Relationship Between Plantar Foot Pressure and Medial Knee Osteoarthritis

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Introduction: The importance of mechanical contributions to osteoarthritis (OA) is well known. However, the contributions beginning at the initial ground forces at the foot have largely been ignored. Previous studies have shown that patients with medial compartment knee osteoarthritis possess larger knee adduction moments (1). The current thought is that the large adduction moment is due to a varus alignment of the lower extremity, including the foot, as the initial segment in the transmission of ground reactive force to the knee. Therefore, any lateral shift in the center of pressure across the plantar foot should influence forces on the knee and be reflected in a higher incidence of medial knee OA. The purpose of this study was to determine if symptomatic medial knee OA is associated with altered loading across the foot during gait.

Methods: 28 subjects with medial knee OA (symptomatic OA according to the ACR Clinical Criteria for OA, radiographic OA of Kellgren-Lawrence (K-L) grades I-III, predominantly medial disease, and ambulatory knee pain ≥20mm on a 100mm scale per question 1 of the WOMAC) were compared to 20 normal controls that were matched for age, body mass index and gender. WOMAC site-specific surveys for each knee and weight-bearing AP knee X-rays were assessed by a single blinded reader. Exclusions included symptomatic arthritis of the hip, ankle, or foot; structural foot pathology; glucocorticoids within 3 mos.; or any inflammatory arthritis. Each subject walked barefoot over a Musgrave pressure plate (Musgrave Ltd UK) with a sampling rate of 50 Hz. 6 tests were performed on each subject. The center of pressure (COP) was plotted against the longitudinal axis of the foot. The medial to lateral COP index was calculated for each subject by the deviation from the longitudinal axis, and normalized for speed. A positive index suggests an overall medial loading of the foot, whereas a negative index implies lateral loading.

Results: A representative pressure distribution from a normal control is seen in Fig. 1a. The COP trace runs close to the longitudinal axis of the foot. Fig. 1b is a representative pressure distribution from a medial knee OA patient. Here, the COP trace runs far lateral to the longitudinal axis of the foot. The COP indices in the OA group demonstrated high-lateral loading (-6.0±4.3, mean±S.D), whereas the normal controls displayed a more central COP pattern (-1.08±3.4). Student’s t-test demonstrated statistical significance between the two groups (p < 0.0001) (Figure 1). Further evaluation of the OA patients revealed that there was no correlation between the severity of WOMAC pain and the COP (r^2=0.05, p=0.84), nor was there correlation between COP and radiographic severity as determined by K-L grade (r^2=0.19, p=0.41)

Discussion: These data represent the first demonstration that plantar pressure patterns of patients with medial knee OA differ significantly from those of normal control individuals; moreover, the OA patients showed a strong preponderance towards loading the lateral aspect of the foot, as demonstrated by COP data. This result is consistent with the biomechanical concept that abnormal loading at any one site within the kinetic chain of the lower extremity has consequences at distant sites within the chain, and suggests that loading patterns in the feet are related to OA in the knee. It is of course not clear from these data whether the abnormal lateral loading of the foot predisposes the patient to medial knee OA, or vice versa. The fact that there was no correlation either between COP and pain or between COP and radiographic severity may strengthen the argument that lateral loading of the foot precedes clinical knee OA; if the converse were true, that patients with medial knee OA alter their gait toward medial plantar loading to avoid antalgic gait, then a correlation between the severity of OA and the degree of lateral COP would have been expected. A larger, and perhaps longitudinal, study must be carried out to fully determine the relationship between plantar COP both before, and after, the development of medial knee OA. Once there is a clear understanding of the relationship between the biomechanical aspects of foot pressures and joint disease, the manner in which an individual walks may eventually be used, in part, to assess risk for medial knee OA.

Discussion:


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