by demonstrating the convergent validity of the seated balance measures with gait performance, our results support the repurposing of the Wii Board as a cheap, practicable, and novel assessment tool of seated balance.

Table 1. Sociodemographic and functional characteristics of the study group (*n*=84)*

Variables	All Patients (n=84)	Gait speed <1.0m/s (n=33)	Gait speed ≥1.0m/s (n=51)	*P* value†
Age, years	67.7 ± 7.2	71.6 ± 6.1	65.1 ± 6.8	<0.001
Female sex, no. (%)	62 (74)	29 (88)	33 (65)	0.023
Height, m	1.56 ± 0.07	1.53 ± 0.06	1.58 ± 0.07	0.001
Mass, kg	65.5 ± 13.2	66.9 ± 12.2	64.6 ± 13.8	0.44
BMI, kg/m^2	27.1 ± 5.0	28.7 ± 5.1	26.1 ± 4.7	0.02
Bilateral symptoms, no. (%)	56 (67)	22 (67)	34 (67)	1.00
Gait speed, m/s	1.06 ± 0.29	0.77 ± 0.18	1.24 ± 0.17	<0.001
Knee impairments				
Body mass adjusted knee extensor strength, Nm/kg	1.14 ± 0.47	0.94 ± 0.36	1.27 ± 0.49	0.001
Knee pain (/10)	3.48 ± 1.70	3.53 ± 1.74	3.45 ± 1.69	0.84
Knee flexion range of motion, degrees	113.3 ± 14.6	107.6 ± 14.4	116.9 ± 13.6	0.004
Seated balance measures				
Range ML, cm	0.53 (0.71)	0.59 (0.24)	0.51 (0.27)	0.037‡ (0.08; 0.01 to 0.16)
Standard Deviation ML, cm	0.095 (0.18)	0.11 (0.059)	0.090 (0.076)	0.08 (0.016; -0.002 to 0.032)
Range AP, cm	0.40 (1.11)	0.44(0.23)	0.31(0.25)	0.017 (0.11; 0.02 to 0.18)
Standard Deviation AP, cm	0.080 (0.28)	0.089(0.07)	0.062 (0.06)	0.017 (0.023; 0.003 to 0.042)

* Values are the mean ± SD or median (interquartile range) unless otherwise indicated. BMI = body mass index; ML= mediolateral; AP=anteroposterior.

† Student's *t*-test was used for comparison of continuous variables. Exact chi-square test was used for comparison of categorical variables.

‡ Between group differences in seated balance were assessed using exact Wilcoxon-Mann-Whitney test. The values between parentheses are the Hodges-Lehmann estimator of median differences and 95% CI.

Table 2. Optimal cutpoints for seated balance measures to identify patients with poor gait speed (<1.0m/s), based on receiver-operating characteristic curves (*n*=84)*

	Cutpoint (cm) (Youden Index)	n	AUC (95% CI)	Sensitivity (%) (95% CI)	Specificity (%) (95% CI)	Positive LR† (95% CI)
Range ML	0.56 (0.29)	36	0.64 (0.52 to 0.75)	61 (44 to 75)	69 (55 to 0.80)	1.9 (1.2 to 3.2)
Standard Deviation ML	0.010 (0.27)	37	0.62 (0.50 to 0.73)	61 (44 to 75)	67 (53 to 0.78)	1.8 (1.1 to 2.9)
Range AP	0.34 (0.37)	50	0.65 (0.54 to 0.77)	82 (66 to 91)	54 (41 to 68)	1.8 (1.3 to 2.6)
Standard Deviation AP	0.062 (0.30)	51	0.65 (0.54 to 0.77)	82 (66 to 91)	55 (41 to 68)	1.8 (1.3 to 2.6)

*95% CI = 95% confidence interval; LR= likelihood ratio; AUC = Area under the receiver-operating characteristic curve; n= number of patients whose seated balance measures fell above the cutpoint; ML= mediolateral; AP=anteroposterior.

†The positive likelihood ratio is the ratio of posttest odds to pretest odds given a positive test result.

