Methods: Twelve subjects with a traumatic-onset meniscal tear were recruited for this study (11 males; mean age: 19.5 ± 18.3 years; 10 lateral tears/2 medial tears). Testing consisted of gait analysis and questionnaires. Retro-reflective markers were placed prior to five walking trials at a self-selected speed. Marker position was recorded with a motion capture system (Motion Analysis Corp), and ground reaction forces were recorded with two force platforms (Advanced Mechanical Technology Inc). The stance phase was analyzed bilaterally, and the variables were sagittal plane knee angle excursion during weight acceptance and from the end of weight-acceptance to midstance, and peak vertical ground reaction force (PVGRF) at heel strike and toe-off. Subjects self-reported knee pain intensity on the 11-point (0–10) numeric rating scale (NRS), fear of movement/re-injury on the shortened Tampa Scale for Kinesophobia (TSK-11), and pain catastrophizing on the Pain Catastrophizing Scale (PCS). Knee angle excursions and PVGRFs were compared between sides with paired t-tests. If a significant difference was found, the magnitude of asymmetry was computed (knee angle excursion: uninjured side-injured side; PVGRF (injured side/uninjured side) *100). Pearson’s Product Moment correlation determined the association between gait asymmetry and questionnaire scores.

Results: Gait variables and questionnaire scores are reported in the Table. Knee angle excursion during weight acceptance and from weight acceptance to mid-stance was reduced on the injured side compared to the uninjured side (p = 0.009 and p = 0.023, respectively). PVGRF at heel strike and toe-off was not significantly different between sides (p = 0.794 and p = 0.869). The asymmetry in knee angle excursion during weight acceptance was negatively correlated with NRS score (r = -0.580, p = 0.048). The asymmetry in knee angle excursion from weight acceptance to midstance was negatively correlated with TSK-11 score (r = -0.833, p = 0.001).

Conclusions: Knee angle excursion on the injured side was reduced during the stance phase of gait in people with traumatic meniscal tear. During weight acceptance, knee pain intensity increased as the magnitude of asymmetry decreased; and from the end of weight acceptance until midstance, fear of movement/re-injury increased as the magnitude of asymmetry decreased. Thus, subjects with greater knee motion on the injured side displayed elevated pain and fear of movement/re-injury. These data indicate a potential link between biomechanical measures and relevant psychosocial factors from the fear-avoidance model. Although mean PVGRF was not significantly different between sides, asymmetry was as high as 12% (either under- or over-loading on the injured side) for some subjects.

Table: Gait variables and questionnaire scores

<table>
<thead>
<tr>
<th></th>
<th>Uninjured Side</th>
<th>Injured Side</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee angle excursion during weight acceptance (°)</td>
<td>12.0 (4.0)</td>
<td>9.1 (2.9)</td>
<td>2.0</td>
</tr>
<tr>
<td>Knee angle excursion from weight acceptance to midstance (°)</td>
<td>6.0 (2.8)</td>
<td>3.3 (2.3)</td>
<td>2.0</td>
</tr>
<tr>
<td>PVGRF at initial contact (N)</td>
<td>1350.0 (385.6)</td>
<td>1093.4 (262.0)</td>
<td>2.0</td>
</tr>
<tr>
<td>PVGRF at toe-off (N)</td>
<td>1060.0 (287.5)</td>
<td>805.2 (360.6)</td>
<td>2.0</td>
</tr>
<tr>
<td>NRS Score</td>
<td>3.3 (2.3)</td>
<td>12.2 (3.1)</td>
<td>2.0</td>
</tr>
<tr>
<td>TSK-11 Score</td>
<td>22.3 (3.1)</td>
<td>12.8 (3.8)</td>
<td>2.0</td>
</tr>
</tbody>
</table>

182
THE EFFECTS OF CHANGES IN BODY COMPOSITION ON DYNAMIC KNEE JOINT LOADING
A. Boulayopoulos1, T.B. Birmingham2, D. Olver2, P. Lemon2, J. Giffen1, K. Leitch1. 1Wolf Orthopaedic Biomechanics Laboratory, London, ON, Canada; 2The Univ. of Western Ontario, London, ON, Canada; 1Fowler Kennedy Sport Med. Clinic, London, ON, Canada

Purpose: Most patients with varus gonarthrosis experience abnormally high loads on the medial compartment of the tibiofemoral joint due to the combination obesity and malalignment. Fat loss and functional strengthening programs are suggested to improve body composition and knee joint health, particularly by decreasing the load borne by the joint during walking. The purpose of this study was to compare measures of knee function in patients with varus alignment and medial compartment knee osteoarthritis before and after a comprehensive physiotherapy program targeting changes in body composition.

