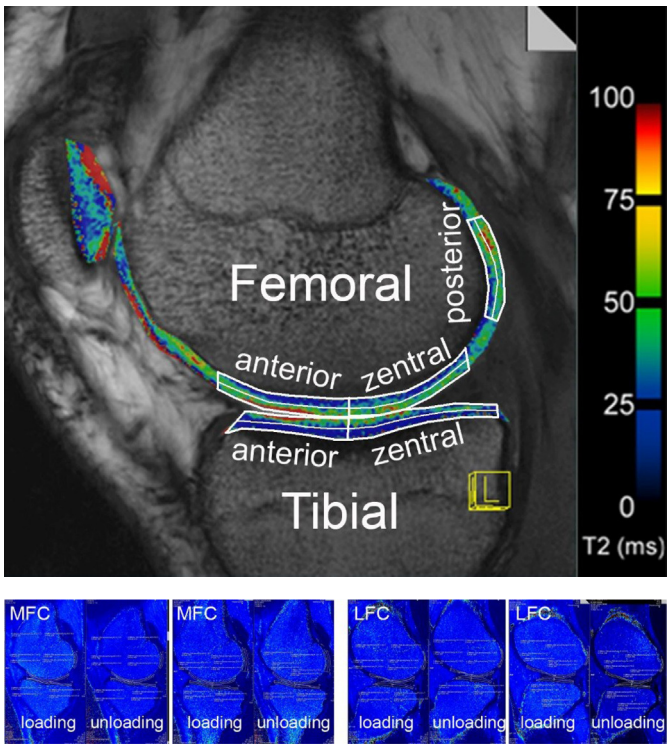

± 11.7 ms; p = 0.217) and central (loading: 43.4 ± 10.0 ms; unloading: 44.6 ± 11.0 ms; p = 0.214)) of the weight-bearing aspect of the femoral condyle, as well as all other cartilage areas (Tibial anterior (sup./deep): loading: 43.2 ± 8.8/30.8 ± 7.3 ms, unloading: 44.2 ± 9.8/31.1 ± 6.9; p = 0.276 and 0.678); (Tibial central (sup./deep): loading: 47.2 ± 8.5/31.1 ± 6.3, unloading: 47.8 ± 10.0/31.3 ± 7.1; p = 0.463 and 0.693); (as well as femoral posterior (sup./deep): loading: 58.8 ± 13.1/46.6 ± 10.1, unloading: 58.3 ± 12.7/45.3 ± 9.2; p = 0.695 and 0.144) did not reveal a significant difference of the T2 values.

Conclusions: This prospective analysis is the first available approach to understand cartilage kinematics in young professional soccer players and to prevent cartilage injuries. The increase of the T2-values during unloading takes place in the area were traumatic and osteochondral cartilage lesions usually appear and were most often osteoarthritic changes take place in later years. The presented approach may help to monitor soccer players at high risk for cartilage injuries.

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QUANTITATIVE MRI (QMRI) FEATURES PREDICT SYMPTOMATIC KNEE PAIN DURING THE NEXT YEAR: DATA FROM THE OAI

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Purpose: Predicting those who will develop near-term chronic knee pain may accelerate the development of effective OA therapies. The purpose of this work was: 1) To describe the qMRI differences between subjects with and without symptomatic knee pain; 2) To develop a 12-month predictive index of symptomatic knee pain based on qMRI analysis.

Methods: Subjects from the Osteoarthritis Initiative (OAI) with untreated right knee pain were selected for this study. Those whose right knee symptomatic pain scores (RKSX) were 2, indicating "Pain most days of a month in past 12m" and whose corresponding RKSX scores for the prior year were lower were included. Age, BMI and gender matched subjects without right knee pain were selected as a control cohort. 3D DESS WE MRI images were analyzed using software (Qmetrics Technologies, Rochester, NY) that automatically segmented articular cartilage into whole femur, tibia and patella, and sub-regional central medial femur, central lateral femur, medial tibia, lateral tibia, medial trochlea, lateral trochlea, medial patella, and lateral patella. A human observed qualified the success of the segmentations. Segmentations that failed to accurately delineate cartilage tissue were removed from the analysis. Cartilage volume, area, thickness, curvature and DESS signal contrast properties were computed for each region. Descriptive statistics were generated for thickness, curvature and signal contrast measurements. All measurements were adjusted for BMI, age and gender differences. Next, the measurements were z-transformed using the rank inverse normal transform. Finally, individual measurements were classified as low-control-quartile ($p < 0.25$), mid-control-range ($0.25 < p < 0.75$) and top-control-quartile ($p > 0.75$). At each class the z-score was maintained. The qMRI analyses at the time of recording the RKSX = 2 observation (T-0) and year prior (T-1) were selected. Matching T-0 visit was determined for the control group, based on the T-0 visit of the age-gender-BMI matched case subject. Multivariate logistic models were used to build a Knee-pain predictor. The model selection was found using a bootstrapped-step-wise feature selection algorithm based on the Integrated Discrimination Improvement (IDI). Knee-pain-models were developed for the T-1 and T-0 time points, and both models were internally validated using a tenfold cross-validation. The odds ratio (OR) for each model feature was evaluated. Finally, we determine the practicality of the index to select patients that will develop pain in the next by determining of the number of subjects that could be correctly predicted with a 5% false positive rate.

