Methods: Gait analysis of 2,900 patients from AposTherapy dataset (ApósTherapy, Herzeliya, Israel) suffering from knee OA were included in the study. Men and women were analyzed separately. The analysis included three stages - clustering, classification and clinical validation. Clustering of gait analysis data by the kmeans method created four groups. Two thirds of the patients were used to create a simplified classification tree algorithm. The model's accuracy was checked by using the remaining one third of the patients. Clinical validation of the classification method was done by SF-36 and WOMAC questionnaires.
Results: The clustering algorithm divided the data to four groups according to gait analysis severity. The classification tree algorithm used stride length and cadence as predicting variables for classification. The correct classification accuracy was 89.5%, and 90.8% for women and men, respectively. Clinical scores of the WOMAC and SF-36 questionnaires correlated well according to severity group. For example, in women, the rate of total knee replacement within a year after the gait analysis was 1.4%, 2.8%, 4.1% and 8.2% for knee OA grades 1-4, respectively.
Conclusions: Spatio-temporal gait analysis can be used to classify patients with knee OA according to disease severity. The most differentiating variables for classification are stride length and cadence. Furthermore, gait analysis based on disease grading correlated with clinical data of pain, function and quality of life.

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KNEE POWER IS AN IMPORTANT PARAMETER IN UNDERSTANDING MEDIAL KNEE JOINT LOAD IN KNEE OA

K.M. Calder, N. Arora, K.A. Beattie, J.D. Adachi, M.R. Maly. *McMaster Univ., Hamilton, ON, Canada*

Purpose: The progression of knee osteoarthritis (OA) is facilitated by excessive knee loading. Theoretical models of knee joint loads demonstrate that muscular contributions likely relate strongly to the load transmitted through the knee. The relationship between knee loading with muscle strength and muscle power in people with knee OA remains unclear. The purpose of this study was to determine the extent to which the variance in knee extensor strength and power explain variance in loading magnitudes in participants with clinical evidence of knee OA.
Methods: Participants between the ages of 40-70 who met the American College of Rheumatology clinical criteria for OA were recruited. The knee adduction moment (KAM) was measured during gait trials using Optotrak Certus position sensors (NDI, Waterloo, Canada) and a synchronized floor-mounted force plate (AMTI, Watertown, MA, USA). Rigid, infrared marker clusters were secured to the sacrum, thigh, shank and foot of the study leg. Participants ambulated barefoot at self-selected speeds until five trials were captured. The KAM waveform was generated using inverse dynamics using commercial software (Visual 3D, C-Motion, Inc., Germantown, MD, USA). Loading magnitude was quantified as the mean non-normalized knee adduction moment impulse to reflect the total medial knee load encountered during gait. Muscular contributions were knee extensor strength and power. For strength, five maximal effort isometric knee extensor (MVIC) contractions were performed with the knee at 60°, where the peak torque value was normalized to body mass (Nm/kg). For power, ten isotonic contractions with the resistance set at 25% of MVIC were performed as quickly as possible to measure power (Watts), where the middle 5 contractions were averaged and represented knee extensor power. Covariates included age, sex, knee pain and obesity. Knee pain was measured using the pain subscale of the Knee Injury and Osteoarthritis Outcome Score (KOOS-pain) while obesity was characterized by abdominal circumference (mm). The relationship between loading magnitude with knee extensor strength and power was examined using two sequential forward linear regression models, after controlling for age, sex, knee pain and obesity.
Results: Fifty-three adults (61.6 $\pm$ 6.3 years, 11 men) participated. Loading magnitude was correlated with sex (r=-0.29, p<0.05), where males had greater loading magnitudes than females (13.61$\pm$10.72 and 8.82$\pm$4.86; p<0.05). Loading magnitude was also correlated with abdominal circumference (r=0.46, p<0.05), and knee extension power (r=0.44; p<0.05). Regression analysis between loading magnitude and knee extensor strength showed that 22% of the variance in the loading magnitude was explained by the covariates in the model (p=0.003), not knee extensor strength (p=0.66). Regression analysis between loading magnitude and knee extension power revealed that 30.2% of the variance in loading magnitude was explained by the model (p=0.01), with knee power contributing 9.2% (p<0.05).
Conclusions: Knee extensor power is a more important parameter than isometric knee strength in understanding loading magnitude during gait in knee OA. Further examination into the relationship between knee power and knee OA may provide insight into loading and muscular changes during symptomatic and structural disease progression.

