and the 3D volumes of BMEL were calculated. The signal intensity (SI) increase of BMEL versus normal bone marrow (NBM) was calculated as: \((SI_{BMEL} - SI_{NBM}) / SI_{NBM} \times 100\)%. Cartilage degeneration was graded using the modified Whole-Organ MRI Score (WORMS) in each compartment as well as in cartilage overlying BMEL in the FSE images. Cartilage was segmented semi-automatically in SPGR images. Five compartments were defined: patellar, lateral/medial femoral condyle (LFC/MFC), lateral/medial tibia (LT/MT). 3D cartilage contour was overlaid to aligned T1, and not with the volume of BMEL. A paired t-test was used to compare the overall cartilage T1 values between patients with and without BMEL. A paired t-test was used to compare the T1 values and clinical grading between BMEL-overlying cartilage and surrounding cartilage, respectively. The Pearson correlation coefficients were calculated between grading between BMEL-overlying cartilage and surrounding cartilage, respectively. Without BMEL in this population.

The overall T1 values and grading were significantly correlated with cartilage degeneration in patients with BMEL compared with those without BMEL (42.6±3.8 ms vs 39.6±1.1 ms, \(P=0.012\)). In patients with BMEL, both T1 values and WORMS grading were significantly elevated in BMEL-overlying cartilage compared to surrounding cartilage (49.5±4.3 ms vs 43.3±4.0 ms, \(P=0.001\) for T1, and 4.7±1.7 vs 1.2±1.6, \(P=0.001\) for WORMS grading). Increased T1 values in BMEL-overlying cartilage were correlated with increased SI of BMEL (R=0.64, \(P=0.005\)), but not correlated with BMEL volume (R=0.1, \(P=0.63\)). No significant differences were found in KL and WOMAC gradings between patients with and without BMEL in this population.

Conclusions: Patients with BMEL showed overall higher T1 values in cartilage compared with those who had no BMEL, suggesting BMEL may be correlated with disease severity of OA. Furthermore, in patients with BMEL, both T1 values and WORMS grading were increased in BMEL-overlying cartilage, suggesting a local spatial correlation between BMEL and more advanced cartilage degeneration. Interestingly, we found the degree of T1 elevation in BMEL-overlying cartilage is correlated with signal intensity increase of BMEL, but not with the volume of BMEL.

### 426 NATURAL COURSE OF MRI DETECTED KNEE CARTILAGE DEFECTS OVER 5 YEARS IN MIDDLE AGED INDIVIDUALS. ASSOCIATIONS WITH MUSCLE FUNCTION AND CLINICAL OUTCOME

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**Purpose:** To study the natural course of knee cartilage defect over 5 years in middle aged persons. We hypothesized that: (1) impaired muscle function would predict worsening in MRI detected cartilage defects; (2) a higher number of cartilage defects would be associated with worse pain and function.

**Methods:** A prospective, population based cohort was recruited in 1990, consisting of 183 middle-aged individuals (48% women) with chronic knee pain (the Spenshult cohort). Inclusion criteria were: age 35−54 years, knee pain (the Spenshult cohort). Inclusion criteria were: age 35−54 years, knee pain and function.

**Conclusions:** No significant differences in change in normalized volume and denuded area in the adjacent chondral plate for each category of BML while controlling for age, BMI and gender. Adjusted means were compared between the four BML groups using Tukey's method.

**Results:** The 150 subjects in this analysis had a mean age of 60.9 years and a mean BMI of 20.3 kg/m². With respect to the central medial tibia (CMT), the mean area was greatest when large and distant BML lesions were present, compared to the presence of small and close small and distant lesions (35.5 mm vs. 29.2 mm and −2.9 mm, \(P<0.05\)) (see table). With respect to the central medial femur (CMF), the same pattern is present. Large and distant BML were associated with greater change in denuded area compared to small and close small and distant BML (64.3 mm² vs. 6.5 mm² and 4.6 mm², \(P<0.05\)). There were no significant differences in change in normalized volume among the four groups in the CMT or CMF. There were insufficient numbers of subjects with large and close lesions to permit comparisons.

**Conclusions:** Size and depth of BML are associated with increased cartilage loss in large and close BML. Size and depth were associated with greater cartilage loss than small lesions of any depth. Although not reaching statistical significance, there is a trend which indicates a combined effect of size and depth in the amount of cartilage loss. Further analyses looking at BML depth are needed. Scoring systems...
which include BML depth as well as size may be more valid than scoring systems not including BML depth.

