throughout stance ($\rho=-0.626$, $p=0.017$) (Fig. 2) and approached statistical significance for the medial shift in COP during the first half of stance ($\rho=0.490$, $p=0.075$). Subjects who responded to the flexible shoe intervention ($n=11$), defined as more than a 5% reduction in KAM at 12 weeks compared to their own shoes at baseline, had a greater medial shift in barefoot COP than subjects who did not respond ($n=3$) ($p=0.008$) (Fig. 2).

**Conclusions:** Over 12 weeks of use, walking with flexible shoes significantly reduces loading at the medial tibiofemoral joint in participants with knee OA and shifts the foot COP medially during barefoot walking. This medialization in foot COP is directly associated with the reduction in dynamic medial knee loading. Understanding these relationships may help design future biomechanical interventions for knee OA as well as make recommendations regarding choice of footwear.

Figure 1. Medial-Lateral Pressure Index (MLPI): MLPI compares the COP line during gait to the anatomical longitudinal center line of the foot, defined as a line connecting the midpoint of the tip of the 2nd toe and the centroid of the heel.

Figure 2. The relationship between the change in KAM and the shift in COP (MLPI). The larger the KAM reduction, the greater the medialization of COP.

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**BIOMECHANICAL AND NEUROMUSCULAR ALTERATIONS IN KNEE OSTEARTHRITIS AND ASYMPTOMATIC CONTROLS: A LONGITUDINAL STUDY**


**Purpose:** Cross sectional studies report differences in knee joint biomechanics and muscle activation patterns during gait among those with different medial compartment knee osteoarthritis (OA) severity and asymptomatic controls, providing evidence of a link between the local joint loading environment and OA progression. Due to a lack of longitudinal data, the effect of time on these patterns and whether those with knee OA experience more rapid changes is unclear. This study sought to determine whether knee joint moment and muscle activation pattern alterations during gait at follow-up were different between those diagnosed with mild/moderate knee OA and asymptomatic controls (ASYM).

**Methods:** Seventy nine participants 35 years or older (ASYM, $n=41$ and OA, $n=38$) had three dimensional lower limb motion, ground reaction forces and surface electromyograms (EMG) from medial and lateral vasti (VM/VL) and hamstrings (LH/MH) muscle sites recorded during self-selected speed walking at two sessions: baseline and follow-up (5+ years later). OA diagnosis was based on clinical and radiographic criteria (Kellgren Lawrence median score $=2$) and mild/moderate classification was based on functional and clinical criteria at baseline. Knee joint moments (flexion-KFM, adduction-KAM and internal rotation-KRM) were calculated from inverse dynamics and were amplitude-normalized to body mass (Nm/Kg). Surface EMG were normalized to maximum voluntary isometric contractions. Moment and EMG Waveforms time-normalized to gait cycle were entered into Principal Component (PC) Analysis models to capture key waveform features. Each participant’s waveform was scored for each PC. Three factor (group, session, sex) ANOVA models tested for main effects and interactions for each PC score ($\alpha=0.05$). Tukey post hoc analyses were performed on significant results.

**Results:** ASYM were younger (47.4±8.1 vs 56.9±7.2 years), had lower BMI (25.5±4.4 vs 30.8±5.8 Kg/m2) and lower WOMAC Total scores (0.2±1.0 vs 28.7±17.9) than OA at baseline. Follow-up sessions occurred 7±1.6 and 7±1.9 years after baseline for ASYM and OA respectively. Related to the study purpose, significant session and session by group interactions only are presented here. Gait speed did not change for the ASYM group (1.39m/s), but was lower at follow-up (1.17m/s) compared to baseline (1.25m/s) for the OA group. Four of 7 moment PC scores were different ($p<0.05$) between sessions: KFM showed prolonged flexion during mid-late stance, higher extension moment peak at heel strike, higher overall KAM magnitude and higher mid-stance KAM amplitude for session 2. Two moment PC scores had group by session interactions ($p<0.05$): ASYM group at session 2 had greater difference between initial peak and mid-stance KAM amplitude compared to OA for both sessions; ASYM had a larger difference between the early external and late internal KRM for session 1 compared to all others, with the late stance KRM for OA session 1 higher than both groups for session 2 (Figure). Three of 12 EMG PC scores had significant ($p<0.05$) session main effects or interactions. Overall MH activity was higher for OA session 2 compared to both ASYM sessions (Figure), but neither group had a session difference. VL had a group by session interaction with the late stance/early swing activity lower in OA session 2 than all others. VM session main effect showed higher activity in late stance/early swing for session 1 versus session 2.

**Conclusions:** Higher overall and mid-stance KAM magnitude and prolonged KFM during mid-late stance at session 2 are features previously associated with higher OA severity. Since they were not specific to the OA group, these features may be more sensitive to aging changes in joint structures. Only one ASYM subject developed symptomatic OA, but 14 OA participants progressed based on a one grade change in medial joint space narrowing (JSN) score, with 5 having maximal JSN at baseline. Decreased gait speed, KAM early to mid-stance magnitude, KRM range, and increased medial hamstring magnitude in the OA compared to ASYM group between sessions are also consistent with pattern alterations from cross-sectional studies of knee OA severity. Interactions indicate a differential response in these features over time with knee OA. In conclusion, specific
moment and neuromuscular patterns during gait were altered between sessions for both groups in the same direction, suggesting age-related changes independent of OA presence whereas other features had differential changes indicating an OA progression response.

