Methods: We studied 249 knees of which 123 were from healthy subjects (defined by a score of 0 on the Kellgren-Lawrence (KL) index determined from x-rays) and 126 from subjects with mild to severe OA (a KL score of 1 or greater). The subjects were 21-80 years old with an average age of 56 years, and 45% were females. The subjects were submitted to MRI examination of both knees using an Esaote C-Span low-field 0.18 T scanner performing Turbo 3D T1 sequences with an average sagittal slice thickness of 0.81 mm. 31 knees were scanned once more within a week in order to determine inter-scan reproducibility.
A software method for automatic cartilage segmentation of MRI data that separates the voxels into cartilage and background based on prior knowledge of the cartilage structure was further developed by incorporating an automatic scheme that normalizes for position variation of the test subjects in the scanner. This normalization was achieved by iteratively first shifting the center of mass found from the automatic segmentation towards a prior center location, and then repeating the automatic segmentation procedure.
The medial tibial and femoral cartilage compartments were segmented using this software method and volume estimates were obtained from the segmentation outcome. The estimates were normalized by the width of the tibial plateau in order to enable comparison of test subjects of different sizes.
Results: The inter-scan reproducibility for the 31 knees that were scanned twice within a week was evaluated using pairwise difference and linear correlation between pairs of measures. The automatic method yielded a correlation coefficient of 0.96 for the volume estimate between pairs of estimates on the same knee for medial tibial and femoral cartilage (Fig. 1). The mean absolute value of pairwise volume differences was 4.5%.
Before making the segmentation robust to position variation the linear correlation coefficient was 0.92 and the mean absolute pairwise difference was 7.6% for the volume estimate.
The cartilage volume obtained from the automatic method with position normalization incorporated was significantly lower in OA knees than healthy knees according to an unpaired t-test ($p = 0.001$).

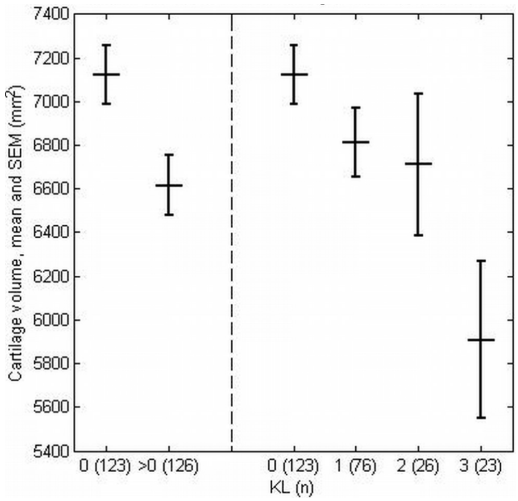

Fig. 1. Medial tibial and femoral cartilage volume and KL index.

Conclusions: The results show that the volume estimation from the automatic cartilage segmentation method is robust to variations in test subject placement in scanner, with a decrease of the average pairwise volume difference to 4.5% when position normalization is incorporated compared to 7.6% without. The method has high reproducibility (linear correlation coefficient of 0.96), and it can separate healthy from OA populations with statistical significance ($p = 0.001$). Therefore, and because the automatic segmentation method is fully automatic, it may be useful in multi-center clinical studies.

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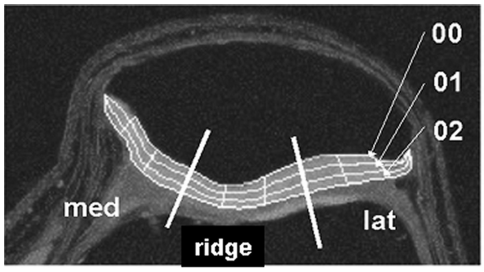
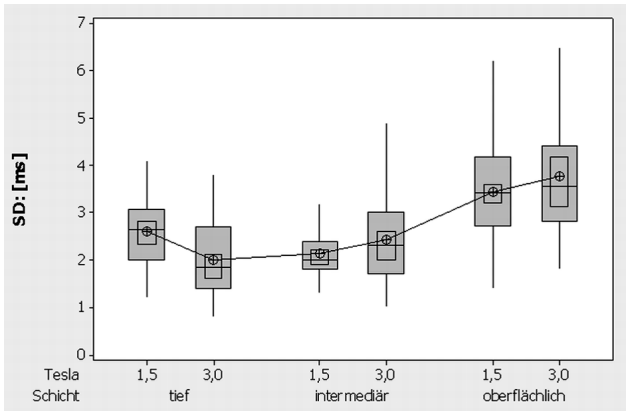
T2 RELAXATION TIME MEASUREMENTS IN HUMAN PATELLAR CARTILAGE: GLOBAL AND REGIONAL REPRODUCIBILITY