Results: At pain incidence (RKSX = 2), 77 cases with reliable qMRI analyses were included (38:39 Males:Females). 165 controls were matched at the incident point (84:81 Males:Females). The entire cohort had an average age of 66.21 ± 9.5 years with a BMI of 26.9 ± 4.6. Subjects with available prior year qMRI analyses included 60 cases and 138 controls. Table 1 shows the qMRI parameters that were able to separate cases from controls at the time of pain incidence and one year prior. The model at pain incidence indicated that superficial femur signal contrast, the curvature of the tibia, and patella were different between cases and controls with odds ratios of 3.38, 4.5 and 4.15 respectively. One year prior to the incidence of pain, the thickness of patella cartilage, the cartilage signal contrast of the medial patella and that of the femur were discriminant between subjects that progressed to pain and subjects that did not. The odds were 11.0, 3.0 and 1.8 respectively. The model at one year prior to pain onset was able to accurately predict 28% of the subjects that progress to pain with only 5% false positives.

Table 1
qMRI features that separate subjects without pain from subjects with symptomatic knee pain.(−) OR for differences al the low-control-quartile. (+) OR for differences in the lop-control-quartile.

Model	Description	Cases	Control	Odds Ratio
T-0 AUC 0.80 (0.73–0.87), Sensitivity 36% at 95% Specificity	Femur Contrast (Mean)	2.131 (0.608)	2.485 (0.562)	3.38 (2.20-5.18) (−)
	Medial Paid la Area	418.5 (63.7)	434.8 (85.7)	6.21 (1.62–23.77)
	Tibia Curvature (Trimmed)	−0.012 (0.006)	−0.009 (0.006)	4.54 (1.28–16.14)
	Tibia Area	1855.1 (247.1)	1930.5 (310.2)	7.20 (1.86–27.83)
	Patella Curvature (Mean)	0.009 (0.008)	0.011 (0.006)	4.15 (1.23–14.02)
	Lateral Trochlea Contrast (5%)	−2.453 (1.551)	−2.702 (1.612)	1.94 (1.16–3.23) (+)
	Lateral Tibia Contrast (95%)	3.663 (0.877)	3.991 (0.852)	3.75 (1.07–13.15)
T–1 AUC on (0.75–0.88) Sensitivity 0.28 at 0.95 Sensitivity)	Patella Thickness (5%)	0.708 (0.037)	0.714 (0.037)	11.01 (2.38–50.93)
	Medial Patella Contrast (Std)	1.376 (0.294)	1.301 (0.222)	3.02 (1.73–5.29) (+)
	Femur Contrast (Mean)	2.131 (0.608)	2.485 (0.562)	1.80 (1.06–3.06) (−)
	Patella Contrast (Std)	1.777 (0.478)	2.000 (0.439)	2.15 (1.24–3.70) (−)
	Lateral Patella Curvature (Std)	0.059 (0.005)	0.060 (0.007)	2.65 (1.37–5.14) (−)
	Lateral Trochlea Thickness (Std)	0.678 (0.131)	0.668 (0.138)	0.11 (0.03–0.52)

Conclusions: The quantitative features of 3D WE DESS images are different between subjects with pain and those that will not develop symptomatic pain. Furthermore, the lack of signal contrast between cartilage and surrounding tissue as well as the presence of abnormal cartilage thickness in the patella and abnormal bone shape (curvature) are strong predictors the imminent onset of frequent knee pain. Based on these results it is possible to use qMRI to select patients that will develop chronic pain in the next year.

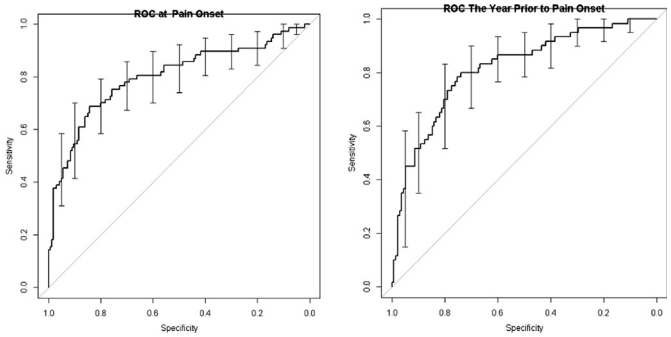

Fig. 1. Receiver operative curve (ROC) for the models that separates cases-and-controls. Left. discriminant model at the lime of recoding pain symptoms on most days for the lust 12 months. Right, model ROC of the year prior to recording the symptomatic pain.

