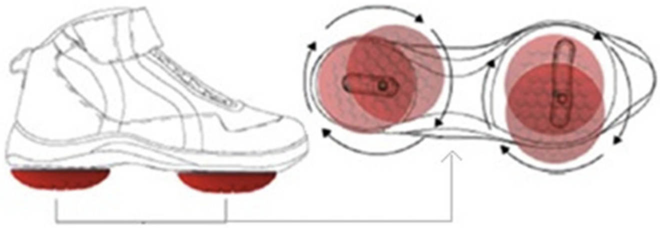

Figure 1: COP manipulation was accomplished using a platform in the form of a shoe in which 2 adjustable convex-shaped biomechanical elements are attached to the feet by means of a shoe sole specially designed with 2 mounting rails. One element is located under the hindfoot and the other under the forefoot, enabling continuous positioning of each element in multiple planes.

Results: Peak external flexion moment and the associated flexion angle at the time of peak moment increased 16% (p=0.093) and 6% (p=0.017) from A-COP to P-COP, respectively. Peak external extension moment and the associated extension angle at the time of peak moment increased 10% (p=0.047) and 4% (p=0.035) from A-COP to P-COP, respectively. Flexion impulse increased 51% (p=0.047) from A-COP to P-COP. Range of motion (ROM) increased 6% (p=0.011) from A-COP to P-COP (Table 1).

Table 1
Mean(SD) of sagittal-plane gait kinetics and kinematics for A-COP and P-COP.

	A-COP	P-COP
Peak Flexion Moment [N-mm/kg]	1029.99(304.43)	1199.78(417.66)
Peak Extension Moment [N-mm/kg]	-1003.44(380.74)	-1107.12(494.66)
Flexion Angle @ Peak Flexion Moment [deg]	28.16(5.74)	29.71(5.59)
Extension Angle @ Peak Extension Moment [deg]	-10.29(5.13)	-10.74(4.74)
Flexion Impulse [N-mm*s/kg]	44.11(22.13)	66.41(23.08)
ROM [deg]	39.13(2.78)	41.42(2.46)

Conclusions: In accordance with our hypothesis, sagittal COP manipulation significantly altered gait kinetics and kinematics associated with the hip. This may have clinical implications for hip OA. Hip OA patients may walk with reduced extension moment and ROM which are significantly correlated with increased level of pain and are pain-avoidance mechanisms that may reduce load on the femoral head. This antalgic mechanism may be at the cost of an asymmetric gait that is detrimental to other joints in the trunk and lower limbs. Also, increased flexion moment may be linked to development of anterior hip pain. In addition, flexion impulse may be an indicator of muscle forces, and hence load, acting on the joint. Thus, an anterior COP, which reduces extension and flexion moments, flexion impulse, and ROM may reduce pain and load on the joint and allow a more normal and symmetric gait. This remains to be shown in hip OA patients.

202
PROXIMAL, LOCAL AND DISTAL GAIT ADAPTATIONS TO FOOT ORTHOSES IN INDIVIDUALS WITH PATELLOFEMORAL JOINT OSTEOARTHRITIS: AN EXPLORATORY STUDY

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Purpose: Patellofemoral joint (PFJ) osteoarthritis (OA) is increasingly being recognised as an important source of knee pain and morbidity, and may be related to greater PFJ stress. Increased foot pronation, hip internal rotation (IR) and hip adduction during gait, as well as greater knee extension moment, may heighten PFJ stress. As such, interventions that decrease these variables could potentially reduce PFJ stress. Foot orthoses can change kinematics in young adults with PFJ pain, but are yet to be investigated in an older cohort with OA. This study investigated the immediate effects of foot orthoses on specific kinematics and joint torques during walking in individuals with PFJ OA.