C. Glaser, T. Mendlik, J. Weber, C. Trumm, R. Stahl, M. Reiser
Ludwig Maximilians University, Munich, Germany

Purpose: T2 relaxation time is a promising MRI parameter for the assessment of cartilage damage in early as well as advanced OA. However, to date, there is lack of data on reproducibility of T2 measurements. Therefore, in this study global and regional reproducibility of patellar cartilage T2 relaxation times were investigated.
Methods: 7 T2 map and T1-w FLASH WE (WE) data sets from 4 imaging sessions were obtained from the right patellae of ten healthy volunteers using a multiecho (3000/13,2/8 echoes, 20 sections) sequence. Cartilage was segmented in the WE sequence and this segmentation was overlaid on the Multiecho data. Then T2 values were calculated for the total cartilage, 3 layers, 3 facets and - after further subdividing the cartilage plate - for 240 Roi's covering the patellae. Reproducibility was calculated as the root mean square average of the individual coefficients of variation [%] and standard deviations [ms] for intra- and inter-session reproducibility.
In 6 additional volunteers, reproducibility (at equal resolution) was compared between data from 1.5T versus 3T.
Results: The reproducibility error was between 3% and 7% for total, layer- and facet-wise calculated T2. Roi's reproducibility was between 6% and 29%. There was no difference between intra-session and inter-session reproducibility. There was a tendency to worse reproducibility values in the upper as compared to the lower layer. Reproducibility in the peripheral Roi's (median: 13%) was worse than in the central portions (median: 11%) of cartilage, but omission of the cartilage periphery did not positively affect globally calculated T2 precision values.
There was no significant difference for absolute reproducibility





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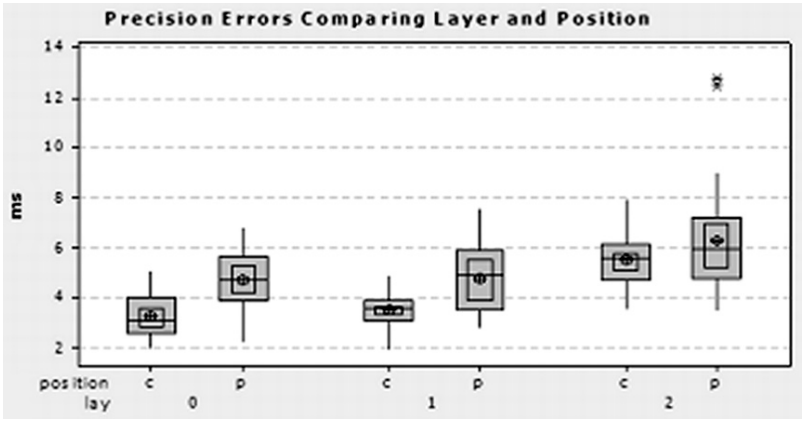

errors between 1.5 Tesla or 3 Tesla at constant spatial resolution. However, different relative reproducibility errors were found between the cartilage layers.
Conclusions: The precision errors were reasonably small as compared to the reported (up to 180%) change from healthy to diseased cartilage in the literature suggesting a good discriminatory power of the technique. Our data give a first estimate of global and regional reproducibility errors of T2 in healthy human patellar cartilage, may serve as a base for sample size calculations and may contribute to plan the study design in both longitudinal and cross-sectional trials in OA.

