Variation of radius of curvature around the femoral head and its associations with gender and incident radiographic hip osteoarthritis: Data from the Osteoarthritis Initiative

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We determined the association of these MR features with development of radiographic knee OA using binary logistic regression analyses by calculating odds ratios (OR) with 95% confidence intervals (95%CI). Adjustments were made for age, sex and BMI. The provided ORs are for 1 unit increase in score. Furthermore, sensitivity, specificity and predictive values were calculated for (dichotomized) statistically significant associated MR features. Finally, we calculated the area under the curve (AUC) of the receiver operating characteristic curve, to test the discriminative ability of associated MR features. The discriminative ability is reasonable with an AUC above 0.7, and strong above 0.8.

Results: Data of 148 participants were analyzed with a mean age of 56 years and 78% women. At baseline most patients (60%) had a KL score of 1; 28% developed radiographic OA. 16 patients (11%) had completely normal MR images. In 89 knees (60%) we assessed any form of cartilage loss, 81 knees (55%) had at least one osteophyte and 25 knees (17%) had a BML. A Baker’s cyst was present in 38 knees (26%) and effusion was seen in 54 knees (36%). 80 knees (54%) showed meniscal pathology. Femorotibial OA on MR images was seen in 14 knees (9%) according to Hunter’s proposed criteria. Statistically significant associations with radiographic OA after five years were: cartilage defects (OR 1.7 [95%CI 1.1, 2.6] and AUC 0.593), osteophytes (OR 3.1 [1.7, 5.7] and AUC 0.663), BMLs (OR 2.0 [1.2, 3.4] and AUC 0.573), effusion (OR 2.1 [1.2, 3.5] and AUC 0.621), meniscal pathology (OR 2.8 [1.3, 6.3] and AUC 0.615) and femorotibial OA at baseline (OR 9.7 [2.6, 35.6] and AUC 0.605). No associations were seen for Baker’s cysts. Sensitivity was highest for cartilage defects (any), osteophytes (any) and presence of meniscal pathology, however not higher than 71%, with specificities ranging from 40 to 50%. Specificity above 90% was seen for higher graded MR features being osteophytes grade ≥2, BMLs grade ≥2, moderate to large effusion and femorotibial OA, although with a low sensitivity ranging from 22 to 27%. For osteophytes grade ≥2, effusion grade ≥2, and femorotibial OA on MR the pretest probability of development of radiographic OA in 5 years at least doubled from 28% to positive predictive values above 60%.

Conclusions: In early knee OA, MR depicts OA associated pathology in cartilage, bone and meniscus, where the radiograph fails to detect these changes. Although MR imaging has potential in identifying patients at risk for developing radiographic knee OA, the MR features had insufficient sensitivity and specificity with AUCs below 0.7 to be used as diagnostic biomarkers in early knee OA.
LONGITUDINAL CHANGE IN FEMOROTIBIAL CARTILAGE THICKNESS ARE CONTINGENT ON MALALIGNMENT, BUT NOT ON ITS SEVERITY, DIRECTION, OR THE BODY MASS INDEX

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Purpose: The interaction of alignment and body mass index (BMI) as risk factors for osteoarthritis (OA) progression is controversial and has not yet been studied using quantitative MRI-based outcomes of cartilage thickness loss. The objective of this study was thus to determine the relative and interactive contributions of frontal plane alignment and BMI on quantitative measures of cartilage thickness over 2-years in patients with radiographic knee OA. Specifically, this study aimed to investigate how quantitative cartilage thickness measures change as a function of: the severity of malalignment (neutral, mild or severe), the direction of malalignment (varus or valgus), and the interaction between malalignment and BMI.