Methods: A within-subjects, repeated measures trial utilised participants with PFJ OA who were involved in a larger randomised clinical trial (age $\geq$ 40 years; PFJ osteophytes on skyline radiographs; anterior knee pain during activities that load the PFJ e.g. steps or squatting; tibiofemoral joint OA K&L grade $<$ 3). Baseline pain severity (pain during walking on a 10cm visual analogue scale; Knee Injury and Osteoarthritis Outcome Score (KOOS)) was recorded to characterise the cohort. Data were collected during walking under two conditions: i) sandal (Nike Strap Runner); and ii) sandal with prefabricated foot orthoses (Vasyli International) for 10 walking trials (self-selected speed) using a nine-camera VICON motion analysis system (Oxford Metrics, Oxford, UK), and three AMTI force plates. An eight-segment biomechanical model was constructed using OpenSim software (Simbios, Stanford University, CA, USA) and used to compute all kinematic and torque data. For each participant, peak angles were calculated for subtalar eversion, ankle dorsiflexion, and hip adduction and IR, as well as peak knee extension torque. Changes in peak angle or torque with orthoses compared to shoes alone were plotted to evaluate patterns of change at the foot, ankle, knee and hip.

Results: 19 participants completed the study (12 females; age 55$\pm$9; baseline pain with walking 1.8$\pm$1.9cm; KOOS pain 68$\pm$20, symptoms 70$\pm$14, activities of daily living 78$\pm$16, sport/recreation 57$\pm$21, quality of life 52$\pm$17). Consistent kinematic adaptations were seen at the foot and ankle, with the majority of participants who demonstrated changes in peak angles showing reductions in peak subtalar eversion (7/10, 70%) and ankle dorsiflexion (13/17, 76%). More than half the cohort showed reductions in knee extension moment with orthoses (12/19, 63%), while the majority of those who demonstrated change in hip adduction with orthoses had reduced peak adduction (10/14, 71%). Greater variability in response was seen for hip IR; 3/19 (15%) showed no change, 7/19 (37%) showed reduced peak IR while the remainder had an increase in peak IR (6/19, 32%).

Conclusions: Individuals with PFJ OA who demonstrate distal gait adaptations to foot orthoses show consistent reductions in subtalar eversion and ankle dorsiflexion, which are components of foot pronation. This suggests that foot orthoses may have potential to reduce PFJ stress via adaptations at the foot and ankle. Furthermore, reductions in knee extension torque were seen in the majority of participants, and indicate another potential mechanism for reducing PFJ stress. However, greater variability in proximal adaptations to foot orthoses at the hip suggests potential for subsequent decreases or increases in PFJ stress. Findings of this exploratory study highlight the need for further research regarding the relationship between foot orthoses and PFJ stress, and suggest that individual responses, particularly more proximally, are an important consideration when prescribing foot orthoses as an intervention for PFJ OA.

203
THE INFLUENCE OF PAIN OBESITY AND QUADRICEPS STRENGTH ON THE GAIT OF OSTEOARTHRITIS PATIENTS

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Purpose: Walking is a fundamental basic daily activity. Patients with osteoarthritis (OA) are known to have an altered walking pattern. Our goal was to contribute to the understanding of the influence of pain quadriceps strength and obesity on this gait pattern.

Methods: Fifty-eight subjects (45 female, 13 male) with Knee OA diagnosed according to American College of Rheumatology clinical and radiological criteria (Kellgren-Lawrence grade 2 or 3), between the ages 51-82 (mean= 65,2$\pm$7,9 year), BMI 20.3-49.3 kg/m^2 (mean = 29.4 $\pm$ 5.2), height 1.45-1.76 m (mean = 1.59 $\pm$ 0.07) and weight 47- 100 kg (mean = 72,9 $\pm$ 11.0) were recruited from an initial cohort of 89 subjects. Gait was assessed with the Novel PEDAR® system, during a 8m walkway. To limit the influence of initial acceleration and terminal desaccelaration, data was treated in the mid 6m. Pain was measured with the Western Ontario and

McMaster Universities Osteoarthritis Index- Pain sub-score. Isokinetic strength was measured with the *Biodex System III,* in a concentric/concentric mode at 60o/s. The range of motion for testing was pre determined from 20o to 80o.

