Does The Presence Of Femoroacetabular Impingement Morphotype Lead To Early Osteoarthritis? Comparison Of Non-Osteoarthritic Hips Of Young And Old Individuals

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Purpose

Femoroacetabular impingement (FAI) has recently been described in the literature as a cause of labrochondral damage, which in turn could predispose to early hip osteoarthritis (OA). Surgery is considered by many as the treatment of choice to relieve symptoms, and in some cases, prevent the progression towards hip OA. The diagnosis and surgical indications are partly based on the evaluation of imaging findings, including many radiological, computed tomography (CT) and magnetic resonance imaging (MRI) signs of FAI. However, recent studies have shown that the prevalence of these imaging signs can be quite high in young asymptomatic populations, suggesting that these findings can represent anatomic variants.

The pathogenic role of FAI in hip OA has also been controverted by some authors; but to date, no prospective longitudinal study is available to clearly answer this question.

We thus aimed at indirectly assessing whether FAI morphotype leads to early OA in asymptomatic patients in a cross-sectional study by testing both of the following hypotheses (cf. Fig 1): 1. The presence of FAI morphotype leads to early OA and 2. The presence of FAI morphotype by itself does not lead to early OA. We compared two groups of asymptomatic individuals: adults below 40 (group 1) and adults above 60 years old (group 2). We excluded all patients with hip OA from these groups. It is generally accepted that FAI morphotype is acquired before adulthood. The prevalence of FAI should then remain constant over age and be similar in the two age groups. However, if FAI morphotype leads to early OA, patients with FAI in group 2 would have developed OA and would therefore be excluded. Thus, the prevalence of FAI should be lower in group 2 compared to group 1. Conversely, if FAI morphotype alone in asymptomatic patients does not lead to early OA, the prevalence of FAI morphotype should remain similar in the two age groups. We aimed at testing these hypotheses for different cutoff values of FAI signs found in the literature, as well as for the measurement values of these signs.
Fig. 1: Two hypotheses were tested independently: 1. FAI morphotype leads to early OA. Consequence: different prevalence between the two age groups. 2. FAI morphotype does not lead to early OA: Consequence: same prevalence between the two age groups.
Methods and Materials

We prospectively included patients undergoing (thoraco)-abdomino-pelvic MDCT for non-orthopedic indications who were asymptomatic for the hip (based on a questionnaire), excluding hips with OA (based on the CT examination).

Two age groups of 75 hips each were obtained:

#40 year-old: mean age 29, 30 women;

#60 year-old: mean age 66, 41 women.

Prevalences and quantitative values of cam-type (alpha angle, femoral head-neck offset) and pincer-type (acetabular version angle, acetabular index, lateral center-edge angle, crossover sign, posterior wall sign) morphotype were compared using both difference and equivalence tests.

Interobserver agreement was assessed on a subset of 20 hips.

Detailed imaging technique:

Volumetric raw data from the CT scans of each hip were reformatted in different axial and axial oblique planes. A 300mm-thick coronal multiplanar reconstruction (MPR) with an averaging of pixel intensities was also obtained to simulate a pelvic radiograph (Fig. 2 and 3), care was taken to have the tip of the coccyx project on the midline, at approximately 2 cm above the upper border of the pubic symphysis. Four planes were obtained, cross-referencing with the sagittal and coronal planes:

- axial oblique plane through the center of the femoral head and the anterior aspect of the femoral head-neck junction, along the axis of the femoral neck (alpha angle at 90° and femoral head-neck offset) (Fig. 4 and 5)

- double oblique plane through the center of the femoral head and the antero-superior aspect of the femoral head-neck junction at about 45° to the axial plane, along the axis of the femoral neck (alpha angle at 45°) (Fig. 4)

- axial plane through the deepest part of the acetabula (acetabular version angle) (Fig. 6)

- 300mm-thick coronal MPR parallel to the line through the posterior aspect of the acetabula (acetabular index, lateral center-edge angle, crossover sign, posterior wall sign) (Fig. 2 and 3).
Images for this section:

**Fig. 1:** Two hypotheses were tested independently: 1. FAI morphotype leads to early OA. Consequence: different prevalence between the two age groups. 2. FAI morphotype does not lead to early OA: Consequence: same prevalence between the two age groups.