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SENSITIVITY TO CHANGE OF VARIOUS RADIOGRAPHIC SCALES IN HAND OA, INCLUDING MODIFIED KALLMAN AND VERBRUGGEN SCORES

E. Maheu[1], C. Cadet[2], G. Baron[3], P. Ravaud[3], M. Dougados[4]
[1]St Antoine Hospital, Paris, France, [2]Rheumatologist, Paris, France, [3]Unité d'épidémiologie clinique et de Biostatistiques, Hôpital Bichat, Paris, France, [4]Paris-Descartes University, Medicine Faculty; AP-HP, Cochin Hospital, Rheumatology B Department, Paris, France

Purpose: Hand osteoarthritis (0A) could be a relevant model to study OA progression in structure-modification trials. Various methods are proposed to radiologically assess hand OA and its progression. The Kallman and Verbruggen scores have shown good inter- and intra-observer precisions in a previous work. However, these scores could be simplified to be used in structure-modification trials. **Objective:** To study the sensitivity to change of Kallman, Vergbruggen and modified Kallman and Verbruggen radiological scoring methods proposed to assess hand OA.
Methods: Two trained readers scored separately 105 pairs of radiographs (baseline; year 1), selected from patients enrolled in a randomised controlled trial, for inter-reader reliability and sensitivity to change. They scored twice 60 pairs among the 105 for cross-sectional and longitudinal intra-reader reliability. Radiological hand OA assessment used were: Kallman; Verbruggen scoring methods and modified Kallman (each of the 6 items composing the score were studied and osteophyte and joint space narrowing assessments coupled) and Verbruggen scores (without scoring the metacarpo-phanlangeal (MCP) joints). The sensitivity to change was compared by calculating the standardised response means (SRM).
Results: SRMs ranged as indicated in Table 1.
Conclusions: All methods compared well with respect to sensitivity to change. However, the Verbruggen score doesn't not loose any sensitivity when scored without the MCPs, and scoring only osteophytes and joint space narrowing does not alter the sensitivity of the originally proposed Kallman grading scale. The Kallman and its modification (osteophyte + joint space assessment) were slightly more sentitive to change. Erosions could be also, separately scored as they assess a particular stage of hand OA progression.

Table 1. SRM of radiological scoring methods

SRM	Reader 1	Reader 2
Kallman Total	0.22	0.26
Osteophyte + Joint space narrowing	0.23	0.23
Joint space narrowing	0.17	0.23
Sclerosis	0.09	0.20
Subchondral cysts	0.14	0.06
Lateral deviation	-0.04	-0.09
Osteophyte	0.21	0.12
Erosions	0.23	0.27
Verbruggen Total PIP-DIP without MCPs	0.200.20	0.230.23

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REPRODUCIBILITY OF MORPHOLOGICAL, RELAXOMETRY AND GEOMETRICAL CHARACTERIZATION OF THE HIP JOINT WITH MAGNETIC RESONANCE IMAGING

J. Carballido-Gamio[1], T.M. Link[1], X. Li[1], E.T. Han[2], M.D. Ries[1], S. Majumdar[1]
[1]University of California, San Francisco, CA, [2]GE Healthcare Global Applied Science Laboratory, Menlo Park, CA

Purpose: Morphological characteristics derived from MRI such as cartilage thickness and volume, as well as relaxometry parameters such as T2 and T1-rho have demonstrated their potential to characterize OA of the knee. After the knee, the hip joint is the most affected by OA, and accurate and precise quantitative assessment of hip cartilage based on MRI may contribute to the early detection of cartilage abnormalities which is important to evaluate the progression of the disease and related treatments. Accuracy of the morphological and relaxometry techniques has been previously reported, however no values for T2 of hip cartilage have been published. Thus, the objective of this work was twofold: 1. To test the feasibility of in vivo T2 measurements of hip cartilage. 2. To quantify the reproducibility of in vivo measurements derived from MRI of the hip cartilage: thickness, volume, T2, and T1-rho; as well as the size of the femoral head, which is referred as an important geometrical index.
Methods: Sagittal MR images of the hip joint of 5 asymptomatic volunteers were obtained at 3 T using a bilateral dual-phased array coil. Subjects were placed supine in the scanner, the coil was secured to the hip joint, and the feet were positioned in adduction (45 degrees). Images included a 3D water excitation SPGR (WE-SPGR; ~10 min) sequence with spatial resolution