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ALTERATIONS IN SAGITTAL-PLANE KNEE JOINT KINEMATICS AND KINETICS DURING GAIT IN KNEE OSTEOARTHRITIS PATIENTS WITH COMPLAINTS OF INSTABILITY

S. Farrokhi, M. O'Connell, A. Gil, G. Kelley Fitzgerald. *Univ. of Pittsburgh, Pittsburgh, PA, USA*

Purpose: Self-reported knee instability, described as subjective sensation of buckling, shifting, or giving way of the knee joint, is often reported by patients with knee osteoarthritis (OA). While previous research efforts have primarily focused on determining the associations between knee joint instability and physical impairments such as knee joint laxity and quadriceps weakness in knee OA patients, little work has been done to investigate dynamic knee joint function during a functional activity. To this end, findings from population-based studies suggest that episodes of knee instability are significantly associated with both self-reported and performance-based functional deficits. Therefore, the purpose of the present study was to evaluate the differences in knee joint biomechanics during gait in knee OA patients with and without self-reports of instability.
Methods: Sixty nine patients with knee OA (radiographic disease severity $\geq$ 2) were divided into two groups of Knee OA Stable (N=47; 59.1% female, mean age 64.0$\pm$8.4 years, body mass index 28.6$\pm$4.9 Kg/m^2) and Knee OA Unstable (N=22; 46.8% female, age 61.0$\pm$7.1 years, body mass index 30.9$\pm$5.4 Kg/m^2). Knee OA patients were included in the Unstable group only if they reported knee instability ratings of $\leq$ 3 on the knee stability scale which indicates that the symptom of instability affected their ability to perform activities of daily living. All patients underwent instrumented gait analysis at a self-selected speed in a biomechanics laboratory. Knee joint angles and external knee joint moments were quantified and evaluated for all subjects for the weight acceptance, single limb stance, and pre-swing phases of gait. Independent sample t-tests were used to evaluate between-group differences at a significance level of P < 0.05.
Results: Both groups walked with similar self-selected gait velocities. Additionally, group comparisons revealed similar knee joint angles and knee joint moments during the weight acceptance phase of gait. However, compared to the OA Stable group, knee OA patients in the Unstable group walked with significantly greater average knee flexion angles during the single limb stance (14.2°$\pm$7.0° vs. 10.4°$\pm$5.1°; P = 0.01) and pre-swing phases of gait (24.3°$\pm$5.2° vs. 20.0°$\pm$5.6°; P < 0.01). Patients in the OA Unstable group also walked with larger average knee flexion moments during both the single limb stance (0.32$\pm$0.2 Nm/kg vs. 0.17 $\pm$0.3Nm/kg; p = 0.04) and pre-swing phases of gait (0.25$\pm$0.2 Nm/kg vs. 0.17 $\pm$0.2Nm/kg; p = 0.05).
Conclusions: The observed increase in average knee flexion angle during the single limb stance and pre-swing phases of gait in this study differ from current theories that associate knee instability with a joint stiffening strategy in patients with knee OA. The increase in knee flexion angle during weight-bearing increases the need for greater quadriceps force to control the associated increases in external flexion moments. Increased quadriceps force, in turn, may represent a strategy to provide dynamic stability by creating larger joint compressive forces. However, stabilizing the knee joint through increased joint compression may have deleterious long-term consequences in terms of hastening the rate of disease progression which requires further investigation. Additional research to better elucidate the relationship between knee joint instability and altered joint biomechanics during various functional tasks in knee OA patients with reports of instability are warranted to determine whether they are helpful or harmful compensations.

