

SENSITIVITY OF QUANTITATIVE UTE MRI TO DEGRADATION OF HUMAN TEMPOROMANDIBULAR DISCS

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INTRODUCTION: The temporomandibular joint (TMJ), whose main components include a TMJ disc and mandibular condyle, facilitates jaw movement. Disorders of the TMJ (TMD) affects 10-15% of the U.S. population.¹ TMJ disc degeneration also occurs in TMD, and the current MR diagnoses^{2,3} focus on morphologic evaluation but not quantitative tissue parameters, the latter of which may be sensitive to early stage changes. Additionally, TMJ tissues have inherently short T2 values; their quantitative evaluation benefits from ultrashort time-to-echo (UTE) techniques^{4,5} that use TEs of $\sim\mu$ s and capture signal before decay. In particular, UTE T1rho technique introduced recently,⁵ is promising for T1rho quantification of short T2 tissues. TMJ disc degeneration may be simulated *in vitro* using enzymatic treatments⁶ such as trypsin to degrade biochemical components of proteoglycans.

The objective of this study was to determine if UTE T1rho property is sensitive to biochemical degradation incurred in TMJ discs by trypsin digestion.

METHODS: Samples. TMJ slices (n=4), 5-mm thick, were obtained by sectioning cadaveric skulls (n=3; 72 \pm 12.1 yrs, mean \pm SD) with a precision band saw. **MR Imaging. Apparatus.** GE 3T Signa HDx MR scanner with modified T/R switch with a 3" surface coil. **UTE T1rho MRI.** A 2D projection-reconstruction sequence,⁵ utilizing T1rho-weighted preparation pulses, was used: TR=500 ms, TSL_{prep}=0.02 to 14 ms (4 TSLs), FOV=8 cm, slice=2 mm, readout=512, projections=511, FA=60°, BW=±50 kHz, NEX=2, fat-suppression. **Enzyme Treatment.** TMJ discs were resected and subjected to a series of 3 digestions of 4 hrs each (Fig.1A), using 5 ml of 0.5 mg/ml of trypsin at 37°C. MRI of the tissue, and GAG assay⁷ of the bath, were performed after each step. **Image Analysis.** Region of interest (Fig.1B) was selected for the entire TMJ disc. Signal intensity were averaged and fit to appropriate mono-exponential functions to determine UTE T1rho values. **Statistics.** To determine effects of digestion duration on MR property and GAG release, repeated measures ANOVA (α =0.05) and posthoc comparisons were used. Linear regression was used to compare incremental GAG loss and change in UTE T1rho values.

RESULTS: UTE T1rho values (Fig.2) increased with treatment duration (all p<0.001). Compared to 0 hr baseline values, both 8 and 12 hr values were significantly higher (each p<0.05), increasing \sim 200% by the end of the experiment. Cumulative GAG loss into the bath (Fig.3) also increased with time (p<0.01). Incremental increases in UTE T1rho values of trypsin-treated discs correlated significantly with incremental GAG loss (Fig.4).

DISCUSSION: These results suggest sensitivity of T1rho values to biochemical changes, including loss of glycosaminoglycans, in TMJ discs incurred by trypsin digestion. The change in UTE T1rho values correlated significantly with GAG loss for individual samples. UTE T1rho measurement may be useful for longitudinal assessment of TMJ disc degeneration involving biochemical changes, before severe structural deterioration has occurred.

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REFERENCES: ¹Stowell+ *J Am Dent Assoc* 2007; ²Chirani+ *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2004; ³Vilanova+ *Semin Ultrasound CT MR* 2007; ⁴Gatehouse+ *Clin Radiol* 2003; ⁵Du+ *Magn Reson Med* 2010; ⁶Duvvuri+ *Osteoarthritis Cartilage* 2002; ⁷Farndale+ *Connect Tissue Res* 1982;

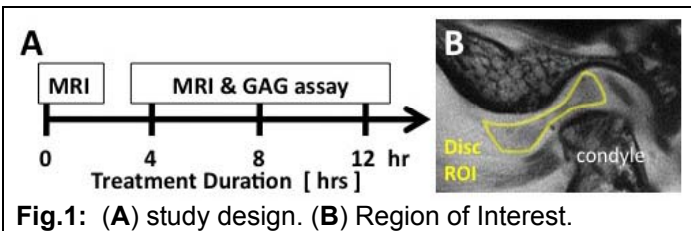


Fig.1: (A) study design. (B) Region of Interest.

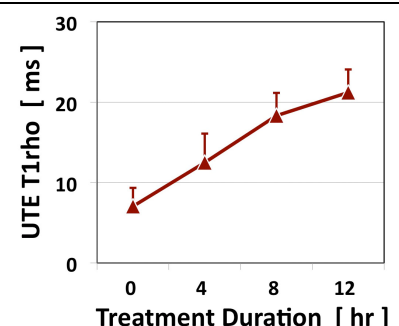


Fig.2: Average UTE T1rho values. Mean \pm sem, n=4.

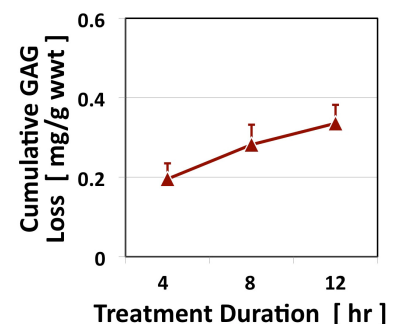


Fig.3: Cumulative GAG loss. Mean \pm sem, n=4.

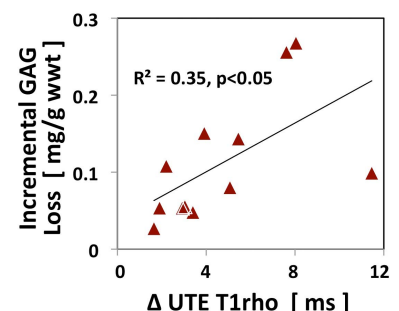


Fig.4: Correlation of incremental GAG loss and change in UTE T1rho values.