

Repeatability of Multi-component T₂* Mapping on Human Knee Cartilages at 3T

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INTRODUCTION

With ultrashort echo time (UTE) acquisitions, effective transverse relaxations (T₂^{*}) in human knee cartilages have been found to have multiple components, mostly two components (short and long) (1). The short-T₂^{*} component (~4ms) has been shown via NMR studies to be from water molecules trapped within collagen fibers in the cartilage extracellular matrix (ECM) (2), and thus it has potential to be an imaging marker sensitive and specific to disorganization of collagen fibers during cartilage degeneration. However, the reproducibility (or repeatability) of multi-component T₂^{*} measurements has not been established yet, leading to concerns on moving forward the technique to clinical studies. This work fills the gap of knowledge with a repeatable study on healthy human subjects performed on a 3T MRI scanner.

EXPERIMENTS AND DATA PROCESSING

Experiments A repeatability study was conducted on seven healthy subjects (age 28.7±5.0, male/female 5/2) on a 3T MRI scanner (Magnetom Trio Tim, Siemens Medical Solutions, Erlangen, Germany) with 8-channel knee coil (Invivo Inc., Gainesville, FL), AWSOS sequence (3), and 11-TE acquisitions, under an IRB approved protocol. Three session scans were performed on each of the subjects on three consecutive days, the same time on each day (6:30-8:00pm). The subjects were asked to keep their daily physical activities as consistent as possible across the 3-day study period. All the subject/coil set-ups and scans were implemented by the same person. MR imaging parameters were: sinc RF pulse (0.8ms duration and 1.5 cycles), fat saturation, TR/θ=80ms/30°, TE=0.6-40ms, slices=60 at thickness 2mm, FOV=140mm, matrix size=256, resolution=0.55mm, in-plane spirals=24, spiral readout Ts=11.52ms, total acquisition time TA=1.92min for each TE, and isocenter positioning of the knee joint and manual shimming. **Data Processing** For multi-component T₂^{*} mapping, the selections of the slices and regions of interest (ROIs) in the slices were performed by the same person. Four typical locations were selected on the cartilage of each subject (Fig. 1). Superficial and deep layers (divided through the center of entire cartilage thickness) were segmented manually, leading to eight regions of interest (ROIs) for each subject (Fig. 1). The mean, standard deviation (SD), median and coefficient of variation (COV) of a quantity (i.e., short-T₂^{*} time, short-T₂^{*} intensity, long-T₂^{*} time, long-T₂^{*} intensity, or single-component T₂^{*} time) were calculated for each subject across the three repeat scans, producing repeatability (precision error) measurement for individual subjects, or intra-subject repeatability. The repeatability across the subjects (or inter-subject repeatability) was calculated based on the mean values from each subject by averaging.

RESULTS AND DISCUSSION

Fig. 2 shows the inter-subject COV of short-T₂^{*} time, long-T₂^{*} time and single-component T₂^{*} time for all the superficial- and deep-ROIs, plus full-thickness ROIs (a combination of the superficial- and deep-ROIs). The COV of short-T₂^{*} time was <10% for patellar cartilage and <15% for all the other ROIs, even though at small mean values (3.4ms) for short-T₂^{*} time. The COV of long-T₂^{*} time was <13% for all the ROIs, benefiting from large mean value (21.6ms). In comparison, the COV of single-T₂^{*} time was <12% for all ROIs except one ROI at superficial layer. The COVs for the layered ROIs (~8%) were larger than those for the full-thickness cartilage (~5%) due to imperfect segmentations. These values are in line with those in literature (4). Therefore, the multi-component T₂^{*} mapping in human is repeatable. **REFERENCES:** [1] Qian Y, etc. MRM 2010; 64:1427-1432. [2] Lattanzio PJ, etc. MRM 2000; 44:840-851. [3] Qian Y, etc. US patent 7,750,632. 2010. [4] Glaser C, etc. MRM 2006; 56: 526-534.

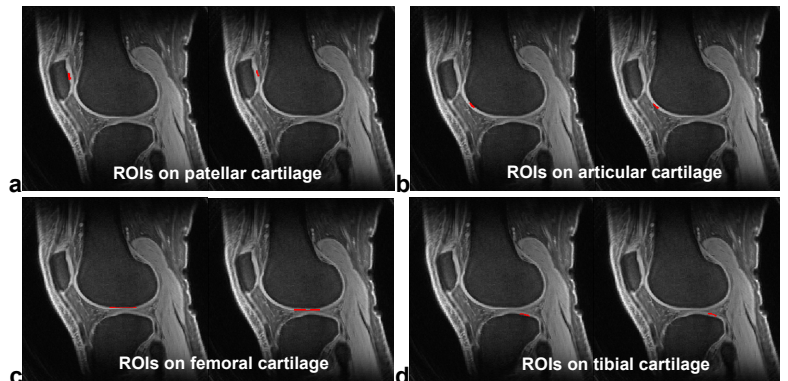


Fig. 1. Regions of interest (ROIs) for the repeatability study of multi-component T₂^{*} mapping: deep (left) and superficial (right) layers in a-d.

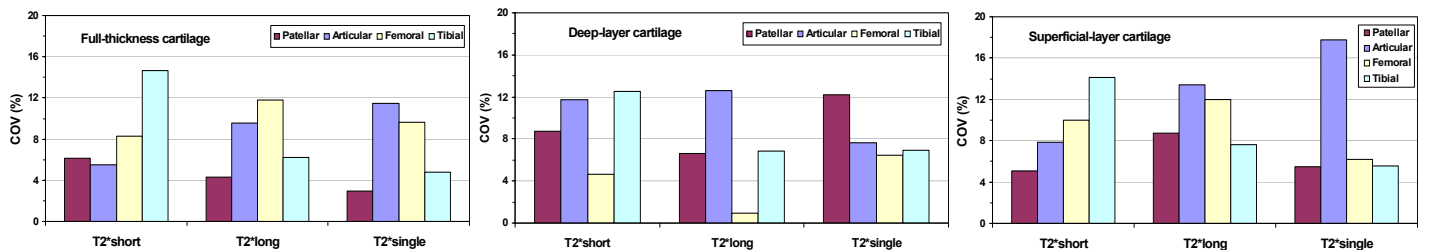


Fig. 2. Coefficient of variation (COV) of the repeated measurements of multi-component T₂^{*} mapping.