Examination Of Kinematics For Symptomatic And Asymptomatic Fai During Functional Tasks

Kevin D. Dwyer1, Mario Lamontagne, PhD2, Paul E. Beaule, MD1.
1University of Ottawa, Ottawa, ON, Canada, 2University of Ottawa, Ottawa, ON, Canada.

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Introduction: Femoroacetabular impingement (FAI) is an aspherical anatomical deformity located at the hip joint that can result in symptoms of pain and physical impingement that hinders motion. Studies have shown that FAI subjects had restricted pelvic and hip kinematics when compared to controls in level walking [1-3], squatting [4], and during physical exams [5]. What remains unknown is whether the kinematic deficiencies found are due to mechanical impingement or a result of pain, soft tissue damage and muscle control disorders. To date no study has analyzed the motion patterns of asymptomatic FAI during functional tasks. The purpose of this study was to analyze the 3D hip and pelvis kinematics during walking and squatting tasks and compare physical examination between both asymptomatic and symptomatic FAI groups.

Methods: Overall Sixty-one participants were biomechanically and physically assessed, however only forty-eight male participants were classified into three groups: (1) symptomatic FAI (sFAI) - patients who have aspherical femoral head with a large alpha angle (AA), labral damage and pain symptoms (n=16, 38.8 ± 8.6 years, BMI: 27.3 ± 4.6), (2) asymptomatic FAI (aFAI) - participants who have large alpha angle and bone deformity at the femoral head/neck junction but no symptoms of pain (n=18, 31.2 ± 5.0 years, BMI: 25.8 ± 2.8), and (3) controls (CON) - healthy age- and BMI matched participants (n=14, 32.57 ± 6.8 years, BMI: 26.38 ± 3.4). All subjects underwent a computerized tomography (CT) scan to measure AAs and assign to their respective groups (aFAI or CON). Subjects were excluded if they had a history of other lower body injuries or osteoarthritis. Following the CT scan, hip flexion, internal and external rotation physical examinations were performed. Using a 10 camera Vicon MX motion analysis system, with 2 Bertec and 2 Kistler force plates, five maximal depth squats and level walking trials were recorded. Lower limb kinematics variables were calculated for the affected side. Participants also filled out a WOMAC questionnaire. A one-way ANOVA analysis was performed on each of the above-mentioned variables with an alpha value of 0.05.

Results: A summary of kinematic results is presented in Table 1. Peak hip abduction angle, external rotation, internal rotation, and WOMAC pain and total scores showed significant between group differences (p<0.05): peak hip abduction angle during gait, internal rotation and external rotation during the physical examinations were significantly reduced in the sFAI group compared to aFAI and CON. Noteworthy trends were also observed whereby sFAI had reduced peak depths (p=0.10) and ROM (p=0.053) during squats as well as reduced hip flexion angles (p=0.051) compared to aFAI and CON. The WOMAC questionnaire found the sFAI had significantly higher levels of pain and a reduced overall score compared to aFAI and CON.

Discussion: The kinematic restrictions found in sFAI in this study have been reported previously [1-4]. Interestingly, aFAI did not demonstrate such biomechanical deficiencies, and in general, aFAI mirrored the results of the CON group. The major difference aFAI and sFAI groups are the presence of pain, joint and soft tissue damage which was quantified by WOMAC scores, of which the sFAI had significant higher pain (higher pain scores appears as a lower overall value on the WOMAC pain assessment) score and lower overall score. This indicates that the motion deficiencies of the sFAI group during squats and walking may be due to soft tissue, joint damage and pain rather than the cam deformity. Since the aFAI is able to achieve higher squat depth and pelvic ROM compared to the sFAI group during squats, and greater external and internal rotation, and hip flexion during physical exams, and shows no significant differences from the CON group, it is unlikely the cam deformity largely contributes to the deficiencies found in the sFAI group.

Significance: This study was the first to analyze the kinematics of an asymptomatic FAI group and it was found that they did not have biomechanic deficiencies. This result shows that the mechanical impingement and AA may not be enough to predict FAI, and the varied results for sFAI groups found in this study and previous studies is likely due to the soft tissue damage and hip pain associated with sFAI and not found in either aFAI or CON groups.

Acknowledgments:
Table 1—Means and (SD) of certain variables prospectively evaluated, physical examination, and WOMAC assessment for CO, aCO, and COC groups. Asterisk (*) indicates a significant difference at the p<0.05 level.

<table>
<thead>
<tr>
<th></th>
<th>Start</th>
<th>Walk</th>
<th>Physical Exams</th>
<th>WOMAC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equal Depth</td>
<td>Total</td>
<td>Peak Hip.</td>
<td>Total</td>
</tr>
<tr>
<td>CO</td>
<td>55.4 (8.4)</td>
<td>15.6 (3.1)</td>
<td>12.7 (2.4)</td>
<td>15.3 (2.3)</td>
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<tr>
<td>aCO</td>
<td>57.5 (9.9)</td>
<td>17.1 (6)</td>
<td>16.7 (4.9)</td>
<td>15.3 (2.3)</td>
</tr>
<tr>
<td>COC</td>
<td>55.2 (1.1)</td>
<td>12.1 (0.6)</td>
<td>13.1 (1.6)</td>
<td>13.1 (0.7)</td>
</tr>
<tr>
<td>p-value</td>
<td>0.10</td>
<td>0.35</td>
<td>0.10</td>
<td>0.10</td>
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