Methods: Twelve patients (age: 52 ± 43 years, BMI: 28 ± 3 kg/m²) with varus alignment and medial compartment knee osteoarthritis who were referred to an orthopaedic surgeon volunteered. Participants completed an 8-week, physiotherapist-supervised, group-based, lower extremity strengthening and balance program (2days/week), supplemented with fat loss and body composition seminars (1day/week). We evaluated changes in percent body fat, fat mass and lean body mass using air displacement plethysmography (Bod-Pod), knee extension and flexion strength using an isokinetic dynamometer (peak torque at 60°/sec), and walking gait using an eight-camera motion capture system synchronized with a floor-mounted force platform. We focused on gait speed, the external adduction moment about the knee, including its vertical ground reaction force and frontal plane lever arm. We also evaluated changes in the six minute walk, the lower extremity functional scale (LEFS), the Knee Injury and Osteoarthritis Outcome Score (KOOS) and the Physical Component Score of the Short Form 12 (SF-12) health status questionnaire. We evaluated mean changes with paired t-tests and 95% confidence intervals (CI). We then explored correlations between changes in selected variables.

Results: Two participants dropped out of the study due to stated time constraints. The remaining participants completed the program without adverse events. Percent body fat (mean change; 95% CI = -3.3%; -4.4, -2.2%) and fat mass (mean change; 95% CI = -4.7 kg; -6.4, -3.0 kg) decreased without significant changes in lean body mass (mean change; 95% CI = 0.2 kg; -1.5, 1.1 kg). Knee extension strength (mean change; 95% CI = 3.4 Nm; 12.0, 58.8 Nm) and flexion strength (mean change; 95% CI = 25.7 Nm; 8.8, 42.6 Nm) increased. Only the KOOS pain domain (mean change; 95% CI = 8.6; 0.0, 17.5) and the SF-12 Physical Component Scores (mean change; 95% CI = 6.0; 1.4, 10.5) improved after the program. Walking speed also increased (mean change; 95% CI = 0.08 m/sec; 0.0, 0.16 m/sec). Although peak vertical ground reaction force during walking did indeed decrease after the program (mean change; 95% CI = -36.7 N; -67.6, -5.9 N), the peak knee adduction moment (mean change = 2.5 Nm; -2.7, 7.7 Nm) and frontal lever arm (mean change; 95% CI = -0.42 cm; -1.0, 0.71 cm) did not (Figure 1). The decrease in overall body mass (mean change = -4.49 kg, -6.6, -2.4 kg) was significantly correlated to...
change in ground reaction force ($r = 0.63 \ p = 0.05$), but not to change in knee adduction moment ($r = 0.12, \ p = 0.74$).

**Conclusions:** These findings suggest patients with varus alignment and medial compartment knee osteoarthritis can experience substantial improvements in body composition and muscular strength, resulting in modest improvements in pain and function, without concomitant decreases in knee joint loading. Although potential decreases in internal loading not assessed with the present methods cannot be ruled out, these results are consistent with the major role that malalignment plays in dynamic loading of the medial compartment of the tibiofemoral joint. The findings also emphasize the potential benefit of supplementing programs that improve body composition with interventions intended to improve malalignment.

**183**

**THE EFFECTS OF NORDIC WALKING POLES ON MECHANICAL KNEE JOINT LOADING IN INDIVIDUALS WITH MEDIAL COMPARTMENT KNEE OSTEOARTHRITIS**

D.J. Bechard, T.B. Birmingham, K.M. Leitch, T.R. Jenkyn, J.R. Giffin, the Univ. of Western Ontario, London, ON, Canada

**Purpose:** Walking poles have become popular devices promoted to lessen the load on the knee while enabling increased physical activity. The purposes of this study were to (1) evaluate the effect of walking poles on the knee adduction moment in patients with knee OA compared to unaided gait, and (2) explore the effect of various pole-walking techniques. We hypothesized that using poles would decrease the knee adduction moment due to reductions in vertical ground reaction force, and that the degree of reduction would depend on the force and angle of the pole.

