

Relationship between Frontal and Sagittal Plane Kinetics During Walking in Subjects With and Without Knee Pain

Karen L. Perell PhD, RKT^{1,2}, Achal Sahai BS¹, Meika Fang MD³

¹Physical Medicine and Rehabilitation Gait Laboratory, VA Greater Los Angeles Healthcare System, Los Angeles, CA; ²Division of Kinesiology and Health Promotion, California State University, Fullerton, Fullerton, CA; ³Department of Medicine, VA Greater Los Angeles Healthcare System, Los Angeles, CA

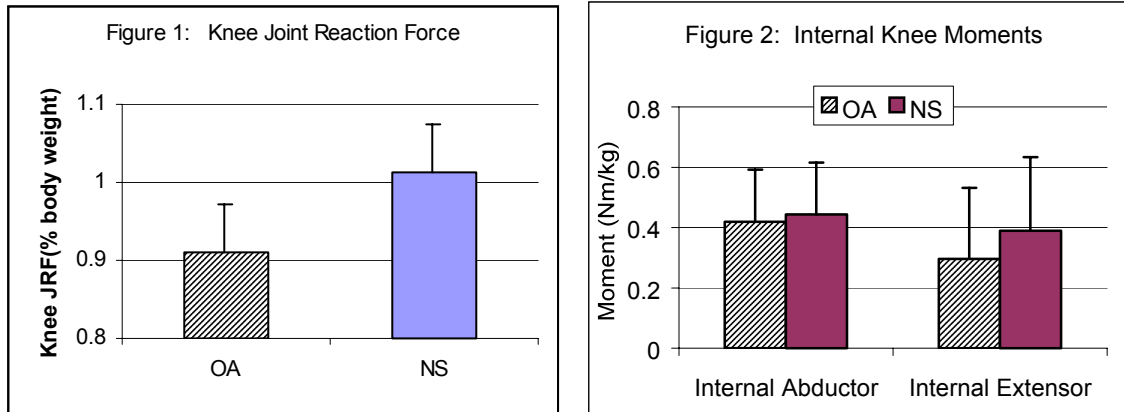
Introduction: Much work has been done to investigate the frontal plane knee moments and joint reaction forces in people with osteoarthritis. It has been suggested that increased internal knee abductor moments lead to increased knee joint reaction forces medially due to the need for increased internal knee extensor moments. There is an assumption that patients with osteoarthritis reduce their internal knee abductor moment in order to reduce their knee joint reaction forces, and thus, alleviate pain¹. The relationship between the internal knee abductor moments, internal knee extensor, and compressive knee joint reaction forces, however, has not been demonstrated in the literature. Consequently, the purpose of this study was to determine the relationship between the internal knee abductor moments, internal knee extensor moments, and compressive knee joint reaction forces. Using gait analysis, this study compared frontal and sagittal plane knee kinetics in subjects with and without knee pain.

Statement of Clinical Significance: A greater understanding of the relationship between gait parameters will enhance our understanding of pain relieving mechanisms for patients with osteoarthritis.

Methodology: 15 men diagnosed with knee osteoarthritis (OA) and 13 non-symptomatic (NS) community dwelling men participated in the gait analysis. Subjects in both groups ranged in age from 52-83 (mean = 68 years, standard deviation = 11 years). Retroflective markers were placed bilaterally on the head of the first metatarsal, posterior calcaneus, lateral malleolus, lateral femoral condyle, anterior superior iliac spine, sacrum, acromion process, lateral humeral epicondyle, and ulnar head, as well as wand markers placed on mid thigh and mid shank (Helen Hayes marker system). Each subject was instructed to walk along a walkway at a comfortable pace using their own shoes. Two to three practice trials were permitted to habituate the subjects to the testing environment. Three acceptable trials were obtained for each limb. Demographic data were collected from each subject via an interviewer-administered questionnaire and the subject's medical chart. Walking velocity, peak internal knee extensor moment, peak internal knee abductor moment, and peak compressive knee joint reaction force were averaged across three walking trials for each limb. Peak values for each parameter were compared between limbs (affected vs. unaffected) using a paired t test. For group comparisons, limb data were averaged together, since between limb comparisons did not demonstrate significant differences in either group, and compared using an unpaired t test. Correlations were made between walking velocity and peak values of the other variables and between peak internal knee abductor moment and both the peak internal knee extensor moment and the peak compressive knee joint reaction force. StatView (v.5.0,

SAS Institute, Inc., Cary, NC, USA) was used for all statistical analyses. The level of significance used in this study was $p \leq 0.05$.

Results: Comparisons between the OA and NS groups revealed significant peak magnitude differences in the maximum compressive knee joint reaction force ($p= 0.0003$) (Figure 1), but not in the internal knee abductor moment ($p=0.5121$) (Figure 2) or the internal knee extensor moment ($p=0.1567$) (Figure 2). Walking velocity was significantly decreased ($p = 0.0017$) in the OA group (OA average \pm standard deviation: 0.913 ± 0.246 m/s; NS average \pm standard deviation: 1.254 ± 0.270 m/s).



Figures: Group averages and standard deviations for peak compressive knee joint reaction force (**Figure 1**) and internal knee abductor and extensor moments (**Figure 2**).

No significant correlations were observed between walking velocity and the knee kinetic parameters or between the internal knee abductor moment and the other knee kinetic parameters in the OA group. In the NS group, however, walking velocity was moderately correlated with peak internal knee abductor moment ($r = 0.603$; $p=0.0274$) and there was a trend toward a moderate relationship between peak internal knee abductor moment and peak internal knee extensor moment ($r = 0.521$; $p = 0.0680$).

Discussion: In the OA group, we did not find a relationship between the frontal and sagittal plane knee kinetics in an effort to reduce compressive knee joint reaction forces. Knee joint reaction forces, however, were lower in the OA group relative to the NS group. It is possible that individuals with OA develop a walking strategy to maintain stability and reduced compressive knee joint reaction forces via elevated internal knee extensor moments in compensation for elevated internal knee abductor moments.

References:

¹Schnitzer et al. (1993) *Arthritis & Rheumatism*, 36(9):1207-1213.