

Feasibility of dGEMRIC and T2 mapping at 1.5T in detecting patellar cartilage lesions

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Introduction

Delayed gadolinium-enhanced MRI of cartilage (dGEMRIC) has been shown to be a reliable method for assessing tissue proteoglycan content (1, 2). T2 relaxation time mapping of cartilage on the other hand provides information on the integrity and arrangement of the collagen network (3, 4). A previous study indicated that low gadolinium concentration in tissue minimally affects determination of cartilage T2, enabling conduction of dGEMRIC and T2 mapping in one MRI session (5). As far as we know no studies combining these quantitative methods with clinical MRI evaluation have been published.

Methods

Fourteen cadaveric right patellae (age 55±18 years) were equilibrated overnight in 0.5mM Gd-DTPA²⁻ solution. A GE Signa TwinSpeed 1.5 T (GE Healthcare, Milwaukee, WI, USA) clinical scanner with a transmitting body coil and a receiving 3" surface coil was used. T2 maps were calculated from multi-slice multi-echo spin-echo experiments (GE prototype sequence with improved slice profile, TR=1000 ms, 8 TEs between 10.3 - 82.4 ms, 3-mm slice thickness, in-plane resolution of 0.313 mm, ETL=8, measured at room temperature). Following this, a T1 relaxation time (dGEMRIC) measurement was performed using a single-slice inversion recovery fast spin-echo sequence (TR=1700 ms, TR=11 ms, 6 TIs between 50 - 1600 ms, ETL=6). From the T2 measurement series, three images were chosen to represent typical images used in visual MRI evaluation of cartilage (TE=10ms for proton density weighing, TE=41 for intermediate weighing and TE=82 for T2 weighing). Each patella was examined at three different locations, resulting in 42 individual imaging positions considered as separate cases, each examined quantitatively with dGEMRIC and T2 measurements as well as by analyzing visually the images chosen for spin-echo imaging.

The measured dGEMRIC and T2 data was visualized in color-coded relaxation time maps using a GE Advantage Windows 4.0 workstation. Cartilage areas with a focal increase in the signal of the weighted images or T2 relaxation time, or a decrease in the dGEMRIC index (T1 relaxation time) were recognized as cartilage lesions. A visually detected lesion had a minimum change of approximately 3 to 9 ms on T2 maps and 20 to 30 ms on dGEMRIC maps. The visual evaluation of the spin-echo MRI images and the dGEMRIC and T2 maps was performed in consensus by two radiologists.

Results

Thirty-three focal cartilage lesions were detected with at least one imaging method: 15 with spin-echo imaging, 21 with T2 mapping and 20 with dGEMRIC. Only eight of the 33 lesions were seen with all methods. The average size of these eight lesions was 8.7±4.8 mm on spin-echo images, 12.8±4.9 mm on T2 maps and 16.1±10.3 mm on dGEMRIC images. Seven lesions were visible with dGEMRIC, but not with T2 mapping or spin-echo MRI, and accordingly nine lesions were visible on T2 maps but not on dGEMRIC or spin-echo images. While spin-echo images showed fewer lesions than either T2 maps or dGEMRIC, there were two lesions that were only visible on spin-echo MRI. Two lesions were visible on T2 maps and dGEMRIC but not with spin-echo sequences.

Lesions appeared significantly wider on T2 maps and dGEMRIC as compared to spin-echo MR images (p=0.001 and p=0.002 for T2 and dGEMRIC, respectively; Wilcoxon signed ranks test). dGEMRIC images showed a trend toward wider lesions as compared to lesion size on T2 maps, but this difference was not statistically significant.

Discussion

This study shows that the detection of cartilage lesions can be improved by combining T2 mapping and dGEMRIC with weighted images typically used in clinical MRI evaluation of cartilage degeneration. Further, combining these MRI methods may provide unique and clinically significant information on the degenerative mechanism behind cartilage changes.

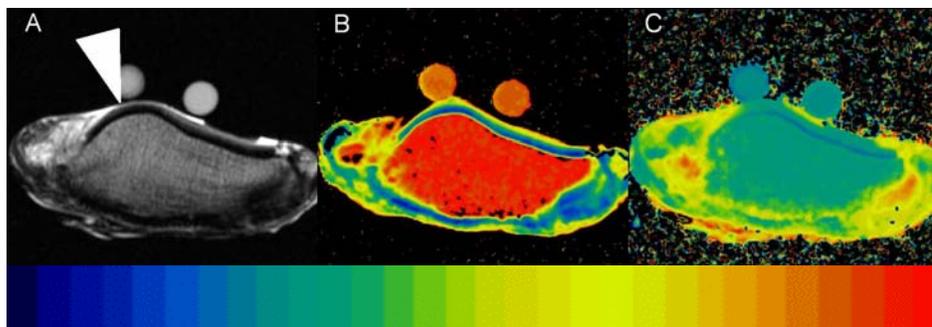


Fig. 1:

The cadaveric patella is visualized the articular surface upwards. An arrowhead shows medial articular surface of the patella; on the right is the lateral articular surface, between them the apical region. Below is the color ramp used ranging from blue to red (10 to 100 ms for T2 maps, 100 to 400 ms for dGEMRIC images). The round objects over the cartilage surface are MRI-visible capsules used in a related study.

This image example shows a medial and apical cartilage lesion only visible on the dGEMRIC image (C), but not on spin-echo MRI (A) or the T2 map (B).

References

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