7 Tesla Sodium (23Na) Imaging for the Assessment of patellar cartilage damage after patella-dislocation: preliminary results.

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Target audience

Musculoskeletal radiologists, articular cartilage scientists, OA scientists

Purpose

As the average life expectancy is increasing worldwide, the incidence of osteoarthritis (OA) is also increasing. OA is a major cause of disability, resulting from a reduced joint space and mobility. As OA is resulting in total joint replacement [1], it is of high interest to detect early changes of the articular cartilage. In the last decade, great afford has been made to develop biochemical MRI techniques, in order to determine the composition of articular cartilage. One of these techniques is Sodium imaging which directly correlates with the quantitative occurrence of glycosaminoglycans (GAG) [2]. Loss of GAG is known as the earliest change of cartilage degeneration before other changes occur. The purpose of this study was to evaluate the feasibility of $_{23}$Na (sodium) MR imaging, for the detection of OA at the patella cartilage in patients after patella-dislocation and to compare the results to healthy volunteers and cadaver samples.

Methods

Nine patients after patella-dislocation, mean age 26.4 years (± 5.6), nine healthy volunteers, with a mean age of 26.1 years (±5.0) and 5 cadaveric samples (mean age 75.8 ± 7.4 years), were enrolled in this study. All measurements were performed on a 7T MR whole body system (Magnetom, Siemens Healthcare, Erlangen, Germany) using a twenty-eight-channel transmit/receive knee array coil (Quality Electrodynamics LLC, Cleveland, OH, US) and a 15-channel $_{23}$Na-only transmit/receive knee coil (Quality Electrodynamics LLC, Cleveland, OH, US). For morphological imaging a 2D-PDw-TSEfs-sequence (TR/TE = 4390/26 ms; FOV = 159*130 mm2, 20 slices; matrix size = 448*366; resolution = 0.36*0.36*3.0 mm3; flip angle = 130; bandwidth = 245 Hz/pixel) and a T1w-3D-GRE sequence (TR/TE = 8.3/3.57 ms; FOV = 185*156 mm2, 224 slices; matrix size = 384*324; resolution = 0.48*0.48*0.48 mm3; flip angle = 8; bandwidth = 450 Hz/pixel) were performed. Axial sodium images were derived from an optimized 3D GRE-sequence (TR/TE = 17.0/8.34 ms; FOV = 190*190 mm2, 32 slices; matrix size = 64*128; resolution = 1.48*1.48*3.0 mm3; bandwidth of 80 Hz/pix; 13 averages; 50 degree flip angle). Morphological cartilage grading was performed and sodium SNR values were calculated. Mean global sodium-values and SNR were compared between patients and volunteers and cartilage defect grades using an analysis of variance. In cadaver samples, the patella was divided into medial and lateral and from each side, 5 contiguous cartilage samples were analysed with a GAG assay (Blyscan B3000 GAG Assay) for GAG content quantification. These values were compared with SNR values.

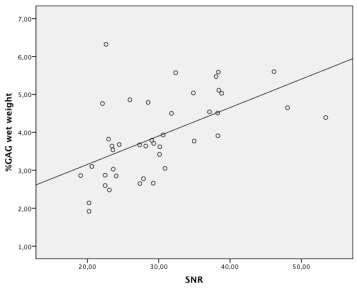

Fig.1: Scatter plot showing the correlation between SNR and %GAG wet weight

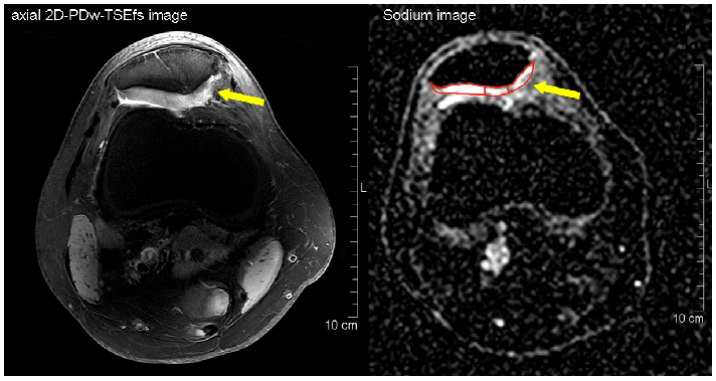

Fig.2: Axial morphologic image (left) with corresponding sodium image (right) and marked cartilage defect (yellow arrow)

Results

The ICRS grades of the patients are shown in Table 1. The mean SNR in sodium images for cartilage was 13.5±2.5 in patients and 14.8 ±3.7 in volunteers (p= 0.014). ANOVA-analysis yielded a marked decrease of the sodium-SNR with increasing grade of cartilage lesions (0.002). SNR values according to the number of patella dislocations also showed significantly different values (P= 0.010). The mean SNR in sodium images for cadaver samples was 27.4 ± 8.4 on the medial side of the patella and 30.6 ± 8.2. on the lateral side. The mean GAG values were 3.9 ± 1.1 %GAG wet weight on the medial side and 3.9 ± 11 %GAG wet weight on the lateral side. The correlation between sodium SNR and biochemical assay is shown in Figure 1 with a statistical significant correlation (r=0.563; p<0.001).

ICRS Grade	Nr. of Patients
No Defect	**1**
I	**3**
II	**3**
III	**2**
IV	**-**

Tab.1: Number of patients and corresponding defects according to ICRS grading

Discussion

The results demonstrate the feasibility of $_{23}$Na (sodium) MR imaging for the detection of degenerations of the patella cartilage in patients after patella dislocation. The data depict a lower GAG content in patients after patella dislocation. These results are in good agreement with findings by Sillanpää et al [3]. Furthermore sodium imaging in patella cadaver samples has shown a high correlation with histochemical evaluation of GAG content.

Conclusion

$_{23}$Na MR imaging helps to differentiate between native and degenerated patella cartilage in patients after patella luxation and has the potential to detect early stages of OA.

References

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