FOOTWEAR DESIGN AFFECTS DYNAMIC KNEE LOADS IN KNEE OSTEOARTHRITIS (OA) OF THE KNEE

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Purpose: The onset and progression of knee OA are known to be associated with high dynamic loading of the knee, as assessed by the peak external knee adduction moment (PPdM). We recently demonstrated that in OA of the knee, walking barefoot significantly decreases the PPdM compared to the subjects’ own walking shoes (Arthritis Rheum 54:2923, ’06). These data suggest that footwear may significantly affect joint loads at the knees. However, specific properties of footwear that may be associated with increased joint loading are not clear. We hypothesize that shoe flexibility is an important load-reducing feature. Here, we directly test the effects of several types of common footwear in addition to specifically, the role of footwear flexibility on dynamic knee loading in OA of the knee.

Methods: 30 subjects with radiographic (Kellgren Lawrence grades: 20 grade 2 and 10 grade 3) and symptomatic (at least 30 mm pain on a 100 mm scale while ambulating on a flat surface) knee OA underwent gait analyses using an optoelectronic camera system and multi-component force plate. Subjects were evaluated for gait while wearing (1) flat walking shoes and (2) the same flat shoe modified by cuts in the sole to promote increased flexibility, (3) flip-flops, (4) supportive “stability” shoes (Brooks Addiction), (5) Dansko clogs and (6) barefoot. Subjects walked at their normal walking speed, and comparisons were performed on runs matched for speed. Subjects were permitted to acclimate to each new condition prior to gait testing. The PPdM (%body weight × height, %BW × ht) was calculated and represented the primary endpoint. PPdMs with each shoe type were compared to those during barefoot gait using repeated measures analyses of variance with post-hoc paired contrasts used to compare individual shoe types, p < 0.05 was considered significant.

Results: 20 females and 10 males were evaluated, with mean age (± SD) of 60.3 ± 10 years. Overall, there were significant differences in the PPdM between the different footwear conditions (p < 0.001) (Table). The highest PPdMs were associated with the stable, supportive footwear, the clogs and stability shoes. Both these shoes had significantly higher PPdMs than barefoot as well as both walking shoes and flip flops (p < 0.05). The flat walking shoes (without sole cuts) was associated with significantly higher PPdM than barefoot walking (p = 0.042) as well a significant 4% increase in the PPdM compared to the similar shoes with sole cuts (p = 0.034). There were no significant differences in PPdM between the flat walking shoe with sole cuts, flip-flops, and barefoot walking.

Conclusions: In light of previous studies which demonstrated that high heels are associated with increased peak knee loads, these data confirm that shoe design is a critical feature of dynamic loading at the knee. Furthermore, although several features of footwear may affect loading, this study demonstrates that shoe flexibility is an important load-reducing feature of footwear. Large prospective studies are necessary to assign clinical significance to these findings, however, it appears that flat, flexible footwear are biomechanically advantageous, in terms of knee loading. These findings are particularly relevant in knee OA, where dynamic joint loads are known to be related to pain and disease progression.

129 FOOTWEAR DESIGN AFFECTS DYNAMIC KNEE LOADS IN KNEE OSTEOARTHRITIS (OA) OF THE KNEE

130 RELATIONSHIP OF REGIONAL ADIPOSITY TO KNEE JOINT LOADS IN KNEE OSTEOARTHRITIS

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Purpose: The NIH Obesity Research Task Force recently highlighted understanding the different mechanisms of various fat depots in causing serious health conditions as a major goal. Our purpose was to determine the independent associations between abdominal and thigh fat depots in causing knee OA. These data suggest, for the first time, that regional fat depots also influence knee joint loads independent of BMI, in particular, thigh and abdominal subcutaneous fat were significantly associated with knee compressive forces. A decrease in fat resulted in lower knee compressive forces.

Results: After adjusting for BMI, gender, and walking speed, thigh total fat, thigh subcutaneous fat, abdominal total fat, and abdominal subcutaneous fat were significantly associated with knee compressive forces. A decrease in fat resulted in lower knee compressive forces.

Knee compressive forces and fat regions

<table>
<thead>
<tr>
<th>Fat Region</th>
<th>j (SE)</th>
<th>P-value</th>
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<tbody>
<tr>
<td>Thigh total fat</td>
<td>0.945 (0.466)</td>
<td>0.05</td>
</tr>
<tr>
<td>Thigh subcutaneous fat</td>
<td>0.995 (0.469)</td>
<td>0.04</td>
</tr>
<tr>
<td>Abdominal total fat</td>
<td>0.185 (0.063)</td>
<td>0.01</td>
</tr>
<tr>
<td>Abdominal subcutaneous fat</td>
<td>0.202 (0.081)</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Similar results were obtained for A-P shear forces, patellofemoral compressive forces, and quadriceps muscle forces. Thigh intermuscular fat, abdominal intermuscular fat, and abdominal visceral fat were not significantly associated with any of the knee joint forces. Hamstring muscle force was not significantly related to any thigh or abdominal fat measures, and gastrocnemius force was only related to abdominal subcutaneous fat.

Conclusions: It is well known that obesity is a major risk factor for knee OA. These data suggest, for the first time, that regional fat depots also influence knee joint loads independent of BMI, in particular, thigh and abdominal subcutaneous fat depots.

Bone Biology

131 PERI-ARTICULAR OSTEOPHYES ON THE UPPER AND LOWER EXTREMITIES OF JAPANESE SKELETONS

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Purpose: Peri-articular osteophytes emerge with ageing and develop as the pathological condition of osteoarthritis (OA) progresses. These osteophytes enlarge the surface areas to diminish the mechanical stress on the joint; however, these osteophytes also tend to restrict the range of motion and cause local irritation and pain. Peri-articular osteophytes emerge by enchondral ossification of fibrous cartilage at the synovial bone-cartilage junction. Unfortunately, there have been few studies demonstrating the epidemiological findings of these osteophytes in humans. In this study, peri-articular osteophytes formed around major joint surfaces of the upper