![Diagram of BML scoring system (tibia).](Image)

### Table 1: Comparison of mean change in cartilage parameters by BML category

<table>
<thead>
<tr>
<th>BML Category</th>
<th>Volume (mm³, 95% CI)</th>
<th>Denuded Area (mm, 95% CI)</th>
<th>n</th>
<th>Volume (mm³, 95% CI)</th>
<th>Denuded Area (mm, 95% CI)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large and distant</td>
<td>43</td>
<td>−0.06</td>
<td>35.5</td>
<td>27</td>
<td>−0.10</td>
<td>64.25</td>
</tr>
<tr>
<td>Large and close</td>
<td>9</td>
<td>−0.05</td>
<td>12.2</td>
<td>4</td>
<td>0.03</td>
<td>29.01</td>
</tr>
<tr>
<td>Small and distant</td>
<td>34</td>
<td>0.02</td>
<td>−2.94</td>
<td>43</td>
<td>0.05</td>
<td>4.56</td>
</tr>
<tr>
<td>Small and close</td>
<td>64</td>
<td>0.01</td>
<td>0.29</td>
<td>76</td>
<td>−0.03</td>
<td>6.50</td>
</tr>
</tbody>
</table>

* *p* < 0.05 compared to large and distant after controlling for age, gender and BMI.

**Conclusion:** This is the first report which compares knee cartilage thickness measures taken from 3T MR images acquired using three different vendors’ scanners in OA subjects. Intra-scanner precision errors are in line with other studies. Systematic differences between vendors’ cartilage thickness results are comparable with intra-scanner variability. Increased variability was exhibited between the Philips and GE scanners which may be due to differences in RF coil technology or image post-processing.

**Acknowledgments:** C. Bos (Philips Medical Systems), S. Dezonie (GE Healthcare), G. Green (YNIC, York), L. Gregory (TIU, Manchester), and AstraZeneca (Cheshire, United Kingdom).

### Inflammation, Angiogenesis & Synovial Tissue Biology

**Purpose:** The aim of this study is to investigate whether cartilage thickness, measured from MR, is comparable between 3 different vendors’ 3T scanners. The ability to use different centres/vendors’ scanners would facilitate patient recruitment and data acquisition in studies of Osteoarthritis (OA). The NIH OA Initiative uses Siemens scanners, but both Philips Medical Systems and GE Healthcare also manufacture 3T scanners.

**Methods:** 12 subjects with knee symptoms of OA and one or more risk factors had their symptomatic knee scanned on each of the 3 vendor’s scanners. Mean age 49.3 ± 10 years (range 32–59 y); mean BMI 28.3 ± 6.2 (range 22.1–44.2). The MR systems are located in three sites in the UK: Manchester (Philips), York (GE), Liverpool (Siemens). The NIH OA study protocol was used for the Siemens scanner and corresponding protocols were developed for the Philips and GE scanners in collaboration with the vendors. The RF coils used were transmit-receive (GE), receive-only (Siemens) and 8-channel phased-array (Philips). To enable intra-scanner analysis, following the Philips acquisition, subjects were repositioned and the sagittal 3D sequence repeated.

Manual cartilage segmentation of the sagittal 3D sequence was performed by a single observer, blinded to subject identity, using EndPoint software (Imorphics, Manchester, UK). Subchondral bone was automatically segmented using a statistical appearance model to define a reference bone shape in each image which provided a dense set of 60,456 and 39,238 anatomically corresponding points on the subchondral bone surfaces of the distal femur and proximal tibia respectively. Cartilage thickness was measured above each corresponding point and mean thickness (ThCtAB) was computed within anatomical trimmed regions, also defined using the correspondences.

**Results:** The figure shows intra-scanner (Philips) and inter-scanner agreement for all scanner pairs for ThCtAB within the trimmed central medial femur (cMF) region and demonstrates small systematic differences. The intra-scanner mean difference was 0.03 mm. Inter-scanner mean differences ranged from 0.05 mm to 0.2 mm. The table shows the intra-scanner and inter-scanner root mean square coefficient of variation (RMS CoV) for the ThCtAB measure for a selection of regions. These range from 2.4%–4.6% (intra-scanner) and 4.2% to 7.7% (inter-scanner).

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