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Fig. 2: Acetabular index (right hip) and lateral center edge angle (left hip).

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Fig. 3: A positive cross-over sign (left hip) and a positive posterior wall sign (right hip), the center of the femoral head is representing by a white cross.

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Fig. 4: The alpha angle.

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Fig. 5: The femoral head-neck offset.

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Fig. 6: The acetabular version angle.
Results

356 patients accepted to participate in our study. 279 patients were excluded because of age requirements, medical or surgical hip joint history, signs of OA at CT and calcium deposits on the hip cartilage. A total of 77 patients were included, divided in two groups 75 hips each, matched for gender as well as BMI.

The difference tests did not show any statistical difference for the prevalence of signs (all p>0.09) or measurements (all p>0.08) of FAI between the two age groups.

The prevalence (cam-type: 15-61% vs. 16-60%; pincer-type: 4-71% vs. 3-81%) and measurement values of FAI morphotype were statistically equivalent between young vs. older patients respectively, except for the crossover (p=0.24) and posterior wall (p=0.27) signs.

The interobserver agreement was substantial to almost perfect (kappa=0.8; ICC=0.69-0.98).

Results for categorical variables (prevalences) are detailed in Table 1.

<table>
<thead>
<tr>
<th>Type of FAI</th>
<th>CT signs</th>
<th>Group 1*</th>
<th>Group 2*</th>
<th>Test for difference§</th>
<th>Test for equivalence‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cam</td>
<td>alpha at 90° (cutoff 55°)</td>
<td>31% (23/75) [19, 46]</td>
<td>28% (21/75) [17, 43]</td>
<td>p=0.86</td>
<td>[-10%, 15%] (LT=15%) p=0.04</td>
</tr>
<tr>
<td></td>
<td>alpha at 90° (cutoff 60°)</td>
<td>15% (11/75) [5, 20]</td>
<td>16% (12/75) [6, 21]</td>
<td>p&gt;0.99</td>
<td>[-11%, 8%] (± 15%) p&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>alpha at 45° (cutoff 55°)</td>
<td>61% (46/75) [45, 82]</td>
<td>60% (45/75) [44, 80]</td>
<td>p&gt;0.99</td>
<td>[-12%, 14%] (LT=15%) p=0.04</td>
</tr>
<tr>
<td></td>
<td>alpha at 45° (cutoff 60°)</td>
<td>48% (36/75) [25, 50]</td>
<td>47% (35/75) [31, 63]</td>
<td>p=0.97</td>
<td>[-12%, 15%] (LT=15%)</td>
</tr>
</tbody>
</table>