**Methods:** We assessed 3-dimensional kinematics and kinetics during walking of 34 patients with medial compartment knee OA. We randomly allocated the order of walking trials with and without poles and controlled walking speed to ±5%. We considered the knee adduction moment the primary outcome measure. We also analysed vertical ground reaction force, frontal plane lever arm, trunk lean, and the kinematics and kinetics of the pole at the time of first peak knee adduction moment. We evaluated changes with paired t-tests and 95% confidence intervals.

**Results:** There was a significant increase in first peak knee adduction moment (2.88 ± 0.79 vs. 2.71 ± 0.78 kgBW*H, $p = 0.001$) and impulse (1.53 ± 0.46 vs. 1.37 ± 0.42 kgBW*Hs, $p = 0.001$) with the poles. Although vertical ground reaction force decreased with poles at the time of first peak knee adduction moment (0.99 ± 0.09 vs. 1.02 ± 0.08 BW, $p = 0.005$), lever arm increased (5.27 ± 1.45 vs. 4.97 ± 1.35 cm, $p < 0.001$), likely due to a decrease in trunk lean (0.12 ± 0.70 vs. 1.33 ± 1.65 degrees, $p = 0.001$). Change in first peak knee adduction moment was significantly correlated with the force applied through the pole in the vertical direction ($r = 0.34, \ p = 0.05$), but not with sagittal plane pole angle ($r = 0.25, \ p = 0.16$).

**Conclusions:** These results suggest walking poles cause a small increase in knee joint load (mean difference = 0.17%BW*H, 95% CI = 0.08, 0.27), despite a reduction in vertical ground reaction force. This increase may vary with how the force applied through the poles, suggesting that future research evaluating technique is warranted. Users of these devices should weigh the benefit of increased activity to the slightly higher knee joint load.

**184**

**ASSOCIATION BETWEEN TRUNK CONTROL AND GAIT SPEED IN KNEE OSTEOARTHRITIS: A CROSS-SECTIONAL STUDY**


1Singapore Gen. Hosp., Singapore, Singapore; 2The Univ. of Melbourne, Melbourne, Australia

**Purpose:** Knee osteoarthritis (OA) adversely affects walking ability in older adults more than any other diseases, and a constellation of OA-related physical impairments affects walking speed, in which knee pain, muscle weakness and loss of knee range-of-motion have been implicated. Thus far, no knee OA studies have investigated the role of trunk control – that is, the strategic posturing and re-positioning of the upper body – in influencing gait performance; yet, there are good neurobiomechanical reasons to think that trunk control may be an important correlate. The purposes of this study were (i) to determine the discriminatory ability of trunk control in assessing poor gait speed, and (ii) to evaluate whether trunk control was a multivariate predictor of gait speed, and above the effects of conventional knee impairments in patients with end-stage knee osteoarthritis.

**Methods:** Eighty-four adults with end-stage knee osteoarthritis awaiting total knee replacement (mean age, 68 years) participated. Trunk control was quantified by the centre of pressure (COP) displacements during quiet sitting on a portable forceplate (Nintendo Wii Balance Board) placed on a height-adjustable plinth. The seated position was chosen to allow better isolation of the postural control of the lumbar spine from that of the lower limbs. Isometric knee extensor strength was measured using an isokinetic dynamometer; knee flexion range of motion, an extendable goniometer; and knee pain, a numeric pain rating scale. Fast-paced gait speed was assessed by the 10-meter walk test and a poor gait speed was defined as a cutoff value of 1.0 meter/second.

**Results:** Patients with poor gait speed had higher seated COP excursions compared with patients without poor gait speed ($r = 0.79 \ p < 0.001$), likely due to a decrease in trunk lean ($r = 0.79, \ p < 0.001$). Change in ground reaction force ($r = 0.63, \ p = 0.05$), but not with sagittal plane pole angle ($r = 0.25, \ p = 0.16$).

**Conclusions:** This study is the first to quantify the role of trunk control in assessing poor gait speed, and to evaluate whether trunk control was a multivariate predictor of gait speed, and above the effects of conventional knee impairments in patients with end-stage knee osteoarthritis.

**Fig. 1.** An ensemble curve (n = 34) of the knee adduction moment, vertical ground reaction force, and lever arm over 100 percent stance with and without the use of walking poles. 95% confidence intervals are shown at the time of the first peak knee adduction moment. *$p = 0.001$.**