Comparison Of T2 Values in the Lateral and Medial Portions of the Weight-Bearing Cartilage of the Hip for Patients with Symptomatic Femoroacetabular Impingement and Asymptomatic Volunteers

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Introduction

- Hip osteoarthritis (OA) is an increasingly prevalent disorder with localized cartilage damage leading to early OA
- The earliest stages of cartilage damage cannot be diagnosed by radiographs alone
- Conventional MRI maintains moderate accuracy in identifying early, localized changes
- Quantitative MRI, such as T2 mapping, may be attractive
  - Sensitive to water content and collagen anisotropy
  - Can detect biochemical changes before structural chondral damage
  - Is non-invasive and does not require gadolinium
  - Quick acquisition time
  - Widespread availability
Femoroacetabular impingement (FAI)
  - Cause of hip pain in young active individuals
  - Leads to OA and may cause early cartilage damage
  - Damage usually begins in the lateral portions of the acetabulum
  - Medial (central) portions of the cartilage are spared initially

Hypothesis
  - Lateral and medial portions of the hip cartilage have different T2 mapping characteristics in patients with FAI and asymptomatics
  - Early damage is localized in the lateral portion of the weight-bearing cartilage
  - T2 mapping could be sensitive to such localized damage
Methods

• All patients and volunteers were prospectively enrolled and provided informed consent
  • 23 symptomatic FAI patients undergoing arthroscopy by one senior orthopaedic surgeon (MJP)
  • 25 rigorously screened asymptomatic volunteers
• All patients and volunteers underwent standard clinical hip MRI + sagittal T2 mapping sequence
  • Patients received pre-op MRI within 48 hours of arthroscopy
  • 3.0 Tesla MRI
• Manual segmentation of cartilage was performed
Methods

Sagittal MR view of the left hip. Horizontal red line crosses the center of the femoral head. The vertical green lines are the vertical planes dividing the femoral head in three zones. The combination of these three lines divide the femoral head and acetabulum into six zones each based on the Geographic Zone method.

Three dimensional representation of the segmentation of the acetabular and femoral cartilage. (Lateral: red and blue Medial: yellow and green). T2 overlay example of medial femoral and acetabular cartilage segmentation.
Results

- Age, gender, BMI: no difference between groups
- Alpha angle: significantly higher in FAI subjects
- T2 values were lower in the lateral portion, in both groups
  - ASYM: 43 vs 53 ms, p<0.001; FAI: 42 vs 49 ms, p=0.016
- In the medial acetabulum, ASYM group had higher T2 values
  - 53 vs 49 ms, p=0.040
- Lateral-medial difference was higher in FAI patients (p=0.047)
- Significant association between the (LA-MA) difference and alpha angle
- These contrasts were not observed when zone 3 was analyzed as a whole (no lateral/medial distinction)
  - acetabulum (46ms vs 43ms, p=0.469); femur (54ms vs 51ms, p=0.515).

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Male/Female</th>
<th>BMI</th>
<th>Alpha Angle (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASYM</td>
<td>28 (22, 32)</td>
<td>13/12</td>
<td>25.5 (20.2, 45.2)</td>
<td>49 (32, 71)</td>
</tr>
<tr>
<td>FAI</td>
<td>28 (18, 35)</td>
<td>14/9</td>
<td>22.5 (19, 30)</td>
<td>66 (44, 89)</td>
</tr>
<tr>
<td>P-value</td>
<td>0.797 (MWU)</td>
<td>0.573 (FET)</td>
<td>0.076 (MWU)</td>
<td>&lt;0.001 (MWU)</td>
</tr>
</tbody>
</table>

*Data presented as median (minimum, maximum). MWU= Mann-Whitney U-test; FET= Fisher’s Exact Tests (FET).
Results

Median and range of T2 values for all subregions.

<table>
<thead>
<tr>
<th>Subregion</th>
<th>Median T2 (ms)</th>
<th>Standard Deviation of T2 (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASYM Subjects</td>
<td>FAI Patients</td>
</tr>
<tr>
<td>All Zone 3 Acetabulum</td>
<td>46 (34, 57)</td>
<td>43 (40, 57)</td>
</tr>
<tr>
<td>LA</td>
<td>43 (32, 60)</td>
<td>42 (38, 57)</td>
</tr>
<tr>
<td>MA WSR</td>
<td>53 (38, 64.5)</td>
<td>49 (36, 69.5)</td>
</tr>
<tr>
<td>p&lt;0.001</td>
<td>p=0.016</td>
<td></td>
</tr>
<tr>
<td>All Zone 3 Femur</td>
<td>54 (45, 66)</td>
<td>51 (39, 77)</td>
</tr>
<tr>
<td>LF</td>
<td>54 (40, 74)</td>
<td>51 (35, 86)</td>
</tr>
<tr>
<td>MF WSR</td>
<td>55 (27, 73)</td>
<td>51 (41, 70)</td>
</tr>
<tr>
<td>p=0.882</td>
<td>p=0.592</td>
<td></td>
</tr>
<tr>
<td>L-M Acet</td>
<td>-8 (-24.5, +6)</td>
<td>-3 (-28.5, +10)</td>
</tr>
<tr>
<td>L-M Femur</td>
<td>+2 (-30, +30)</td>
<td>-3.5 (-30, +31)</td>
</tr>
</tbody>
</table>

*Data presented as median (minimum, maximum). WSR= Wilcoxon Signed-Rank Test (paired test); MWU= Mann-Whitney U Test (independent test); LA= lateral acetabulum; MA= medial acetabulum; LF= lateral femur; MF=medial femur; L-M= lateral minus medial; L-M= lateral minus medial.
Results

• Medial acetabular T2 values correlate with age (rho = -0.305, p = 0.037) and BMI (rho = 0.384, p = 0.007).

• BMI correlated with std. deviation of T2 values in the lateral femur (rho = 0.355, p = 0.013) and medial femur (rho = 0.492, p < 0.001).

• Age correlated with lateral-medial difference of T2 values in the acetabulum (rho = 0.389, p = 0.007),
  • LA-MA difference tends to increase with age.
Discussion

• We propose a novel method to quickly divide the weight-bearing hip cartilage in lateral/medial portions
  • Creating a clinically relevant method of analyzing hip cartilage
• Distinction of lateral vs medial enables detection of earlier cartilage damage
  • (avoids “wash out” phenomenon)
• Difference between the lateral and medial T2 values
  • Asymptomatic: \(-8.0\) ms
  • FAI patients: \(-3.0\) ms
Discussion

• We observed a decrease in T2 values at the medial acetabulum in patients with FAI
  • Previous research reports higher T2 values in the medial acetabulum in asymptomatics
• Positive Correlation between BMI and standard deviation of T2
  • Obesity may cause multiple small areas of early degeneration and is a proven risk factor for OA
• Limitations include
  • small sample size
  • the potential of the method being compromised if the femur is rotated or abducted
  • only the central cartilage zone was analyzed
Conclusions

• Significant contrast between T2 mapping values of lateral and medial portions of the weight-bearing hip cartilage

• Such contrast is not observed when a lateral/medial distinction is not made during analysis

• Separate analysis of the lateral and medial cartilage can be useful in improving T2 mapping usefulness as a tool for early detection of cartilage damage in patients with FAI

• Our method to separate lateral from medial can be automated and used clinically
REFERENCES