Methods: Femorotibial cartilage thickness change between baseline and 2-years was available from sagittal DESS MRI measurements in 558 knees from the Osteoarthritis Initiative (OAI) with radiographic OA at baseline (KLG2-4 in central radiographic readings). Measures of location-specific cartilage thickness loss in the central weight-bearing medial (cMFTC) and lateral (cLFTC) femorotibial compartments, and location-independent subregional cartilage thinning scores (CTINS) as well as ordered values (OV1 = the subregion with the greatest cartilage loss) were compared between categories of malalignment and between knees with low vs. high BMI. The femorotibial angle (FTA) was available as a measure of lower limb alignment from the OAI database and neutral alignment was defined as ±10°. Using the median for varus (-) and valgus (+) knees (+3.5°), mild and severe malalignment were defined as ±2° to ±3.5°, and >±3.5°, respectively. First, measures of cartilage thickness change were compared between knees with any malalignment (mild or severe) vs. neutral alignment, independent of direction, and in a second step, they were compared between all alignment categories: severe varus (n=127), mild varus (n=111), mild valgus (n=43) and severe valgus (n=39) vs. neutral (n=238). Then, cartilage thickness change was compared between knees with mild varus vs. mild valgus malalignment, and severe varus vs. severe valgus malalignment. Finally, knees with a BMI above and below the median (29.8kg/m²) were compared across strata defined by severity and/or direction of malalignment. Analyses were performed using Kruskal-Wallis and Mann-Whitney U tests, adjusting for multiple comparisons.

Results: CTINS, OV1 and cMFTC were significantly larger in malaligned knees (mild or severe) compared to neutral knees (p<0.005). CTINS and OV1 were also significantly larger in mild malalignment vs. neutral, and severe malalignment vs. neutral, when varus and valgus knees were compared. BMI was associated with increased odds of developing incident RHOA, and larger values existed in normal hips of men compared to women. Flattening of the femoral head superolaterally (+80 degrees) and more medially (+40 degrees) were independently associated with increased odds of incident RHOA. These two positions were also ones in which gender differences occurred in normal hips. Increased flexion angle may be a measure of pistol grip deformity, known to be associated with RHOA, but this study showed that flattening of the superolateral portion of the femoral head (seen more frequently in men) and flattening of the more medial portion of the femoral head (seen more frequently in women) are both independent predictors of incident RHOA. The mechanisms by which these are associated with gender and incident RHOA, perhaps partly related to incongruence with the acetabulum, need further investigation.

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Table 2. Showing independent predictors of incident RHOA

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Adjusted OR*</th>
<th>95% CI</th>
<th>p&lt;</th>
</tr>
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<tbody>
<tr>
<td>flexion angle</td>
<td>1.33</td>
<td>1.07–1.65</td>
<td>0.009</td>
</tr>
<tr>
<td>relative curvature (+80)</td>
<td>1.43</td>
<td>1.14–1.79</td>
<td>0.002</td>
</tr>
<tr>
<td>relative curvature (+40)</td>
<td>1.26</td>
<td>1.04–1.52</td>
<td>0.018</td>
</tr>
</tbody>
</table>

* models were adjusted for age, sex, BMI and contralateral RHOA status. ORs for relative curvature are per -1SD (ie: flattening)

Conclusions: Larger flexion angles were associated with increased odds of developing incident RHOA, and larger values existed in normal hips of men compared to women. Flattening of the femoral head superolaterally (+80 degrees) and more medially (+40 degrees) were also independently associated with increased odds of incident RHOA. These two positions were also ones in which gender differences occurred in normal hips. Increased flexion angle may be a measure of pistol grip deformity, known to be associated with RHOA, but this study showed that flattening of the superolateral portion of the femoral head (seen more frequently in men) and flattening of the more medial portion of the femoral head (seen more frequently in women) are both independent predictors of incident RHOA. The mechanisms by which these are associated with gender and incident RHOA, perhaps partly related to incongruence with the acetabulum, need further investigation.

Table 1. Gender differences in femoral head shape measurements in normal hips

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
<th>p&lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>flexion angle</td>
<td>123.2–117.2</td>
<td>116.3–118.0</td>
<td>0.0001**</td>
</tr>
<tr>
<td>relative curvature</td>
<td>0.974–0.885</td>
<td>0.848–0.992</td>
<td>0.0007**</td>
</tr>
<tr>
<td>(+80)</td>
<td>0.982–1.291</td>
<td>1.224–1.359</td>
<td>0.0001**</td>
</tr>
<tr>
<td>(+40)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** of the 20 measurements, only those remaining significant after correcting for multiple comparisons are shown

In the multivariate analysis of the association between femoral head shape and incident RHOA, only 2 relative curvature values (at +80 degrees = supero-medial, and +40 degrees = more medially), along with the flexion point angle were significantly associated with incident RHOA, and all three image-based measurements predicted incident RHOA with similar odds ratios (see Table 2).