Table 3. Multivariable models of the association of fast-paced gait speed with seated balance measures (*n*=84)*

Variables	β ± SE	*P* value
Model 1 (Adjusted R^2 = 0.54†)		
Age	-0.02 ± 0.003	<0.001
Gender	-0.23 ± 0.061	<0.01
Body mass	-0.005 ± 0.002	0.01
Knee pain	-0.025 ± 0.014	0.09
Knee flexion range of motion	0.0019 ± 0.002	0.24
Knee extensor strength	0.096 ± 0.056	0.08
Range ML	-0.24 ± 0.13	0.07
Model 2 (Adjusted R^2 = 0.50†)		
Age	-0.02 ± 0.003	<0.001
Gender	-0.24 ± 0.061	<0.01
Body mass	-0.005 ± 0.002	0.01
Knee pain	-0.027 ± 0.014	0.07
Knee flexion range of motion	0.0019 ± 0.002	0.23
Knee extensor strength	0.09 ± 0.056	0.13
Standard Deviation ML	-1.109 ± 0.52	0.03
Model 3 (Adjusted R^2 = 0.52†)		
Age	-0.02 ± 0.003	<0.001
Gender	-0.21 ± 0.062	<0.01
Body mass	-0.004 ± 0.002	0.02
Knee pain	-0.022 ± 0.014	0.13
Knee flexion range of motion	0.0022 ± 0.002	0.19
Knee extensor strength	0.113 ± 0.056	0.05
Range AP	-0.09 ± 0.11	0.40
Model 4 (Adjusted R^2 = 0.52†)		
Age	-0.02 ± 0.003	<0.001
Gender	-0.21 ± 0.061	<0.01
Body mass	-0.004 ± 0.002	0.03
Knee pain	-0.022 ± 0.014	0.12
Knee flexion range of motion	0.0021 ± 0.002	0.20
Knee extensor strength	0.111 ± 0.056	0.05
Standard Deviation AP	-0.38 ± 0.43	0.38

*Data are unstandardized regression coefficients ± standard errors. Gender (1=men, 2=women); ML= mediolateral; AP=anteroposterior.

† *P*<0.001.

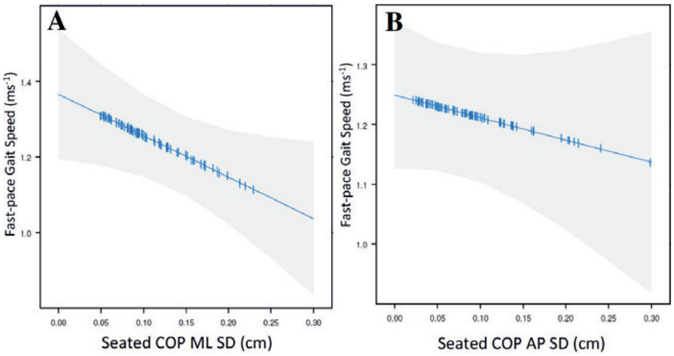

Fig. 1. Partial effects plots of fast-pace gait speed with seated COP ML SD (A) and seated COP AP SD (B) variables, adjusted for demographic, antthropometric, and knee impairment variables. The estimate is indicated by the solid line and the 95% confidence intervals by the shaded (grey) regions. The seated COP SD values fo all patients are indicated by short vertical lines on the regression line. Partial regression coefficient for COP ML SD = −1.10, $P = 0.03$; partial regression coefficient for COP AP SD = −0.38, $P = 0.38$.

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CAN WE PREDICT RESPONDERS TO LATERAL WEDGE INSOLES IN PATIENTS WITH MEDIAL KNEE OSTEOARTHRITIS?

G.J. Chapman[1], R.K. Jones[1], A.H. Findlow[1], M. Parkes[2], L. Forsythe[2], D.T. Felson[2]. [1]*Univ. of Salford, Salford, United Kingdom;* [2]*Univ. of Manchester, Manchester, United Kingdom*

Purpose: Lateral wedge insoles used to treat medial knee osteoarthritis (OA) have been disappointing in terms of effects on pain reduction despite modest mean effects in reducing the external knee adduction moment (EKAM). Studies have shown remarkable variability across persons' EKAM responses to lateral wedge insoles with up to 30% of treated patients demonstrating an increase (worsening) in the EKAM. We hypothesised that dynamic foot biomechanics could be used to identify persons unlikely to respond to lateral wedge insoles.

Methods: As part of a randomised trial of different insoles/footwear for medial knee OA, we tested a control shoe and two lateral wedge insoles, both of which had been previously shown to cause modest average reductions in EKAM. Subjects with medial knee OA underwent a 3-dimensional kinematic (Qualisys OQUS, Gothenburg, Sweden) and kinetic (AMTI, USA) analysis whilst walking in a control shoe and lateral wedge insoles. Subjects also walked barefoot across an EMED-x/R high-speed system (Novel Inc., Munich, Germany) which provided data on dynamic medial and lateral hindfoot and midfoot contact areas, pressures, and also arch angle, foot progression angle (FPA) and centre of pressure excursion index (CPEI). We classified a person as a nonresponder if their averaged EKAM (1st peak of the adduction moment) increased when wearing the lateral wedge compared with control. If there was a decrease in averaged EKAM, the subject was a responder. We tested an alternative definition of responder in which persons with EKAM changes less than the median were classed as nonresponders (includes those with worsening). To identify dynamic foot factors that clustered together, we performed a principal component analysis, identifying 5 factors over and above arch (defined as increasingly planus), FPA and CPEI. These factors included pressure and contact time on the hindfoot, medial midfoot, lateral midfoot and contact area of the hindfoot along with peak pressure on the hind and medial midfoot. We also tested rearfoot posture as lateral/medial hindfoot contact area and time. Since most of the dynamic variables were not parametric, we used Wilcoxon Rank Sum Test to compare responders and nonresponders.

