

3T MR Imaging of the TMJ Using UTE sequence in Volunteers

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Background

The fibrocartilaginous nature of the articular surfaces and disc of the temporomandibular joint (TMJ) suggest that these tissues have relatively short T2 values making them incompletely detected by standard clinical sequences. With the ultrashort echo time (UTE) MR pulse sequence, it is possible to detect short T2 relaxation components in tissues before they decay to a level where they are not detected with conventional spin echo pulse sequences (1-3). In this paper, we report our preliminary results of 3T UTE MR imaging technique to provide previously unknown quantitative T1 and T2* measurements of healthy volunteer TMJ articular fibrocartilage and disc. This technique can provide a means to quantitatively identify early structural alteration in an objective and non-invasive fashion.

Materials and Methods

T1 and T2* values were measured in seven asymptomatic volunteers (10 TMJs, four women, three men, age range 26 to 33 years) on a GE 3T Excite system, with a 3" surface coil. 2D UTE sequences were implemented using a half excitation RF pulse with radial mapping of k-space from the center followed by another half excitation and repeated radial mapping with the polarity of the slice selection gradient reversed. The data from the two half excitations were added to produce a single radial line of k-space. The data generated by repeating this process through 360° in 512 steps, were then mapped onto a 512-square grid and reconstructed by two-dimensional FT. Using this sequence, for the purposes of data collection of T1 and T2* measurements in the condylar fibrocartilage, calculations were made at the apex of the condyle (12 o'clock position). The disc was divided into thirds from the anterior to posterior extent corresponding to the anatomic division of the anterior band (anterior 1/3), intermediate zone (middle 1/3) and posterior band (posterior 1/3). Quantitative data and measurements from the condylar fibrocartilage were acquired by manual placement of linear regions of interest (ROI). This process of measurement was performed in a MATLAB subroutine that applied the same ROI to each image in the series for both T1 and T2* measurements. The ROIs gave signal intensity values to be used to plot the curves of signal intensity versus time from which T1 and T2* values will be estimated by minimization-of-error curve fitting. To measure T1 values in condylar fibrocartilage and disc, for a given TE=12 µs (effective TE), TSR values were obtained at 17, 30, 50, 100, 200, 400, 800, 1600 msec. Other imaging parameters included: 2 NEX, 512 x 499 (399, 311, 165, 141) matrix, and 2 mm slice thickness. To characterize T2* values in the condylar fibrocartilage and disc, a Constant TR – Varying TE technique in conjunction with UTE imaging was used. For a given TR (300 ms), 4 UTE acquisitions with 4 echoes/acquisition were performed: 1st TEs of 0.1, 1.0, 2, 4, 2nd TEs of 7, 9, 11, 13, 3rd TEs of 15, 17, 19, 21, 4th TEs of 25, 29, 33, 37 msec. T2* values for the condylar fibrocartilage and disc were obtained from curve fitting. The intensity vs. TE curves were fitted to an exponential decay.

Results and Discussion

Mean T1 and T2* values of the three zones of the disc obtained from curve fitting values ranged from 750 to 796 ms and T2* values from 6.6 to 8.4 ms. While mean T1 value for articular fibrocartilage overlying the condyle was 839 ms, mean T2* value of the same tissue was 1.95 ms. The T1 and T2* tissue characteristics of the TMJ disc and articular fibrocartilage have been previously unknown.

Conclusion: This data represents a non-invasive means to detect structural and functional alterations in these tissues. Furthermore, this data can be used to develop and optimize sequences for diagnostic purposes and monitoring of therapy.

References

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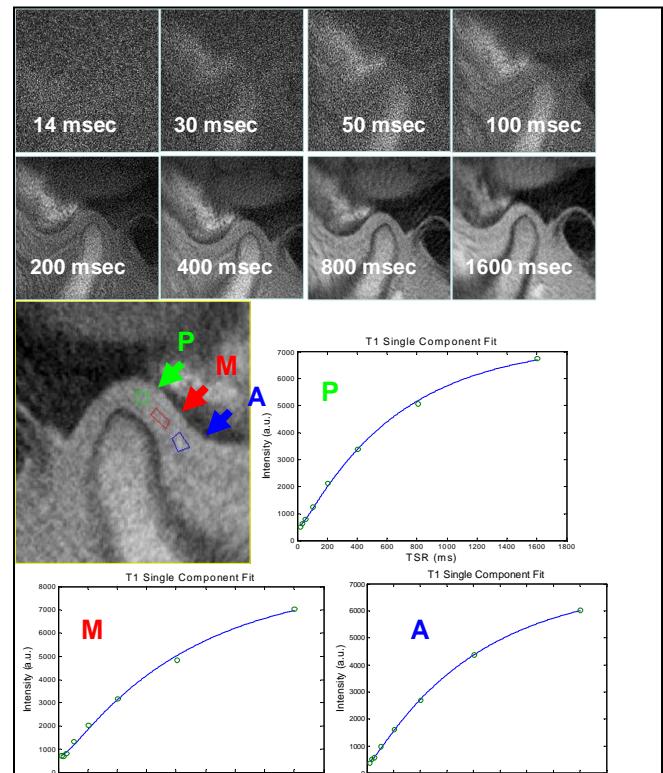


Fig.1 TSR images and T1 fitting for the TMJ disc using the saturation recovery technique from the posterior band (P), intermediate zone (M) and anterior band (A).

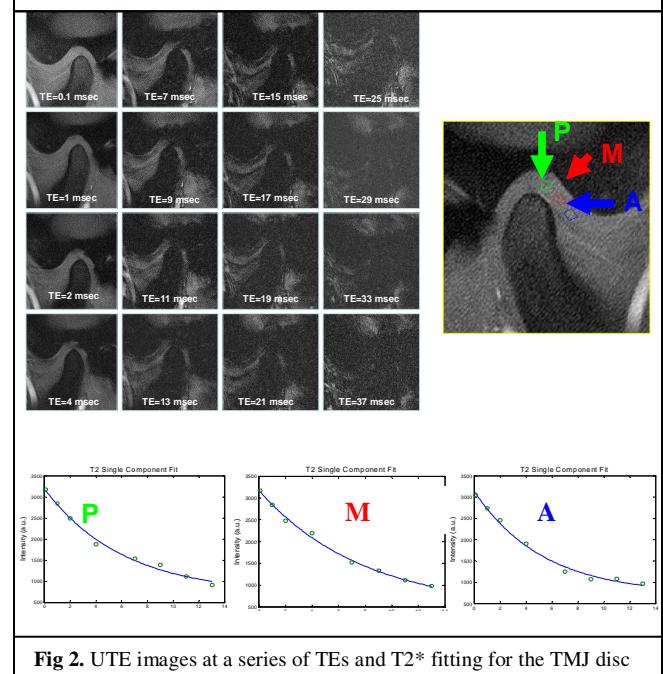


Fig 2. UTE images at a series of TEs and T2* fitting for the TMJ disc from the posterior band (P), intermediate zone (M) and anterior band (A).