Therefore, a brace designed to pull the femur into external rotation and augment hip muscle function might be able to lower the internal knee abduction moment during walking. Several studies have utilized the internal knee abduction moment as an estimate of medial knee joint loading. However, to our knowledge, no study has evaluated the effect bracing of the femur will have on tibiofemoral joint kinetics in patients with medial knee OA. The purpose of this study was to determine if a femoral external rotation strap will reduce medial knee joint loading and decrease pain during level walking in patients with medial knee OA.

Methods: Fifteen women and men with medial knee compartment OA (mean age=60.8±9.8 yrs; BMI=28.1±3.7) ambulated over a 10 meter walkway during two conditions: (1) wearing the femoral external rotation strap (braced) and (2) without the strap (unbraced). Five trials were collected at the subject's self selected pace (±5%) for each randomly assigned condition. The brace used in this study was a thin elastic strap that wraps around the femur and the pelvis thus pulling the femur into external rotation. Three-dimensional kinematic data were collected using an 8-camera infrared motion capture system (Motion Analysis Corp, Santa Rosa, CA) while two force plates collected ground reaction force data (AMTI, Boston, MA) during each walking trial. Pain during level walking was assessed with a 100-mm visual analog scale (VAS) during the braced and unbraced conditions. Peak knee and hip moments and angles were quantified during the stance phase of the normal gait cycle using Orthotrack software (Motion Analysis Corp, Santa Rosa, CA). Peak knee and hip moments and angles were averaged across five trials for the braced and unbraced conditions. Paired t-tests with Bonferroni adjustments were utilized for comparisons between the braced and unbraced conditions (α=0.05).

Results: During the braced condition, hip external rotation angles significantly increased (6.0±5.3 °, unbraced; 15.4±5.3°, braced) and hip adduction angles significantly decreased (4.3±2.5°, unbraced; 1.1±2.5°, braced) ($p<0.05$). The strap also resulted in significantly reduced frontal plane pelvic angles (2.6±2°, braced; 4.7±1.8°, unbraced) ($p<0.05$). There was a 28% lower first peak internal knee abduction moment during the braced versus the unbraced condition ($p<0.05$). Sagittal plane hip and knee angles did not change significantly between conditions ($p>0.05$). Likewise, no significant differences were found in frontal or transverse plane knee angles ($p>0.05$). While walking with the hip strap, subject reported a 35% decrease in their reported pain levels.

Conclusion: These data suggest that increasing femoral external rotation and decreasing adduction of the pelvis can result in a lower knee adduction moment in patients with medial knee OA. During the stance phase of gait, the femoral external rotation strap appears to control frontal plane pelvic motion thus possibly causing the changes in the internal knee abduction moment. As the contralateral iliac crest remains elevated, this could move the center mass closer to the knee joint axis thus resulting in a reduction in the knee joint moment. These findings support the strengthening of the hip muscles as a treatment for patients with medial knee osteoarthritis. Enhanced hip muscle strength could reduce pelvic motion and improve hip stability, thereby decreasing medial knee joint forces. Future studies will need to develop specific treatment regiments that target the appropriate hip muscles to produce long-term improvements for patients with medial knee OA.

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PRINCIPAL COMPONENT CLUSTERING OF FRONTAL PLANE KNEE KINEMATICS

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Purpose: To understand knee gait kinematics of knee osteoarthritis (OA) patients, one must first thoroughly investigate asymptomatic gait patterns as these are the benchmarks to which pathological gait is compared. The literature reveals a wide disparity in normal three-dimensional (3D) knee kinematics, particularly for the frontal and transverse planes. These differences have been explained by high inter-subject variability observed in gait patterns. The purpose of this study is to use a clustering technique to assess the presence of different frontal plane knee kinematic patterns of asymptomatic individuals. By doing so, homogeneous features characterizing each group of clustered gait patterns can be identified.

