ULTRASHORT ECHO TIME (UTE) SPIN ECHO (SE) MR IMAGING FOR THE EVALUATION OF TMJ: BENEFITS OVER GRADIENT ECHO ACQUISITION

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INTRODUCTION

Ultrashort echo time (UTE) MR imaging has been effectively used to qualitatively and quantitatively evaluate short T2 tissues (1). Gradient echo acquisition has been emphasized due to the crucial timing issues required to detect the fast decaying signals from short T2 tissues. However, a short TE is typically not enough for short T2 imaging where the short T2 contrast is compromised by the high signal intensity from the surrounding long T2 water and fat tissues. Subtraction of a first echo with a minimal TE from the second one with a longer TE has been proposed to suppress long T2 tissues and improve short T2 contrast. However, the later echoes in a multi-echo gradient echo UTE acquisition are sensitive to off-resonance effects due to B_0 inhomogeneity and susceptibility. This is especially problematic for high resolution UTE imaging of the temporomandibular joint (TMJ) due to the increased echo spacing and strong susceptibility near the joint tissue air interface. Spin echo sequences are insensitive to off-resonance effects, thus show potential for improved TMJ imaging. Here we report a UTE dual echo spin echo (UTE SE) sequence for better delineation of the TMJ components, mainly the disc and cartilage. Subtraction of the SE image from the first FID image may result in better suppression of long T2 water and fat signals. The UTE SE technique may optimize signal and contrast in tissues with a slightly longer intrinsic T2 than would GE acquisition techniques.

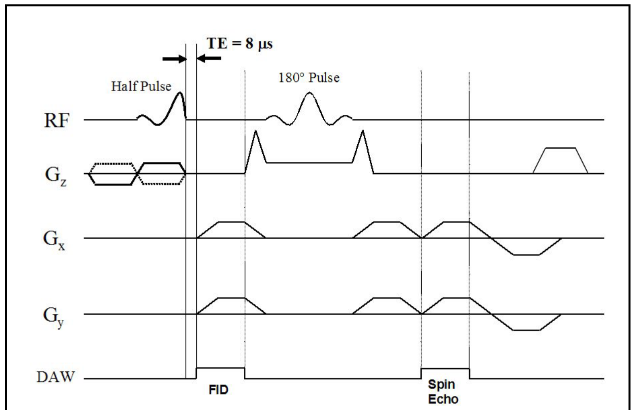

***Fig 1** Pulse sequence for 2D ultrashort TE (UTE) imaging using dual echo spin echo acquisition, where a spin echo is created by adding a 180° refocusing pulse after the UTE FID acquisition. The spin echo data acquisition starts after the refocusing gradient so that the same k-space trajectory can be used for both FID and spin echo on-line image reconstruction.*

MATERIALS AND METHODS

A dual-echo spin echo (SE) 2D UTE sequence (Fig 1) was developed on a clinical 3T scanner system (Signa; GE Medical Systems, Milwaukee, WI). The spin echo was generated by introducing a refocusing 180° pulse after the UTE FID acquisition where a minimal TE of 8 µs was achieved through the combination of half RF pulse excitation, radial ramp sampling and fast transmit/receive switching. The 180° pulse refocuses the long T2 water and fat spins in the second echo, and is therefore less sensitive to off-resonance effects than regular gradient echo acquisition. Bilateral TMJs removed en block from a cadaveric skull were sectioned by band saw at 3mm slice thickness. Images were obtained with a dual-echo GE UTE as well as a dual-echo spin echo UTE acquisition technique. The parameters of the latter were: TR=1000, TE= 8 microsec/16 msec, 2 NEX , 512X511 matrix, 2 mm slice thickness, 8 FOV, 70° flip angle, 50 BW. A 3-inch-surface coil was placed in contact with the tissue slices for signal reception. Substraction images were acquired after the substraction of the spin echo image from the first FID image. Contrast to noise ratio (CNR) was measured between the disc and surrounding soft tissues to evaluate the efficacy of this technique.

RESULTS AND DISCUSSION

Both on UTE SE and UTE GE images, the disc was displayed with the high signal intensity on the first echo, and low in the second **(Fig 2 a and b)**. On UTE SE substraction images (2nd echo spin echo from the first echo FID image), both the disc and the condylar articular cartilage were observed with their high signal intensity and well defined borders **(Fig 2c)**. Similarly within the substraction images of the UTE GE sequence, both the disc and the condylar articular cartilage were observed with their high signal intensity and well defined borders. CNR values on substraction images for UTE SE and UTE GE sequences between the disc and the posterior soft tissues are shown in the table.

	CNR between disc & posterior soft tissues	CNR between disc & cartilage
UTE GE	12	0.6
UTE SE	17	14

Table. Showing the CNR values in the substraction images for UTE SE is higher than the values for UTE GE.

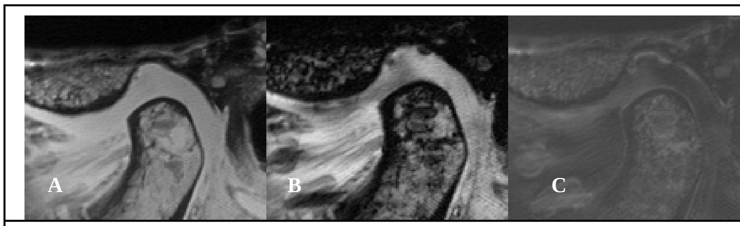

***Fig 2** UTE GE with TR of 451 and first echo of TE with 0.08 us **(A)** and second echo with a TE of 6.6 ms **(B)**. On the subtraction image **(C)** disc and the cartilage is vaguely discernable from the surrounding soft tissues.*

***Fig 3.** UTE FID with a TE of 8 us (A) and TE of 16 ms (B). The subtraction of the FID from the spin echo provides excellent contrast for the TMJ disk and fibrocartilage (C).*

Conclusions

UTE SE MR imaging techniques are successful in providing images with excellent signal and contrast in short T2 tissues such as the TMJ that have significant susceptibility issues.

REFERENCES

1. Robson MD, et al., Magn Reson Med 2005; 53:267-274.
2. Rahmer, et al., MRM 2007