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EARLY CHANGES IN SAGITTAL PLANE KNEE BIOMECHANICS AFTER TOTAL KNEE ARTHROPLASTY

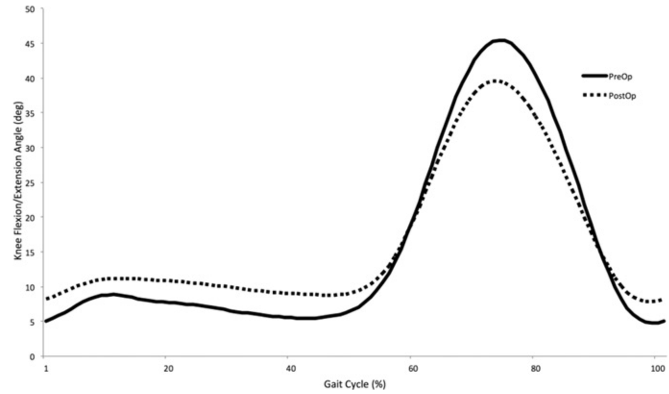
E.M. Debbi[†], B. Bernfeld[‡,§], E. Gray[‖], M. Salai[¶], Y. Levy[¶], A. Gold[¶], R. Debi[#], A. Wolf[†]. [†] *Biorobotics and Biomechanics Lab, Faculty of*

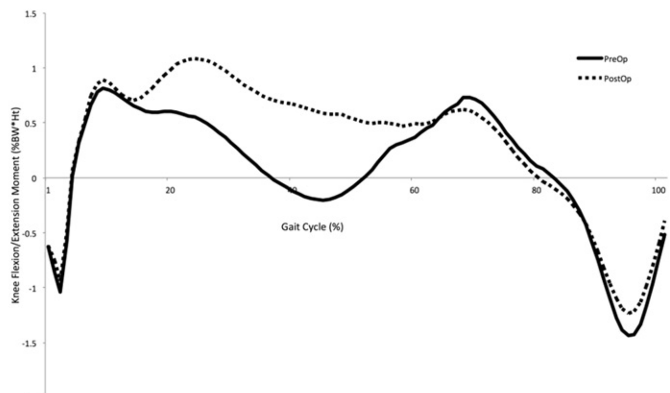
Mechanical Engineering, Technion Israel Inst. of Technology, Haifa, Israel; [‡]Dept. of Orthopedic Surgery, Carmel Med. Ctr., Haifa, Israel; [§]Elisha Hosp., Haifa, Israel; [‖]Sackler Sch. of Med., Tel Aviv Univ., Tel Aviv, Israel; [¶]Div. of Orthopedics, Sourasky Med. Ctr., Tel Aviv, Israel; [#]Dept. of Orthopedic Surgery, Barzilai Med. Ctr., Ashkelon, Israel

Background: Total knee arthroplasty (TKA) is most commonly used for end-stage knee osteoarthritis (OA). TKA procedures are expected to number over 3 million by 2030 in the United States alone. Although TKA is generally successful at reducing pain and improving quality of life after surgery, several studies on the long-term effects of TKA on the biomechanics of the operated knee have shown poor gait patterns postoperatively. Most of these abnormalities have been found in the sagittal plane. Specifically, there is limited knee flexion-extension range of motion postoperatively as well as poor flexion-extension moments. Studies have related these findings to “stiff knee” muscle activation patterns due to habits developed preoperatively, as well as proprioceptive deficiency, instability and quadriceps weakness leading to a “quadriceps avoidance gait”.
There is, however, a lack of information on the early postoperative sagittal plane biomechanics after TKA, as well as adequate comparisons to gait patterns preoperatively. The present study was designed to examine the early biomechanical TKA outcomes in the sagittal plane of the knee to determine if they reflect patterns before surgery or change significantly after surgery. Furthermore, outcomes were examined across different knee prosthetics to determine if differences exist between knee designs.
Methods: Fifty patients were examined before and two months after TKA. Patients underwent a 3D gait analysis using the Vicon Motion Analysis system (Oxford Metrics Ltd., Oxford, UK) and completed the VAS scale for pain. Knee prosthetics included either PCL-retaining or PCL sacrificing, and custom fit design or not.
Results: Results are presented in Table 1. Although pain showed a significant decrease of 21% postoperatively ($p<0.001$), knee flexion-extension range of motion decreased significantly by 22% ($p<0.001$). Knee flexion angle and moment did not change significantly postoperatively ($p=0.231$ and 0.169, respectively) (Figure 1 & 2). Knee extension angle, moment and impulse were significantly worse postoperatively than preoperatively (all $p<0.01$), and extension impulse showed a significant positive correlation of 0.4 with BMI ($p<0.05$) (Figure 1 & 2). Spatiotemporal parameters did not show significant changes after surgery. Gait differences were not found between prosthetic types, age or BMI, but female patients had greater knee extension postoperatively than males.
Conclusions: Knee biomechanics in the sagittal plane worsen significantly in the early postoperative period after TKA. These changes are consistent across different TKA prosthetic designs. When considering long-term postoperative studies, these results suggest that the knee biomechanics of gait in the sagittal plane will improve with time, but they will not reach the levels of function of healthy individuals. Although postoperative training usually involves muscle strengthening and flexion-extension exercise, there may be a need to apply these exercise in a dynamic, walking form. This may help improve early and even long-term gait patterns postoperatively.