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NEW SOFTWARE METHOD TO QUANTIFY EFFUSION-SYNOVITIS IN OSTEOARTHRITIS OF THE KNEE

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Purpose: Effusion-synovitis of the knee, the collection of excessive fluid in the joint, is a common feature of OA and can be visualized with MRI. Several studies have documented semi-quantitative and quantitative methods for assessing this feature in the knee. Automated image processing software methods have been developed to measure cartilage, bone marrow lesions, and osteophytes, however these techniques have not been employed for effusion-synovitis. A quantitative measure of effusion-synovitis volume is potentially more objective and responsive to change in longitudinal studies. The goal of the present study was to document and provide criterion validation for a semi-automated, software method to measure effusion-synovitis of the knee in OA.
Methods: Forty subjects were selected from the Osteoarthritis Initiative (OAI), a multicenter cohort of 4796 participants with or at risk for knee OA. Axial 3T DESS MRI images of the knee were analyzed. A software technique using a thresholding algorithm was used to highlight areas of increased signal intensity. From the highlighted region, a reader selected areas corresponding to synovial fluid on all slices, which were summed to produce the volume measurement. The reading time per knee was also recorded. The correspondence between the MOAKS score and the quantitative assessment was measuring using Spearman's rank correlation.
Results: Patients had an average age of 65.8 years at baseline, and 50% were female, and an average BMI of 29.0 at baseline. Figure 1 is a graph of the software-determined total effusion-synovitis volume versus the MOAKS score. The MOAKS score was distributed as follows: 0: n = 2, 1: n = 10, 2: n = 18, 3: n = 10. The method was efficient, requiring less than 10 minutes per knee. Effusion-synovitis volume by quantitative assessment correlated moderately with MOAKS effusion-synovitis scores ($r = .57$). The ANOVA used to test for differences in mean volume by MOAKS levels was significant ($p = .0004$). Using the Tukey method, all pair-wise comparisons were significant at $p < .05$ except those involving MOAKS = 0, (n = 2) and the difference between MOAKS 1 and 2.
Conclusions: We have documented a semi-automated software method for measuring the volume of effusion-synovitis in patients with OA of the knee, and provided evidence of critrion validity through comparison with the a current standard for scoring effusion, MOAKS. Effusion-synovitis volume correlated moderately with MOAKS score

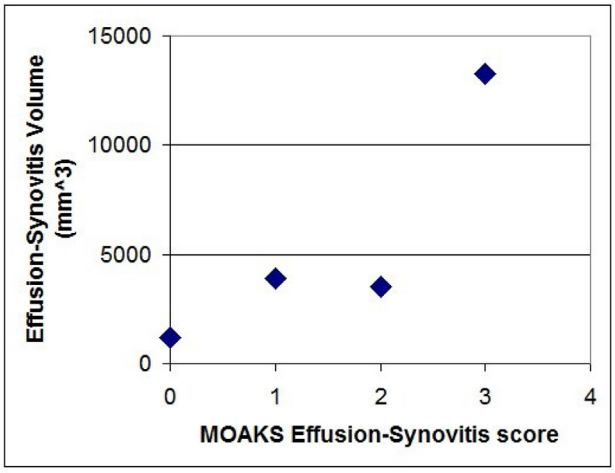

Fig. 1. Graph of the effusion volume as a function of MOAKS Hoff a-synovitis grade.

and we found little difference in volume between MOAKS scores of 1 and 2. This could be due to our limited sample size or to differences in slice selection compared to MOAKS scoring. Future studies with a larger sample size will clarify our results. To our knowledge this is the first automated image processing method to measure effusion-synovitis of the OA knee. An efficient and quantitative measure of this feature in knee OA has the potential to increase objectivity and responsiveness and decrease reader time in trials and large cohort studies, all of which could impact study power and cost.

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QUANTITATIVE MEASUREMENT OF HOFFA-SYNOVITIS: VALIDATION OF A NEW SOFTWARE METHOD

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Purpose: Hoffa-synovitis can be seen in impingement or friction syndromes as well as patellar maltracking. It is also used as a sensitive but not specific surrogate MRI marker for synovitis in OA. Indeed several studies have described qualitative approaches for measuring Hoffa-synovitis in OA. A quantitative measure for Hoffa-synovitis not currently available, but may provide unique information and potentially be sensitive to change.

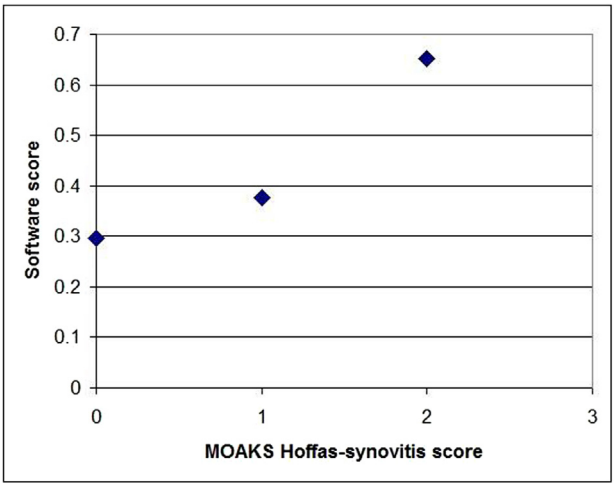

Fig. Graph. of the Software Score as a function of MOAKS Hoffa-synovitis grade.