THE REPRODUCIBILITY OF T2 RELAXATION TIME MEASUREMENT OF KNEE CARTILAGE IN WOMEN AGED OVER 50

T_2 relaxation times of articular cartilage can be obtained from magnetic resonance imaging (MRI) scans. T_2 relaxation times are related to the free water content in the cartilage and used as an indicator of cartilage collagen alignment and 'quality' (Palmer et al., 2013). Increased T_2 relaxation times have been found in those with degenerative changes and osteoarthritis (OA) (Roemer at al. 2014). If changes in T_2 relaxation times are to be used a biomarker for changes in cartilage quality, it is important to quantify reproducibility of the measurement and analysis. The aim of this study was to quantify the amount of variability in T_2 relaxation times from repeated scans and analyses of femerotibial knee cartilage in women aged over 50.

Coronal T_2 maps of the right knee were acquired from six healthy women (age M=56 SD=3.9; BMI M=26.6 SD=3.1). Each participant was scanned twice using a 3.0T MRI scanner (Discovery MR750w, GE Healthcare, Milwaukee, WI) with the scans taking place a week apart. The scan protocol used 4mm slices with ten slices used to position the scan and two removed from each end resulting in eight slices per joint, with no gaps between slices. Slices were positioned using a scout axial scan parallel to the line between the most posterior prominence of each of the femoral condyles. Slices 2, 3 and 4 (with slice 1 being the most posterior) were analysed for each scan using a GE Advantage Workstation (GE Healthcare, Milwaukee, WI. The knee was split into four condylar regions (medial femur, lateral femur, medial tibia and lateral tibia) using the intercondylar tubercles and lateral borders of the tibia to define the cartilage in each ROI. Each of these four regions were split into equal thirds to give 12 cartilage ROIs per slice. This gave a total of 36 ROIs per participant. Average T_2 relaxation times were recorded for each participant in all ROIs. The same observer conducted the analysis twice, on separate days, for each ROI on each scan. For each ROI the coefficient of variance (CV) was calculated for each participant. The root-mean-square average coefficient of variation (CV_{RMS}) was calculated for each ROI to show the population reproducibility of each ROI. The same calculation was conducted for the repeat analysis to quantify the intra-observer variation.

The average CV_{RMS} between the first and second analysis of the same image was 4.4%. The intra-observer correlation of all ROIs, between the first and second analysis was strong ($R = 0.94$, $p < 0.0005$). The average CV_{RMS} between the repeated scans across all slices and ROIs was 9.1%. When comparing different regions there were no significant differences between the CV_{RMS} of the tibial (8.6%) and femoral cartilage (9.7%); medial (9.4%) and lateral (8.4%) compartments; or the central (8.1%), lateral (9.9%) and medial (9.3%) ROIs.

Multanen at al. (2009) investigated the reproducibility of delayed gadolinium-enhanced MRI of cartilage (dGEMRIC) and classified a CV_{RMS} of less than 10% as good and less than 5% as very good. In the current study, values ranged from 3.9 - 15.8% and 27 of the 36 ROIs had CV_{RMS} below 10%. The variability in scans from this study is higher than those reported by Hanilla et al. (2015) who showed an average CV_{RMS} in T_2 relaxation times of 5.3% across the femerotibial and patella cartilage. The variability measured in the current study is less than 13% differences reported between healthy and OA patients in T_2 relaxation times of femerotibial cartilage (Stahl et al., 2009; Dunn et al., 2004). There is an increasing interest in biochemical changes of cartilage and T_2 mapping is one of the most widely used techniques but the reproducibility of the technique has seldom been reported. The current study indicates

that in women aged over 50, the reproducibility is sufficient for the technique to be used to detect changes in a group of participants.