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PEOPLE WITH PATELLOFEMORAL OA WALK WITH DIFFERENT KNEE, HIP AND PELVIC KINEMATICS, COMPARED TO HEALTHY AGED MATCHED CONTROLS

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Purpose: Patellofemoral osteoarthritis (PFJOA) is a common disease, affecting 60-70% of those with symptomatic knee OA. To date, few studies have explored movement patterns of individuals with PFJOA. Kinematics of the pelvis, hip and knee have the capacity to influence PFJ loads and, if shown to be different in people with PFJOA, may be the target of physical therapy intervention. This study aimed to assess the kinematics of the knee, hip and pelvis in PFJOA patients, and compare these data to those of healthy, age-matched controls.

Methods: Sixty-nine participants (64% women, mean age 56±10 years) with symptomatic (anterior knee pain aggravated by activities that load the PFJ such as stair ambulation, rising form sitting or squatting) and radiographic (osteophyte in the lateral PFJ on skyline radiographs) OA were recruited, as well as 18 aged-matched controls (78% women, mean age 53±7 years) with no lower limb pain or radiographic OA evident on skyline or postero-anterior radiographs. Knee Injury and Osteoarthritis Outcome Score (KOOS) data were also collected from the PFJOA participants. Quantitative gait analyses were conducted during overground walking at self-selected speed. Calculations of pelvis, hip and knee kinematics were performed over the stance phase. Peak joint angles were identified in the first half of stance (contralateral toe off) and second half of stance (contralateral heel strike). Data were statistically analysed using the Analyses of Co-Variance (ANCOVA), with age and gender as co-variates (p=0.05).

Results: Participants with PFJOA reported KOOS-pain 65±15, KOOS-symptoms 63±16, KOOS-activities of daily living 73±13, KOOS-sport/recreation 45±23 and KOOS-quality of life 43±16. Few differences in peak knee joint angles were observed between PFJOA subjects and controls. PFJOA subjects walked with less knee internal rotation in the second half of stance phase -2 [-4 to 0], compared to controls. At the hip, PFJOA participants walked with less hip extension in the second half of stance 7 [3 to 11], less hip adduction in early stance 2 [-4 to -1], greater hip adduction at second half of stance 3 [1 to 5], and less hip internal rotation in the first half of stance-3 [-7 to -3], compared to controls.

Conclusions: While few differences in knee kinematics were observed in people with PFJOA compared with aged-matched controls, reduced knee internal rotation, increased hip adduction and medial pelvic tilt were observed, and may be associated with increased PFJ loads. Other kinematic differences, such as anterior tilt, may reflect a mechanism to off-load the PFJ. The results of this study may provide a basis for targeted muscle strengthening exercises and bracing to reduce the burden of PFJ OA.

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A QUANTITATIVE ASSESSMENT OF VARUS THRUST DURING WALKING IN WOMEN WITH EARLY AND ESTABLISHED MEDIAL KNEE OSTEOARTHRITIS.

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Purpose: Varus thrust, known as a abrupt worsening of the existing varus during weight-bearing, has been shown to be present in patients with severe knee osteoarthritis (OA) and is considered as one of the risk factors for the incidence and progression of symptomatic medial knee OA. However, the association of varus thrust with increased severity of knee OA has not been studied yet. Therefore, this study compared the varus thrust during gait between patients with early medial knee OA, established OA and healthy controls. We were also interested to investigate the impact of the presence of varus thrust at baseline on functional decline and clinical worsening of the symptoms in women with medial knee OA at a 2-years follow up.

Methods: Eighteen women with early medial knee OA (according to the classification of Luypen et al), sixteen women with established medial knee OA and sixteen healthy controls were evaluated. At baseline and at two-year follow-up, pain, symptoms, and subjective functional ability were assessed using the Knee Injuiy and Osteoarthritis Outcome Score questionnaire, and objective functional ability was assessed using the Timed Up & Go test (TUG) and the Stair Climbing Test (SCT). In addition, varus thrust was measured by 3D motion analysis of normal gait at preferred speed, as an increase of the knee varus angle during the weight-bearing phase of gait.

Results: Both early and established OA groups reported significantly more knee pain and symptoms and worse functional ability compared to controls at baseline and also at two-year follow-up. However, none of the objective functional measures (SCT and TUG) were significantly different between the three groups. Varus thrust was significantly higher in both early and established OA subjects compared to the control group (p <0.001 and p =0.003, respectively).

In addition, the amount of varus thrust at baseline was significantly correlated with functional objective measures at follow-up (pTUG<0.010, pSCT<0.023). Moreover, baseline varus thrust was also significantly correlated with pain (pBaseline<0.001, pFollow-up<0.004), symptoms (pBaseline=0.008, pFollow-up=0.047) and ADL (pBaseline<0.001, pFollow-up<0.001) at both baseline and follow-up.

Conclusions: Higher values of varus thrust were found both in early and established stages of OA, suggesting that problems with dynamic stabilization of the knee are present already in the very beginning of knee OA, suggesting that varus thrust is probably not a result of disease progression. Varus thrust at baseline was related with poor subjective (ADL) and objective (SCT and TUG) physical function at two-year follow up, which may imply that varus thrust is a problem that has to be addressed in rehabilitation programs.