Results: A factorial analyze was used to investigate the relation of pain, obesity and extension peak torque (PkT) (independent variables) on gait temporal parameters, and the maximum vertical force (N) of ground reaction forces (GRF-V) during heel-strike and push-off phases (dependent variables). PkT (N) was treated separately according to the most affected leg (MAL) and least affected leg (LAL).PkT, didn't influence gait temporal parameters, neither alone nor associated with pain or BMI. Pain and BMI only influenced stance and swing (% of stride), in the MAL, when associated together explaining 23,1% of stance (% stride) with a power of 99,3% ($F_{(9;\ 60)} = 4{,}432$; $p < 0{,}001$), and 23,2% of Swing (% stride) with a power of 99,3% ($F_{(9;\ 60)} = 4{,}438$; $p < 0{,}001$).During heel-strike, GRF-V, was explained by BMI in 55,5% ($F_{(4;\ 56)} = 3{,}427$; $p < 0{,}05$), with 66,5 of power; and PkT 56,6% ($F_{(3;\ 56)} = 4{,}756$; $p < 0{,}05$), with a power of 76%. No significant influence were observed in LAL.During the push-off phase, GRF-V was influenced by BMI 57,2% ($F_{(4;\ 56)} = 3{,}677$; $p < 0{,}05$) with a power of 70%, pain 52,8% ($F_{(3;\ 56)} = 4{,}114$; $p < 0{,}05$) with a power of 69,2%; and PkT explains 75,3% ($F_{(3;\ 56)} = 11{,}181$; $p < 0{,}01$) with a power of 98,8%.

Conclusions: No influence was observed between peak torque and temporal parameters. Neither pain nor BMI influenced gait temporal outcomes unless they co-exist together, subjects have to simultaneously have higher BMI and pain to manifest such alterations. Interestingly this influence was only observed in MAL. During heel-strike of MAL, GRF-V was explained in 55,5% by BMI alone, and 56,6% by PkT. Although these values are similar the confidence measured by power is higher in PkT corresponding to 74,8% (more 9,5% than BMI).

During push-off PkT was also found to be important. GRF-V during push-off was influenced 57,2% by BMI, 52,8% by pain and 75,3% by PkT (98,9% of power) independently.

While pain and BMI play an important role on gait temporal parameters quadriceps strength seems to have an important role in absolute maximum vertical force of ground reaction forces, during both heel-strike and push-off gait phases.

204

COMPARISON OF RANGE OF MOTION OF THE DISTAL LIMB JOINTS OF HEALTHY HORSES WHEN WALKING ON THREE CONVENTIONAL SURFACES

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Purpose: The horse is currently used as a model for the development, progression, and treatment of osteoarthritis (OA). In animal models, various exercise regimens have been used to promote OA development and establish rehabilitation protocols. However, there is a lack of knowledge on the effect of various footing surfaces on the range of motion (ROM) of distal limb joints that are commonly studied. The purpose of this study was to evaluate the range of motion of the carpus, tarsus, metacarpophalangeal (MCP), and metatarsophalangeal (MTP) joints of healthy horses when walking on soft ground, hard ground, and a land treadmill. We hypothesized that each surface will affect the range of motion of each joint differently, and soft ground will provide the greatest range of motion for all joints.

Methods: Nine sound adult Quarter Horses were used. Four retroreflective markers were affixed on the proximal interphalangeal joint, MCP/MTP joints, and mid-distal radius/tibia of the left forelimb and hind limb (markers placed here for future comparison to movement in an underwater treadmill) of each horse to track movement (Fig. 1a & 1b). Horses were filmed with a digital video camera from the left side of the horse at 60 frames/sec while walking on soft ground (arena, SF), hard ground (cement, HD), and on a land treadmill (LT). Ten complete strides were videotaped without interruptions on each surface (velocity of 0.9-1.7 m/s ± 10% acceleration). The 2-D palmar angles of the carpus and MCP, dorsal angle of the tarsus, and plantar angle of the MTP (Fig. 1a & b) were calculated for each joint in each surface (5 strides per surface) using DMAS Equine Gait Trax system (Motion Imaging Corporation). For each stride, the maximal and minimal joint angles and overall ROM were calculated. Differences between surfaces were determined using ANOVA with multiple pairwise comparisons (Tukey's), and significance was set at P<0.05.