Results: We studied 33 patients with medial knee OA (mean age 58.9 yrs, 42% female, mean BMI 32.2, 57% KL grade 2 and 43% grade 3). Wearing lateral wedge insoles produced a mean reduction of 4.1% in EKAM and, as expected, 39% showed an INCREASE in EKAM and were classified as nonresponders. However, there were no significant differences between responders and nonresponders in any of the hind or midfoot variables emerging from the principal components analysis nor were FPA or CPEI associated with the likelihood of response to wedge insoles. Increasingly planus feet showed a higher likelihood of response ($z = -2.08$, $p = .04$) with nonresponders having the five most cavus feet. Also, we found a significant difference between responders and nonresponders in rearfoot posture in that persons with calcaneal varus and a higher contact area on the lateral hindfoot were more likely to be nonresponders (z=2.27, $p = 0.02$). We confirmed these findings when we defined nonresponders using the median change in EKAM on treatment.

Conclusions: In this first examination of factors affecting response to lateral wedge insoles, we found, like others, a wide variability in response with a large percentage actually showing worse EKAMs. Our data suggest that persons with calcaneal varus who walked more on the lateral hindfoot and those with pes cavus were unlikely to respond to lateral wedges. Our findings need replication but indicate that trials may have failed to show effects of lateral wedge insoles on knee pain because dynamic foot pressure needs greater consideration when prescribing lateral wedges. Excluding persons whose foot dynamics make them unlikely to respond to insoles may leave a large group of patients who can experience their potential therapeutic benefits.

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REDUCTION IN KNEE ADDUCTION MOMENT VIA NON-INVASIVE BIOMECHANICAL INTERVENTION. A LONGITUDINAL GAIT ANALYSIS STUDY

A. Haim[1,2], G. Rubin[3], N. Rozen[3], Y. Genis[1], A. Wolf[1]. [1]*Technion-Israel Inst. of Technology, Haifa, Israel;* [2]*Sourasky Med. Ctr., Tel-Aviv, Israel;* [3]*Ha'Emek Med. Ctr., Afula, Israel*

Purpose: Although biomechanical non invasive treatments have been reported to reduce pain and facilitate superior levels of function in patients with medial knee osteoarthritis, the influence of these interventions on the pathomechanics of the disease has yet to be determined. The aim of this study was to examine the kinetic and kinematic outcomes in association with subjective results of a biomechanical intervention program, in order to establish the underlining mechanisms of this treatment approach.

Methods: 25 female patients with symptomatic bilateral medial compartment knee osteoarthritis were enrolled in a customized biomechanical intervention program utilizing daily treatment with a novel foot-worn biomechanical device which allows intra articular load reduction and continues perturbation during ambulation (AposTherapy). All patients underwent consecutive barefoot gait analysis testing prior to treatment initiation and at two follow up visits (3 and 9 month).

Results: A significant reduction in the magnitude of the knee adduction moment and increased range of motion at the knee were noted during barefoot walking after 3 and 9 month of treatment. Furthermore moment reduction was associated with elevated self selected walking velocity, with significant pain reduction and with increased level of functional activity.

Conclusions: The study results verify that locomotor patterns can be effectively modified by such training programs in various stages of the disease. In addition to symptomatic improvement, such training have potent effect on kinetic gait patterns which play a key roll in the pathogenesis of osteoarthritis. We propose that altered dynamic knee loading is accountable for the symptomatic and functional improvement previously reported for these interventions. Application of these treatment principles could possibly lead to suspension of disease progression and be valuable for prevention in early stages of the disease.

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DOES PHYSICAL ACTIVITY LEVEL AFFECT GAIT BIOMECHANICS IN THOSE WITH KNEE OSTEOARTHRITIS?