Methods: Knee 3D kinematic data were recorded during the gait of 111 asymptomatic participants while they walked on a conventional treadmill. Data collection was performed on each knee consecutively. For nine of the participants, measurements were only collected on one knee, giving a total of 213 recordings. Markers were positioned on the participant's knee using a knee marker attachment system developed to reduce skin motion artifacts. The position and orientation of the markers were recorded using an electromagnetic motion tracking system. Frontal plane angles were calculated using the Grood and Suntay convention and presented in the form of curves as a function of the normalized (1-100%) gait cycle, giving 100 measurement points for each participant. Before proceeding to data reduction and clustering, data sampling adequacy was assessed performing the KMO index. Outliers were removed using the Mahalanobis distance. The following two steps allowed for the clustering of the gait patterns into homogeneous subgroups: 1) a dimensionality reduction of the original data to two descriptive features using PCA; and 2) a clustering based on principal component (PC) signs: a positive angle value corresponded to a varus alignment, whereas a negative value corresponded to a valgus alignment. Analysis of variance was performed to verify the homogeneity of the groups in terms of anthropometric characteristics. The PC loading vectors were interpreted in relationship to the gait cycle events in order to validate the clinical meaning of the clustering.

Results: The computed KMO value was 0.97 and it indicated that PCA was appropriate to reduce the dimensionality of the original data. The Mahanalobis distance lead to the removal of 11 outliers, leaving 202 abduction/adduction measurements out the initial 213 dataset elements. The first two PC signs were retained since they explained 94% of the variance. Four distinctive subgroups (C_1, C_2, C_3 and C_4) could be clustered based on the two PC signs. The loading vectors indicated that most of the variability could be explained by events of clinical importance occurring during the stance phase (1st PC loading vector) and during the swing phase (2nd PC loading vector). During the stance phase, subgroups C_1 and C_3 showed a close to neutral alignment, while subgroups C_2 and C_4 showed a valgus alignment. Two different strategies were also identified during the swing phase; subgroups C_1 and C_2 adopted a strategy towards a varus alignment, while subgroup C_3 and C_4 showed a valgus alignment. Subgroups C_1, C_2 and C_3 were similar in terms of anthropometric characteristics. However, the participants in subgroup C_4 were younger and had a lower mean body weight than the three other subgroups.

Conclusions: We demonstrated that there are four distinctive knee frontal plane gait kinematic patterns within an asymptomatic population. This study highlights the need to account for inter-subject variability in gait patterns. This means that knee OA frontal plane kinematic data might need to be clustered and compared to a similar asymptomatic reference profile to be able to conclude on the real effect of the disease on knee kinematics.

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NEUROMUSCULAR FUNCTION AND PEAK GROUND REACTION FORCE ARE ALTERED IN THE MENISCECTOMIZED LEG OF PATIENTS AT HIGH RISK OF KNEE OSTEOARTHRITIS

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Purpose: Patients with knee osteoarthritis (OA) experience severe pain and self-report functional limitations. Reductions in physical function have been associated with reduced muscle strength and altered neuromuscular control. However, it is not known if these changes precede of follow as a consequence of the disease. Recently we observed no reductions in muscle strength in middle-aged patients in a 'pre-osteoarthritis' state (i.e. ~2 years post meniscectomy) despite self-reporting pain and functional limitations. However, a clinically relevant difference of ~10% was observed between meniscectomized patients and controls during functional tasks with multiple degrees of freedom. Reduced functional capacity may reflect a movement strategy to minimize pain and to protect the knee joint by reducing range of motion (ROM), movement speed, and ground reaction force (GRF) and may as such be accompanied by altered patterns of neuromuscular activity. The aim of the current study was to identify differences in knee ROM, movement speed, ground reaction forces (GRF) and neuromuscular activity during stair descent in patients meniscectomized for symptomatic degenerative meniscal tears compared with population-based controls. Changes in the neuromuscular activity in prime mover thigh muscles could potentially affect the focal concentration of bone-on-bone contact forces in the knee joint and may precede future muscle strength deficits and contribute to the progression of OA.