T2 mapping of the articular disc of the temporomandibular joint–a feasibility study

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Target audience

Dental specialists and radiologists focused on temporomandibular joint dysfunction analysis by using biochemical MR imaging.

Purpose

Symptoms of temporomandibular joint (TMJ) dysfunction can seriously compromise patients' quality of life[1]. One of the reasons of TMJ dysfunction is change in the organization and composition of collagen fiber network. The aim of our study was therefore 1) to use MRI T2 mapping of the articular disc to determine whether T2 mapping of the TMJ disc is feasible in routine clinical imaging for collagen fiber organization and network[2,3] and 2) to assess the normal T2 relaxation time distribution within the TMJ and 3) to compare the regional intradiscal T2 relaxation time differences with histological findings.

Methods

Institutional Review Board approval and written informed consent were obtained. Included were 10 asymptomatic volunteers without pain, any mouth-opening limitations, or any clicking phenomena. The mean age (± standard deviation) was 26.1 ± 6.6 years (range, 20 to 43). MR imaging was performed on a 3 Tesla whole-body MR scanner using a flexible, dedicated, eight-channel multi-element coil. T2 mapping was carried out in the parasagittal plane using a CPMG multi-echo spin-echo sequence. The regions of interest (ROIs) for the T2 relaxation time maps of the disc were selected manually by three raters (Figure 1).

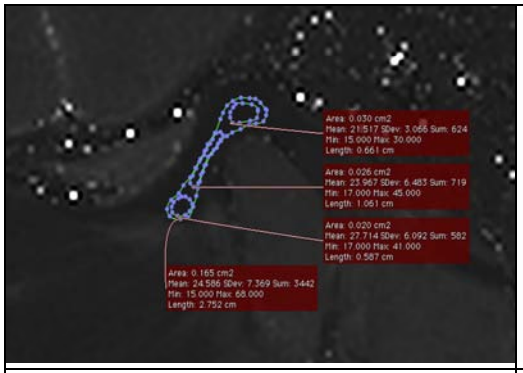

Figure 1: Example of T2 map of TMJ of the selected volunteer with the ROIs delineated.

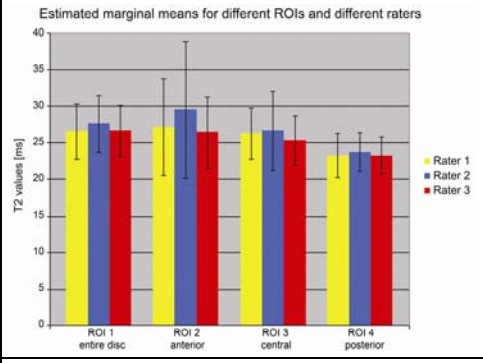

Figure 2: Mean T2 reveal clear tendency toward a decrease from the anterior to the posterior part.

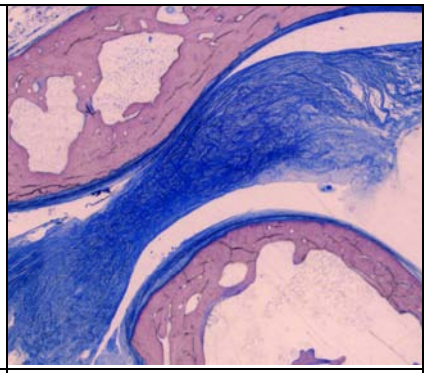

Figure 3: Micromorphology of collagen fibers in the TMJ disc.

Results

Four ROIs were evaluated: ROI1 cover entire TMJ disc, ROI2 is anterior, ROI3 is central and ROI4 is posterior positioned. The mean values for the ROIs ranged between 22.4 and 28.8ms, and the mean for all ROIs was 26.0±5.0. Intraclass correlation (ICC) for inter-observer variability was 0.698 and ICC for intra-observer variability was 0.861. There was no statistically significant difference between raters (p=.091) or sides (p=.810). When T2 values aggregated over both sides and the three raters were compared, post hoc tests revealed significant differences only between ROI 1 and ROI 4 (p=.002). Figure 2 shows a good inter-rater correlation for all ROIs, except for ROI 2 with rater 2. However, the absolute difference in T2 values is small and not statistically significant. The highest T2 relaxation times were found in the anterior part of the articular disc, lower T2 values in the central part of the disc and the lowest values in the posterior part of the disc. A possible explanation for such a distribution of T2 relaxation time values could be collagen fiber density and orientation. As can be seen in histological specimens, in the anterior part of the disc, cross-sectioned collagen fiber bundles appeared thinner, and, in the middle part, collagen fibers were more longitudinally sectioned and showed a more dense and organized orientation (Fig. 3)

Discussion

Our study shows that T2 relaxation time measurements of the articular disc of the TMJ are feasible, with a good inter-and intraobserver agreement. The proposed T2 mapping technique with T2 relaxation time measurements enabled an ultrastructural analysis of the composition of the articular disc of the TMJ.

Conclusion

This biochemical technique is feasible *in vivo*, as shown in our study, when a high-field (3Tesla) MR and a dedicated TMJ coil are used.

References **1.** Dahlstrom L, Carlsson GE. Temporomandibular disorders and oral health-related quality of life. A systematic review. *Acta odontologica Scandinavica.* Mar;68(2):80-85. **2.** Mosher TJ, Dardzinski BJ. Cartilage MRI T2 relaxation time mapping: overview and applications. *Seminars in musculoskeletal radiology.* Dec 2004;8(4):355-368. **3.** Stelzeneder D, Messner A, Vlychou M, et al. Quantitative in vivo MRI evaluation of lumbar facet joints and intervertebral discs using axial T2 mapping. *European radiology.* Nov 2011;21(11):2388-2395.