Knee Biomechanics in the Sagittal Plane Before and After Total Knee Arthroplasty

Parameter	Preoperative	Two Month Follow-Up	Significance
Pain Symptoms			
Visual Analog Scale for Pain	7.2±2.0	5.7±2.0	P<0.001**
Kinematic Parameters			
Peak Flexion Angle in Stance (deg.)	10.2±7.3	12.2±6.4	P=0.071
Peak Extension Angle in Stance (deg.)	4.5±6.7	7.9±6.3	P=0.005**
Peak Flexion Angle in Swing (deg.)	47.3±10.6	41.2±9.0	P=0.001**
Range of motion (deg)	42.9±10.3	33.4±8.7	P<0.001**
Kinetic Parameters			
Peak Flexion Moment (%BW*Ht)	1.4±1.1	1.6±1.3	P=0.231
Flexion Impulse	28.7±26.3	35.4±31.5	P=0.169
Peak Extension Moment (%BW*Ht)	-1.0±1.3	-0.32±0.89	P<0.001**
Extension Impulse	-25.6±31.3	-11.3±19.8	P<0.001**





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DOES A REDUCTION IN KNEE LOADING CONSTITUTE A REDUCTION IN PAIN WHEN WEARING LATERAL WEDGE INSOLES?

R.K. Jones[†], G.J. Chapman[†], M.J. Parkes[‡], L.M. Forsythe[‡], D.T. Felson[‡]. [†]*Univ. of Salford, Salford, United Kingdom;* [‡]*Univ. of Manchester, Manchester, United Kingdom*

Purpose: Previous research has shown that lateral wedge insoles reduce the external knee adduction moment (EKAM) during gait and stair ascent and descent. However, recent randomised trials have failed to find a reduction in knee pain with the use of lateral wedge insoles. Around 30% of individuals have an increase (biomechanical non-responder) in their EKAM with lateral wedge insoles, which suggests that if biomechanical responders and non-responders are looked at separately, a potential relationship between EKAM and pain reduction may be seen. Therefore, the hypotheses of this paper were to determine whether lateral wedge insoles produce an immediate pain reduction during walking and secondly; if a change in EKAM has any relationship with this immediate change in pain when wearing lateral wedge insoles.
Methods: We studied participants with painful medial knee OA who noted pain on walking. In a one day study, they all tried three treatments with the order of the treatments randomised, two different lateral wedge insoles and a control shoe. The major difference between the lateral wedge insoles (Boston and Salford) is one has a medial arch support (Salford). During trials, lateral wedge insoles were inserted into the control shoes and were worn bilaterally. During each treatment, participants underwent a 3D kinematic (Qualysis OQUS, Sweden) and kinetic (AMTI, USA) analysis. As they completed each treatment, participants were asked to compare the knee pain experienced while walking to pain when wearing their own shoes and were asked to score this pain on a 5-point Likert scale scored from much worse to much better than their own shoes. We classified participants as biomechanical responders; if participants had a decreased EKAM wearing both lateral wedge conditions (compared to the control shoe). Biomechanical