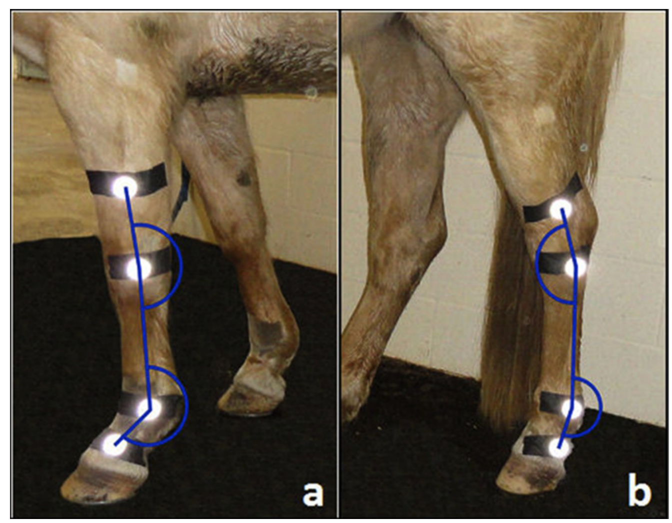
Results: Maximal flexion for all joints was attained when horses were walked on LT, although no significant differences were found between surfaces.

Maximal extension of the carpus was significantly greater when horses were walked on HD [183.2 ± 1.6 (mean degrees ± SD)] compared to SF (181.0 ± 1.5; P<0.05) and LT (180.1 ± 1.5; P<0.01). The tarsus achieved the greatest extension when walking on HD, and the MCP/MTP joints when walking on LT, although no statistical differences were found between surfaces.

ROM for the tarsal joint was significantly greater when horses walked on SF (39.1 ± 5.5) compared to HD (33.7 ± 3.9; P<0.05). ROM of the MTP joint was greater when walking on LT (77.0 ± 9.4) compared to both HD (65.4 ± 5.6; P<0.05) and SF (67.8 ± 7.5; P<0.05). The carpal and MCP joints had the greatest ROM when walking on LT, although no statistical differences were found between surfaces.

Conclusions: Walking surface (soft, hard and land treadmill) influences the flexion and extension of the distal limb joints to a different extent. Therefore, this data should be considered when designing exercise or rehabilitation programs for horses used in OA studies depending upon the joint of interest.

Figure 1: Photographs showing retroreflective markers on the fore (a) and hind (b) limbs of a horse. Measured angles are represented.



205

EFFECT OF CORONAL-PLANE FOOT CENTER OF PRESSURE MANIPULATION ON HIP JOINT BIOMECHANICS DURING GAIT

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Purpose: Manipulation of foot center of pressure (COP) influences knee mechanics and gait patterns in healthy subjects. Footwear allowing change in COP may reduce pain and increase functionality and quality of life in knee OA patients by unloading the diseased joint compartment and provoking more normal gait. There is a lack of controlled trials assessing effects of footwear used to treat OA on the hip. The goal of this study was to establish a relationship between specific coronal-plane COP changes and resulting gait parameters associated with the hip in healthy subjects, and to provide a foundation for future study in the hip OA population. We hypothesized that coronal-plane shift of COP would significantly affect gait parameters associated with the hip.

Methods: Ten healthy young males underwent gait analysis in a lateral COP (L-COP) and medial COP (M-COP) condition. COP was manipulated using a novel biomechanical device (Apos System) (Figure 1). Dependence of coronal-plane kinematics and kinetics on COP location was determined using Wilcoxin signed ranks tests (p<0.05).