Longitudinal changes in MR-based T2 measurements of cartilage and morphological degeneration of the knee in African American compared to Caucasian women. Data from the osteoarthritis initiative (OAI)

Poster No.: C-0983
Congress: ECR 2014
Type: Scientific Exhibit
Keywords: Musculoskeletal joint, MR, Imaging sequences, Arthritis, Epidemiology
DOI: 10.1594/ecr2014/C-0983

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Aims and objectives

Compared to Caucasian-Americans, African-Americans show a higher prevalence of knee osteoarthritis (OA) \(^4\) and a higher risk for progression of OA \(^5,6\). Also oligomeric matrix protein (COMP), a serum biomarker for osteoarthritis, has been shown to be significantly elevated in African-Americans\(^7\). The underlying reasons for these ethnical differences are not yet understood. Besides possible behavioral, social or occupational differences also genetic differences e.g. in biochemical cartilage composition could play a role. In a cross-sectional study investigating the same cohort as our study, significant lower T2 values of the knee cartilage of African American women were found (poster # 2019).

Purpose

The goal of our study was to determine whether T2 values and WORMS cartilage lesions develop differently between African-Americans and matched Caucasian-American women at risk for osteoarthritis over a follow up period of 48 months.

Hypothesis

African Americans show a higher progression of initially lower T2 values and of cartilage lesions compared to age-, BMI-, KL- and site matched Caucasian controls.
Methods and materials

Subjects

Thirty-eight African-American and 38 matched Caucasian-American women from the Osteoarthritis Initiative cohort were studied. Inclusion criteria were age 45-69, BMI 22.5-39.5, availability of knee x rays and knee MRIs at baseline and 48 months follow-up, no radiographic signs of osteoarthritis with a Kellgren-Lawrence-Score (KL)\(^8\) \# 1. Exclusion criteria were history of knee injury or knee surgery, knee- or hip replacement, cartilage and bone affecting diseases at baseline such as rheumatoid arthritis, cancer, gout, polymyalgia rheumatica, diabetes, bypass in legs, serious impairment of liver or kidney function.

Subjects were matched for age, body mass index (BMI), Kellgren-Lawrence-Score and clinical site. The study was compliant with the Health Insurance Portability and Accountability Act-as well as with the rules and regulations of the University of California Committee for Human Research. All subjects had given their written informed consent prior to participation.

MRI sequences:

MR images of the right knee were obtained at baseline and 48 months follow up using five identical 3.0 Tesla scanners (Trio, Siemens) at one of five academic sites in the United States. The following four sequences from the OAI MRI protocol were used for the analysis: 1) sagittal 3-dimensional (3-D) double-echo steady-state (DESS) sequence with water excitation and coronal and axial reformations (echo time [TE] 4.7 msec, repetition time [TR] 16.3 msec, field of view [FOV] 14 cm, slice thickness 0.7 mm, in-plane spatial resolution 0.365 x 0.465 mm\(^2\), flip angle 25°, bandwidth 185 Hz/pixel); 2) sagittal 2-dimensional (2-D) intermediate-weighted turbo spin-echo (TSE) sequence with fat suppression (TE 30 msec, TR 3,200 msec, FOV 16 cm, slice thickness 3 mm, in-plane spatial resolution 0.357 x 0.511 mm\(^2\), flip angle 180°, bandwidth 248 Hz/pixel), 3) coronal 2-D intermediate-weighted TSE sequence (TE 30 msec, TR 3,200 msec, FOV 16 cm, slice thickness 3 mm, in-plane spatial resolution 0.357 x 0.511 mm\(^2\), flip angle 180°, bandwidth 352 Hz/pixel), and 4) sagittal 2-D multislice multiecho spin-echo sequence for T2 maping (TR/TE = 2,700/10,20,30,40,50,60,70, FOV 12 cm, slice thickness 3 mm with a 0.5 mm gap, in-plane spatial resolution 0.313 x 0.446 mm\(^2\), bandwidth 250 Hz/pixel).

MRI T2 Measurement and WORMS reading
For cartilage T2 relaxation time measurement cartilage segmentation was performed using an in-house developed semi-automated spline-based software implemented in MATLAB (The Mathworks Inc., Natick, MA). Mean T2-values were measured for each compartment (patella, medial and lateral femur, medial and lateral tibia) at baseline and at 48 month follow-up. An average T2 value for the joint was obtained by calculating the mean of all compartments. Two musculoskeletal radiologists (A.Y. and M.K.) performed morphological grading of structural lesions of cartilage, menisci as well as bone marrow edema pattern and subchondral cysts by using a modified whole-organ magnetic resonance imaging score (WORMS).

