Patients at risk for tendinopathy and chondropathy in patients with Diabetes mellitus Type I – Identification by means of quantitative Sodium MR Imaging at ultra high field (7 Tesla) – a feasibility study

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TARGET AUDIENCE Musculoskeletal Radiologists and Physicists

PURPOSE The purpose of this study was to investigate possible biochemical alterations of tendons and cartilage caused by diabetes mellitus (DM) Type 1 using quantitative in vivo sodium MR imaging at 7 Tesla.

METHODS An institutional review board approved this prospective study, and written informed consent was obtained. Eight patients (4f/4m, mean age 43a, SD 16,9a, age range: 22-68a) with established diagnosis of DM Type 1 and no history of knee trauma were examined on a 7 Tesla whole body MR with a dedicated knee coil and compared with nine healthy age- and weight- matched volunteers (3f/6m, mean age 40a, SD 17,2a, age range: 23-69a). In all patients and volunteers proton-density Fast Spin Echo (FSE) sequences were obtained for morphological analysis. For sodium MR imaging an optimized GRE sequence with variable TE was used and sodium signal intensity was measured. Further on the sodium signal of the reference sodium capsule and the background noise were measured with Region of interest (ROI) to provide basis data for the normalization process in all participants. Then ROI analysis was performed manually for the femoral condyle cartilage layers and the patella tendon. For the assessment of the intra- and interreader agreement two different readers solitary evaluated the same image data sets. Then Normalized mean sodium signal intensity values (NMSI) were compared between both groups for each reader using ANOVA.

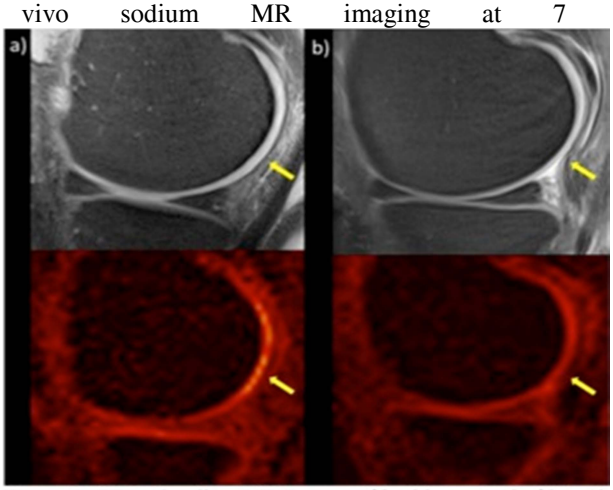

Figure 1: PD and sodium MR Images of healthy control of lateral femurcondyl (a) and of Diabetic patients (b) showing a drop in the sodium signal diabetic patients in morphologic intact appearing cartilage.

		#	NMSI	SD NMSI	t-test (p)
Tendon	Patient	8	76,47	15,94	0,025
	Reference	9	61,19	8,65	
Cartilage	Patient	8	134,22	16,80	0,008
	Reference	9	161,17	18,94	

Table 1: Showing ANOVA analysis of the normalized mean sodium Values (NMSI) of the reference reader with standard deviation for cartilage and tendon measurements showing statistically significance.

RESULTS On morphological imaging femoral condyle cartilage of the non-weight bearing area and patellar tendon were intact in all patients. The inter- and intraobserver reliability was substantial, with intraclass correlation coefficients of 0.93, 0.97 (95% confidence interval) in cartilage and 0.97, 0.97 (95% confidence interval) in tendons. Bivariate ANOVA analysis revealed significant lower normalized sodium values in the femoral cartilage of patients suffering from DM Type1 (p=. 008) whereas in patellar tendon slightly higher normalized sodium values were seen in patients with DM Type 1 (p= 0,025). Although slightly differing mean values and standard deviations were measured of the different readers statistical significance between measurements in diabetic patients and participants was still achieved by each reader in any group (p=.009, p= <.001). ROC analysis showed a mean NMSI of 142.22ms in cartilage and a mean NMSI of 59.03 ms in tendon as the best threshold in the differentiation of patients and volunteers. The diagnostic accuracy for cartilage was 76.47% and 88.24% for tendons.

DISCUSSION Our results suggest that biochemical changes might have already taken place although on morphological images tendons and the non-weight bearing segments of cartilage appear normal. It supports our hypotheses that diabetes as a systemic disease affects cartilage and tendons directly due to increased advanced glycation end products in diabetic patients. In our work increased NMSI values in cartilage and decreased values in tendons were seen which seems controversial at first site but corresponds with recently published works. Trattnig et al. [1] were able to show lower NMSI values in cartilage of patients who have undergone MACT. On the opposite, Juras et al. [2] reported an increase of sodium values in patients with chronic Achillotendinitis. This leads to the assumption that a decrease in the NMSI values in cartilage and an increase in tendons in diabetic patients might have similar underlying changes as can be seen in patients with osteoarthritis or chronic tendinopathy.

CONCLUSION In summary our study showed a statistically significant difference in normalized sodium SNR in patients with diabetes mellitus type 1, compared with a healthy control group. Therefore we assume that biochemical alterations have already taken place although no morphological changes can be seen on routinely performed MRI sequences.

REFERENCES [1] Trattnig, S., et al., 23Na MR imaging at 7 T after knee matrix-associated autologous chondrocyte transplantation preliminary results. Radiology, 2010. 257. [2] Juras, V., et al., Histological correlation of 7 T multi-parametric MRI performed in ex-vivo Achilles tendon. Eur J Radiol, 2013. 82