ABSTRACT

Title: Biomechanical response of the knee meniscus to the axial loads

Work Title: The quantification of the structural changes in deep layer of the knee meniscus using the standardized axial loading

Purpose: Due to the internal structure of the knee joint, the ability to characterize and quantify the dynamic response of the meniscal tissue directly in vivo is highly problematic. The main purpose of this study was to investigate the behavior of the meniscus under loading conditions, using parametric MR imaging.

Methods: Subjects with no history of knee pain or meniscal problems were included in the study (mean age 27.8 ± 1.3 years). To obtain values of relaxation times T2* in the meniscus, the vTE sequence was used with 10 echoes ranging from 0.8 to 10.1 ms. This has resulted in minimizing the echo time, which is an advantage when differentiating meniscal tissue from surrounding components. First of all, an unloaded limb was scanned and immediately after, the limb loaded half of the person´s weight was measured repeatedly in 4 consecutive scans. A custom – made diamagnetic apparatus was developed to simulate stress conditions on the lower limb in a conventional MR scanner. At each 6:10 min measurement, the knee joint was scanned in 64 sections, each image displaying a 1.3 mm section.The two – parametric least squares fitting procedure was used to calculate T2* pixel – wise. ROIs were manually created from each single slice. In each subject, three different compartments of the medial and lateral meniscus were segmented (anterior horn, body, and posterior horn). The differences at the different time – points were calculated. P – value $\alpha < 0.05$ was considered statistically significant.

Conclusion: After healthy meniscal tissue loading, there is the tendency to increase T2* times. A constant increase of T2* times in the menisci after compression was statistically significant in the anterior horn of the medial meniscus. There were no statistically significant trends observed in other horns although there was an overall increase between the first and the last timepoint. The results of this study showed that T2* mapping under loading conditions shows significant increasing of T2* relaxation times in anterior horn of medial meniscus. T2* mapping with variable echo time sequence might be a satisfactorily sensitive technique to detect the changes of meniscus physiology under loading conditions in vivo.

Keywords: deep layer of the meniscus, mechanical load, MRI, T2* changes, changes of meniscal geometry