G. Hatfield Murdock, C. Hubley-Kozey, W. Stanish. *Dalhousie Univ., Halifax, NS, Canada*

Purpose: Knee osteoarthritis (OA) has both a biochemical and biomechanical etiology, with recent work supporting the need to better understand the local joint mechanical environment, particularly when developing conservative management strategies. Physical activity is a common conservative management approach for knee osteoarthritis (OA), but little is known about its effect on the mechanical environment of the knee joint. Biomechanics obtained through gait analysis give insight on the loading environment of the knee. The purpose of this study was to determine whether participating in higher levels of physical activity altered biomechanical characteristics during gait for those with knee OA.

Methods: 58 patients with moderate medial compartment knee OA (MOA) and 57 asymptomatic (ASY) controls were separated into "active" and "sedentary" groups based on self-reported physical activity level. Approximately 50% of subjects (both MOA and ASY) were classified as "Active," meaning they participated in moderate to intense physical activity at least three times per week. Ground reaction forces (sampled at 2000 Hz) and segment motion (sampled at 100 Hz) were recorded during self-selected walking. Three-dimensional knee angles and moments were calculated using inverse dynamics. All waveforms were time-normalized to percent of gait cycle, and moment waveforms were amplitude-normalized to body mass. Main waveform characteristics of the knee flexion angle, and knee flexion, adduction and rotation moments were determined using Principal Component Analysis (PCA). Two factor (group, physical activity level) ANOVAs tested for significant group-by-physical activity interactions, and group and physical activity main effects for PC scores for the first three PCs extracted.

Results: Group and physical activity main effects were found for PC1 for the knee adduction moment, which captured the overall magnitude during stance. The MOA group had higher PC1 scores than the ASY group ($p < 0.05$), and active subjects, regardless of group, had higher PC1 scores than sedentary subjects ($p < 0.05$). There was a group main group for knee adduction moment PC2 scores ($p < 0.05$), which captured the difference between the first peak and mid-stance amplitudes but no other physical activity main effects or interactions. No significant physical activity main effects or interactions were found for the knee flexion angle, knee flexion moment, and knee rotation moment PC scores.

Conclusions: This study shows that only the overall knee adduction moment magnitude differed with physical activity level. Active subjects (regardless of disease group) had higher overall knee adduction moment magnitudes, but physical activity level did not affect the mid-stance knee adduction moment amplitude, which captures the ability to unload the knee during mid-stance. Previous work has shown an increased risk of knee OA progression for those with high initial peak knee adduction moments at baseline, but it has also been shown that the mid-stance knee adduction moment magnitude is highly related to knee OA severity. Thus these differences exist but how they affect knee OA initiation/progression risk will only be understood with follow up.

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SOME WOMEN WITH KNEE OSTEOARTHRITIS PREFER ELEVATED HEEL SHOES

F.R. Nelson[1], R. Zade[2]. [1]*Henry Ford Hosp., Detroit, MI, USA;* [2]*Wayne State University Med. Sch., Detroit, MI, USA*

Purpose: Studies have demonstrated that elevated heels generate increased maximal knee joint loading and increased varus and sagittal torque across the knee joint. This would presumably lead to increased incidence of degenerative disease and pain. The senior author has observed that some patients with symptomatic knee osteoarthritis find pain relief by wearing somewhat elevated heels as opposed to flat shoes. Our purpose was to determine if there is a significant group of patients with knee osteoarthritis who empirically prefer one inch or greater heels for knee pain reduction. Additionally, we wanted to determine if improvement knee pain with heels varies with body mass index (BMI), age, or location of degenerative disease, specifically tibial-femoral or patello-femoral osteoarthritis. Previous studies have analyzed such variables and found similar loading effects regardless of heel characteristics. Therefore we did not consider heel width or exact heel height, as long as it was greater than one inch.

Methods: 340 men and women with knee pain were screened. All patients who appeared to have knee osteoarthritis were routinely asked whether they wore elevated heels and whether heels had an effect on the quality of their pain. Additionally, they were asked if their pain was worse going up or down stairs. Of these, 63 noted a negative or positive difference with elevated heels. Sixty-one were females, and two were males who routinely wore cowboy boots. With IRB approval, the medical record numbers of all screened patients were recorded and matched with a randomly assigned, unidentifiable number so as to preserve patient privacy. The records were then retrospectively reviewed. Heel preference, age, BMI, sex, and radiographic data indicating the location of degenerative disease were recorded for data analysis. Location of osteoarthritis was designated as either tibial-femoral or patello-femoral. Data was initially assessed for normality using Shapiro-Wilk p-values and graphical displays. Student's t-tests were then used to compare age and BMI by group. A Fisher's exact test was used to compare location of degenerative disease by group. Statistical significance was set at $p < 0.05$.