spatial resolution of 0.23×0.23 mm^2, and high contrast between the deepest cartilage layer and subchondral bone. The T2* map generated from the multiecho images using pixel by pixel exponential fitting displays the T2* changes within the layers. Magic angle effects were also observed (10).

CONCLUSIONS

The multislice multiecho UTE sequence is a rapid and efficient way to image cartilage with high SNR and high contrast. Pixel by pixel T2* mapping may provide information of early disturbances of cartilage structure.
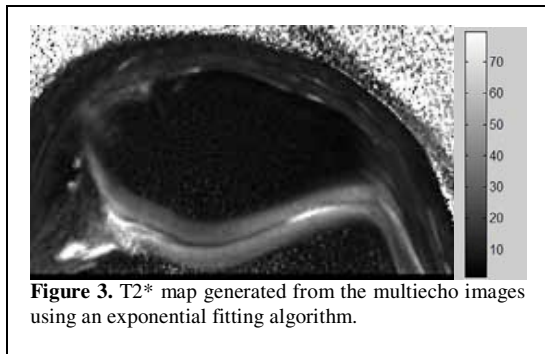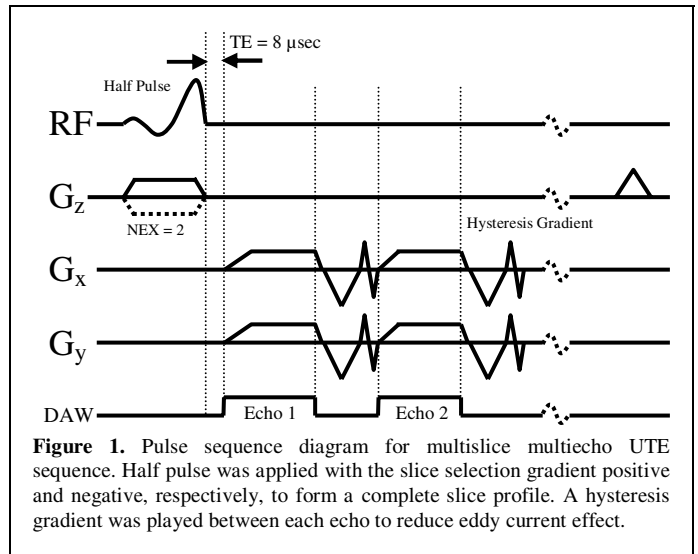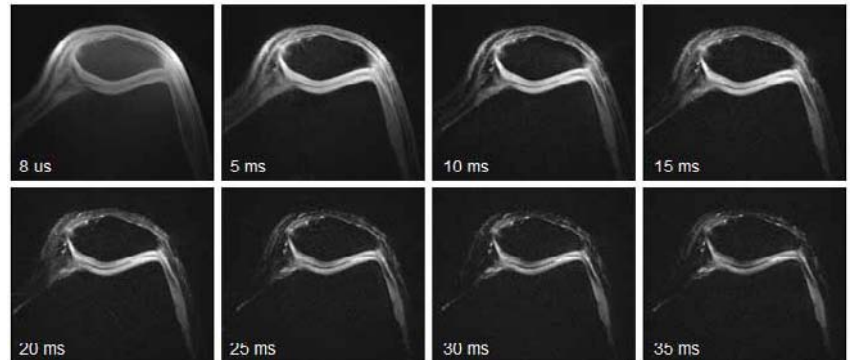

Figure 2. Eight of the twelve echo images acquired with a multiecho multislice UTE sequence. The imaging FOV was 12 cm, readout was 512, producing an acquisition pixel size of 0.23×0.23 mm^2 with a total scan time of 210 sec for 8 slices. A fat saturation pulse was played to suppress fat signal for better delineation of cartilage layers.

Figure 3. T2* map generated from the multiecho images using an exponential fitting algorithm.

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