Results for categorical variables (prevalences) are detailed in Table 1.
<table>
<thead>
<tr>
<th>Metric</th>
<th>Normal (n=75)</th>
<th>Deformity (n=75)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Femoral Head-Neck Offset</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(cutoff 8mm)</td>
<td>21% (16/75)</td>
<td>17% (13/75)</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>[12, 34]</td>
<td>[9, 30]</td>
<td></td>
</tr>
<tr>
<td><strong>Pincer</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetabular Version Angle</td>
<td>19% (14/75)</td>
<td>32% (24/75)</td>
<td>0.09</td>
</tr>
<tr>
<td>(cutoff 15°)</td>
<td>[10, 31]</td>
<td>[21, 48]</td>
<td></td>
</tr>
<tr>
<td>Acetabular Index Angle</td>
<td>5% (4/75)</td>
<td>3% (2/75)</td>
<td>0.68</td>
</tr>
<tr>
<td>(cutoff 0°)</td>
<td>[1, 10]</td>
<td>[2, 7]</td>
<td></td>
</tr>
<tr>
<td>Acetabular Index Angle</td>
<td>71% (53/75)</td>
<td>81% (61/75)</td>
<td>0.19</td>
</tr>
<tr>
<td>(cutoff 10°)</td>
<td>[40, 69]</td>
<td>[47, 78]</td>
<td></td>
</tr>
<tr>
<td>Lateral Center-Edge Angle</td>
<td>4% (3/75)</td>
<td>5% (4/75)</td>
<td>&gt;0.99</td>
</tr>
<tr>
<td>(cutoff 45°)</td>
<td>[0, 12]</td>
<td>[1, 13]</td>
<td></td>
</tr>
<tr>
<td>Lateral Center-Edge Angle</td>
<td>11% (8/75)</td>
<td>11% (8/75)</td>
<td>0.79</td>
</tr>
<tr>
<td>(cutoff 40°)</td>
<td>[5, 21]</td>
<td>[5, 21]</td>
<td></td>
</tr>
<tr>
<td>Crossover Sign</td>
<td>49% (37/75)</td>
<td>40% (30/75)</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>[35, 68]</td>
<td>[27, 57]</td>
<td></td>
</tr>
</tbody>
</table>
Results for continuous data are detailed in Table 2:

<table>
<thead>
<tr>
<th>Type of FAI</th>
<th>CT signs</th>
<th>Group 1*</th>
<th>Group 2*</th>
<th>Test for difference§</th>
<th>Test for equivalence‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cam</td>
<td>alpha at 90° (degrees)</td>
<td>51.9±9.7 [49.7, 54.1]</td>
<td>51.0±9.3 [48.8, 53.1]</td>
<td>p=0.56</td>
<td>[-2.14, 3.96] (± 5°) p&lt;0.01, p&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>alpha at 45° (degrees)</td>
<td>60.8±12.3 [57.8, 63.8]</td>
<td>60.2±13.3 [57.2, 63.3]</td>
<td>p=0.8</td>
<td>[-3.90, 4.97] (± 5°) p&lt;0.01, p=0.02</td>
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<tr>
<td></td>
<td>femoral head-neck offset (mm)</td>
<td>8.7±1.4 [8.3, 9.0]</td>
<td>9.1±1.7 [8.7, 9.5]</td>
<td>p=0.08</td>
<td>[-0.93, 0.04] (± 2 mm) p&lt;0.01, p&lt;0.01</td>
</tr>
<tr>
<td>Pincer</td>
<td>acetabular version angle (degrees)</td>
<td>18.9±4.9 [17.8, 20.1]</td>
<td>18.1±6.1 [16.7, 19.5]</td>
<td>p=0.36</td>
<td>[-0.73, 2.38] (± 5°) p&lt;0.01, p&lt;0.01</td>
</tr>
<tr>
<td></td>
<td>acetabular index (degrees)</td>
<td>6.8±5.2 [5.6, 8.0]</td>
<td>6.2±3.9 [5.3, 7.1]</td>
<td>p=0.46</td>
<td>[-0.84, 1.96] (± 5°) p&lt;0.01, p&lt;0.01</td>
</tr>
<tr>
<td>lateral center-edge angle (degrees)</td>
<td>33.5±6.3 [32.0, 34.9]</td>
<td>33.7±6.2 [32.3, 33.7]</td>
<td>p=0.79</td>
<td>[-2.34, 1.81] (± 5°)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>p&lt;0.01, p&lt;0.01</td>
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</table>
Conclusion

Prevalence and measurements of the majority of CT signs of FAI morphotype were equivalent between the two age groups of non-OA hips.

Our results bring an indirect argument against a pathogenic role of FAI morphotype alone in the development of early hip OA in asymptomatic patients.

As previously stated by other authors, our results emphasize that firstly, care must be taken not to overcall FAI based on imaging findings, secondly, the presence of FAI morphotype at imaging does not alone lead to early OA in asymptomatic patients, so surgical indications should be based on a correlation with clinical findings and not on the presence of FAI morphotype at imaging alone.