**Statistic Analysis**

Statistical significance was tested with the two-sided paired t-test (level of significance: 0.05).
Results

In comparison to Caucasians-Americans, average T2 values of African-American women were significantly lower in all compartments (Figure 1 and 2). Mean T2-values increased significantly over 4 years (p<0.0001) in both groups (Figure 2, Table 1). However, T2 values were not any more different at 48 months follow-up (p=0.11) with the African-Americans showing slightly higher increases in T2 (p>0.05). Interestingly, mean WORMS scores did not show significant differences between African-American women and Caucasians-Americans (p<0.05) at baseline (Table 1). In particular, no significant differences of cartilage lesions and meniscal scores were found. Both groups showed a significant WORMS increase over 4 years (p<0.0001). Compared to Caucasians, African-Americans showed an increased WORMS progression (40% WORMS increase vs. 32%), but findings were not significant, (p=0.25) (Table 1). Regional analysis revealed highest increase of T2-values and WORMS score in the lateral compartment without significant racial differences.
Fig. 1: Figure 1: Color coded T2 map of cartilage fused with the first echo of the multi echo sequence: Knee of a Caucasian-American (A) and a matched African-American (B) subject. Cartilage of the Caucasian subject (A) shows higher T2 values.

© Department of Radiology and Biochemical Imaging, University of California, San Francisco - San Francisco/US
Fig. 2: Figure 2: Progress of cartilage mean T2 of the right knee over 4 years. * = significant differences

© Department of Radiology and Biochemical Imaging, University of California, San Francisco - San Francisco/US

Table 1. T2 relaxation time values and WORMS scores of knee cartilage at baseline and after a follow-up period of 48 months

<table>
<thead>
<tr>
<th>T2</th>
<th>African American n = 38</th>
<th>Caucasian American n = 38</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline*</td>
<td>48 month*</td>
</tr>
<tr>
<td>Average</td>
<td>32.02</td>
<td>33.87</td>
</tr>
<tr>
<td>Lateral Femur</td>
<td>33.63</td>
<td>36.01</td>
</tr>
<tr>
<td>Lateral Tibia</td>
<td>27.51</td>
<td>29.79</td>
</tr>
<tr>
<td>Medial Femur</td>
<td>37.1</td>
<td>38.44</td>
</tr>
<tr>
<td>Medial Tibia</td>
<td>29.03</td>
<td>30.6</td>
</tr>
<tr>
<td>Patella</td>
<td>32.46</td>
<td>34.46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WORMS Cartilage</th>
<th>Baseline**</th>
<th>48 month**</th>
<th>Change</th>
<th>%</th>
<th>Std error</th>
<th>P</th>
<th>Baseline**</th>
<th>48 month**</th>
<th>Change</th>
<th>%</th>
<th>Std error</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>8.73</td>
<td>12.27</td>
<td>3.53</td>
<td>40</td>
<td>0.48</td>
<td>c0.0001</td>
<td>8.73</td>
<td>11.56</td>
<td>2.82</td>
<td>32</td>
<td>0.44</td>
<td>c0.0001</td>
</tr>
<tr>
<td>Lateral Femur</td>
<td>0.31</td>
<td>0.48</td>
<td>0.17</td>
<td>54</td>
<td>0.08</td>
<td>0.06</td>
<td>0.46</td>
<td>0.71</td>
<td>0.25</td>
<td>54</td>
<td>0.1</td>
<td>0.01</td>
</tr>
<tr>
<td>Lateral Tibia</td>
<td>0.68</td>
<td>0.81</td>
<td>0.13</td>
<td>19</td>
<td>0.06</td>
<td>0.057</td>
<td>0.71</td>
<td>0.9</td>
<td>0.19</td>
<td>26</td>
<td>0.07</td>
<td>0.01</td>
</tr>
<tr>
<td>Medial Femur</td>
<td>0.76</td>
<td>1.05</td>
<td>0.28</td>
<td>36</td>
<td>0.12</td>
<td>0.02</td>
<td>0.76</td>
<td>0.94</td>
<td>0.18</td>
<td>23</td>
<td>0.11</td>
<td>0.1</td>
</tr>
<tr>
<td>Medial Tibia</td>
<td>0.02</td>
<td>0.14</td>
<td>0.11</td>
<td>5</td>
<td>0.08</td>
<td>0.16</td>
<td>0</td>
<td>0.15</td>
<td>0.15</td>
<td>0/</td>
<td>0.08</td>
<td>0.056</td>
</tr>
<tr>
<td>Patella</td>
<td>2.11</td>
<td>3.02</td>
<td>0.9</td>
<td>42</td>
<td>0.15</td>
<td>&lt;0.0001</td>
<td>2.180</td>
<td>2.810</td>
<td>0.630</td>
<td>28</td>
<td>0.130</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

* Values are means of T2 relaxation time (ms) ** Values are means of cartilage WORMS score per region
**Table 1:** Table 1. T2 relaxation time values and WORMS scores of knee cartilage at baseline and after a follow up period of 48 months

© Department of Radiology and Biochemical Imaging, University of California, San Francisco - San Francisco/US
Conclusion

Significant increases in cartilage T2 values and knee joint degeneration were found in both, African-Americans and Caucasians over a follow up period of 4 years. However there was no significant difference in the development of T2 values and knee joint degeneration. The equalization of the differing baseline T2 values after 48 months follow-up may in part be explained by the accelerated cartilage degeneration in the African-Americans.
References


