A NOVEL METHOD FOR REDUCING THE KNEE ADDUCTION MOMENT DURING WALKING: A POTENTIAL APPROACH TO SLOW THE PROGRESSION OF KNEE OSTEOARTHRITIS

Fisher, D S; Akanni O A; Mündermann A; Andriacchi, T P
Stanford University, Stanford, CA; VA Palo Alto RR&D Center, Palo Alto, CA
email: fisherds@stanford.edu

INTRODUCTION
The peak adduction moment at the knee during walking has been related to an increased rate of progression for osteoarthritis (OA) at the knee [1]. Thus, an intervention that could lower the adduction moment during gait has the potential to slow the rate of progression of knee OA. The most common approach to lowering the adduction moment during walking has been through the use of a wedge insert [2,3]. However, wedge inserts often cause discomfort and are not well tolerated. A recent attempt at gait retraining using an increased toe out gait has been shown to help reduce the knee adduction moment [4]. However, that method primarily reduced the second knee adduction moment peak, which is the lower peak in most subjects.

The purpose of this study was to report a novel approach to gait retraining with the goal of reducing the peak knee adduction moment. The first hypothesis of this study was that by reducing the load on the lateral side of the foot subjects can reduce their first peak knee adduction moment. The second hypothesis was that the success rate of this gait retraining will be improved with the use of a pressure sensitive feedback system.

METHODS
Nine healthy subjects with no history of lower extremity injuries were tested in this study (3 females, 6 males; age 25 ± 5 years; height 176 ± 7 cm; weight 57 ± 6 kg) with Institutional Review Board approval and signed consent obtained for all subjects. Subjects performed nine walking trials for experimental conditions all at a self-selected normal speed (average 1.43 ± 0.2 m/s). The four experimental conditions included: normal walking, verbally instructed gait retraining, normal walking with a deactivated feedback system, and feedback system gait retraining. Prior to the verbally instructed gait retraining, subjects were coached to load the lateral side of the foot minimally, but to maintain a gait that they could use comfortably with continued usage. For the feedback system gait retraining, subjects wore a device (Figure 1) that measured the lateral foot pressure and vibrated a pager motor, attached to the skin overlying the cuboid, if the load crossed a force threshold. Subjects were asked to walk in such a way as to keep the device from activating the pager motor. This encouraged subjects to shift the load at the foot from the lateral to the medial side.

The external joint moments were measured by gathering motion and force plate data. A three-dimensional optoelectronic system was used to collect the motion data, while a multi-component force plate was used to measure the ground reaction force. External inter-segmental forces and moments were calculated for the lower limbs using previously described methods [5]. The first peak external knee adduction moment for each trial was recorded. Significant differences in the first peak knee adduction moment between experimental conditions were detected using a two-way ANOVA (a < 0.05)

RESULTS
Subjects walked with a lower first peak knee adduction moment after being instructed to shift the load at their foot from the lateral to the medial side (P < 0.001). The adduction moment was reduced by 8.3 ± 4.1% following verbal instruction and by 14.2 ± 3.3% when verbal instructions were combined with the feedback system. While two subjects experienced increased knee adduction moments with verbal instruction only, all subjects walked with lower knee adduction moments when using the feedback system (Figure 2). For five of the nine subjects, the knee adduction moments with the feedback system were substantially lower than when only verbally instructed.

Figure 2: Percent change in the first peak knee adduction moment for verbal instruction only or the feedback system compared to a control condition. Positive values correspond to an increase in the knee adduction moment compared to the control condition.

DISCUSSION
Combining verbal instructions to shift the load from the lateral to the medial side of the foot with a feedback system resulted in an average reduction in the knee adduction moment by 14%, which is a greater reduction than that seen in many shoe intervention studies [2,3]. Thus, gait retraining is not only a very simple solution but has potential reductions even greater than shoe intervention.

Shifting the load from the lateral to the medial side of the foot tends to move the knee closer to the line of action of the ground reaction force. Thus the lever arm of the ground reaction force vector at the knee is shorter resulting in a reduced knee adduction moment.

While both verbal instruction and the feedback system affected the knee adduction moment, the feedback system resulted in both a greater average reduction and a consistent reduction in every single subject (Figure 2). Some subjects performed the modified gait pattern better with the use of the feedback system, which reminded them to shift their load. Therefore, a feedback system appears to be a useful tool when trying to teach a subject a new gait pattern. In addition, a feedback system may help patients to maintain a ‘new’ gait pattern over time. Understanding how to reduce the peak knee adduction moment by shifting the load at the foot from the lateral to the medial side may help patients with medial compartmental knee OA slow their rate of cartilage degeneration.

REFERENCES

ACKNOWLEDGEMENTS
This project was funded in part by NIH Grant AR049792 and the NDSEG Fellowship.