

# Long-term and short-term reproducibility of T2 relaxation time in human knee cartilage

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## INTRODUCTION

T2 relaxation time of articular cartilage has been reported to reflect the orientation and concentration of collagen fibrils [1-2]. The reproducibility of T2 in human patellar cartilage has been reported to be close to 5% [3]. However, the patellar cartilage is the thickest one in the knee, and the reproducibility in other articular surfaces has not been studied earlier. In this study, we investigated the long term and short reproducibility of the T2 measurements at different knee joint surfaces in asymptomatic volunteers at 1.5 Tesla.

## METHODS

The right knees of nine asymptomatic volunteers with no history of knee injury or surgery (age 25-38 years, normal weight, 5 male, 4 female) were imaged at 1.5 T using a clinical scanner (GE Signa HDx, GE healthcare, Milwaukee, WI, USA) three times. The time intervals were one week between the first and the second imaging session, and two weeks between the second and the third imaging session. To observe short-term reproducibility, the measurements were repeated three times within one imaging session for four volunteers. After each measurement the volunteer was removed from the scanner and repositioned. To minimize diurnal variation in cartilage thickness the volunteers were imaged each time at the same time of the day within 3 hours. The flexion angle and rotation of the knee was controlled by stabilizing the ankle to a fixed position with a leg holder and by using a custom-made inflatable cushion to fix the joint within the knee coil. All measurements were performed by the same person. T2 relaxation time was mapped using multi-slice multi-echo spin echo sequence (TR=1000 ms, TE=10-82 ms, ETL=8, 3-mm slice thickness FOV=12 cm, matrix size 256\*256 yielding 0.51 mm in-plane resolution). The mapping was performed in axial and sagittal directions. Single sagittal slices through the center of the lateral femoral condyle and from the center of the patella in the axial plane were analyzed. Cartilage was manually segmented by a single radiologist into superficial and deep ROIs at different topographical locations of the femur, tibia and patella (Figure 1). The absolute reproducibility, as measured by root-mean-square (RMS) coefficient of variation (CV<sub>RMS</sub>) was evaluated both for the entire bulk cartilage of each joint surface in the slice and separately for each ROI at different topographical locations. To evaluate the difference between the long-term and short-term reproducibility, Wilcoxon signed rank test was used.

## RESULTS

The reproducibility results for superficial and deep cartilage regions are shown in Table 1. For bulk T2, the long-time reproducibility was 3.2%, 5.4% and 3.7%, and the short-term reproducibility was 3.9%, 3.9% and 3.4% for femoral, tibial and patellar cartilage, respectively. There were no significant differences between long-term and short-term reproducibility in superficial or deep cartilage when comparing CV<sub>RMS</sub> values (p=0.338 and p=0.700, respectively).

## DISCUSSION

The current results show mostly good reproducibility, on the average 4.1% long-time and 3.7% short-time for bulk, and 6.6% for smaller regions, both long-term and short-term. However, there were remarkable variations between different topographic locations. The poorest reproducibility was found in anterior part of tibia (13-23%), which is probably due to the small size and varying shape of the region. The best mean reproducibility was found at patella, where the cartilage is thick. Similar results have been reported earlier for dGEMRIC measurements of cartilage [5]. The inter-examiner repeatability of segmentation in T2 measurements is reported to be 2-3% [4]. T2 is probably more sensitive to patient positioning as compared to, eg., dGEMRIC because of the magic angle effect. The current results suggest that with careful patient positioning T2 at the different cartilage surfaces of the knee can be measured with good reproducibility.

## REFERENCES

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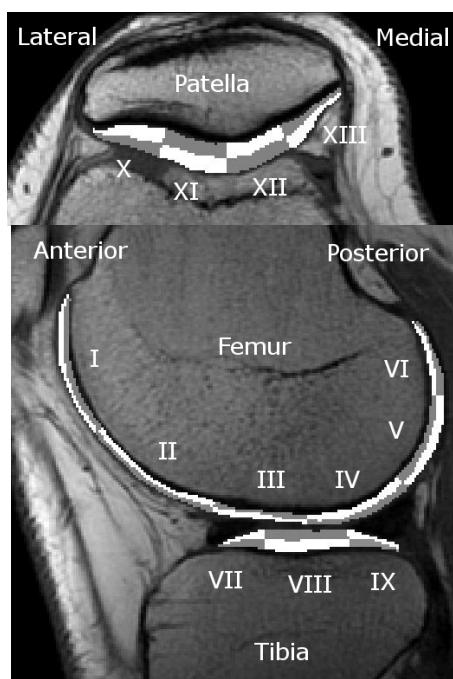


Figure 1. The regions of interest segmented into different joint surfaces.

Table 1. Long-term and short-term reproducibilities for different regions of knee cartilage.

#	Region	Layer*	CV <sub>RMS</sub> (%) long-term	CV <sub>RMS</sub> (%) short-term
Lateral Femoral Condyle				
I	anterior aspect of trochlea	s	4.9	6.1
		d	7.3	5.4
II	posterior aspect of trochlea	s	9.9	11.6
		d	14.3	13.9
III	anterior central part	s	6.3	8.7
		d	12.7	13.9
IV	posterior central part	s	4.4	4.1
		d	8.4	5.1
V	anterior posterior part	s	3.8	3.2
		d	3.8	4.2
VI	posterior posterior part	s	5.1	2.5
		d	4.4	5.1
Lateral Tibial Condyle				
VII	anterior part	s	13.2	12.7
		d	23.1	19.4
VIII	central part	s	7.6	8.4
		d	10.2	19.4
IX	posterior part	s	4.3	5.9
		d	8.8	8.0
Patella				
X	lateral facet	s	3.3	6.4
		d	5.4	3.6
XI	lateral apex	s	2.9	5.2
		d	5.3	4.9
XII	medial apex	s	9.1	4.8
		d	6.4	7.4
XIII	medial facet	s	6.2	6.2
		d	7.1	8.1

\* s - superficial 50% of tissue, d - deep 50% of tissue