

9

SIX WEEKS OF PERSONALIZED GAIT RETRAINING TO OFFLOAD THE MEDIAL COMPARTMENT OF THE KNEE REDUCES PAIN MORE THAN SHAM GAIT RETRAINING

S.D. Uhlrich^{1,2}, J.A. Kolesar^{1,2}, A. Silder¹, M.Z. Berkson^{1,2}, B. Presten¹, H.A. Montague-Alamin¹, N. Edouard¹, D. Willoughby¹, A.K. Finlay², G.E. Gold¹, S.L. Delp¹, G.S. Beaupre^{1,2}. ¹Stanford University, Stanford, CA, USA; ²VA Palo Alto Hlth.care System, Palo Alto, CA, USA

Purpose: Knee osteoarthritis (KOA) commonly originates in the medial compartment of the joint and is thought to be accelerated by excessive loading. The knee adduction moment (KAM) is correlated with the ratio of medial to lateral knee loading and is predictive of medial KOA progression. Thus, reducing the peak KAM is a common target for conservative therapies. Altering the foot progression angle (FPA) during walking by toeing-in or toeing-out reduces the first and second KAM peaks, respectively. Reduced pain has been observed following 6-week gait retraining programs that uniformly prescribed toe-in or toe-out gait; however, it is unknown how this compares to sham gait retraining. We hypothesized that after 6 weeks of gait training, an *altered FPA* group who was prescribed the FPA change that maximally reduced their larger KAM peak would experience a greater reduction in medial knee pain on the numerical rating scale (NRS) than a *consistent FPA* group who was prescribed their natural FPA. We also hypothesized that after 6 weeks of gait training, the *altered FPA* group would retain a greater reduction in peak KAM when walking at their prescribed FPA compared to natural walking than the *consistent FPA* group.

Methods: Forty-five individuals with Kellgren-Lawrence grade 1-3 medial KOA completed this study. Inclusion criteria were medial knee pain of 3 or more on the NRS, the ability to walk for 25 minutes without ambulatory aids, and the ability to reduce the peak KAM by at least 5%. During visits to the gait lab, participants walked on an instrumented treadmill while receiving real-time vibratory biofeedback for any step that deviated by more than 2° from the target FPA. Participants first performed a 30-minute treadmill acclimation visit where they walked with their natural FPA and with 10° of toe-in and toe-out at a self-selected pace. One week later, during the FPA personalization visit (week 0), participants performed five 2-minute walking trials. They walked naturally without feedback and with 5° and 10° of toe-in and toe-out relative to their natural FPA with feedback; these data were used to select the personalized FPA for the *altered FPA* group. Participants who could reduce their peak KAM with an FPA modification were then block-randomized into the *altered FPA* (n=22) or *consistent FPA* (n=23) groups. Faded biofeedback was provided during 6 subsequent weekly in-lab gait training visits. Participants were instructed to practice their personalized FPA for 20 minutes each day outside of the lab. The between-group differences in the two primary outcomes, NRS medial knee pain and reduction in peak KAM, from week 0 to 6 were compared with independent samples t-tests ($\alpha = 0.05$). The exploratory kinetic, kinematic, and WOMAC outcomes were also compared with t-tests ($\alpha = 0.05$).

Results: At week 6, the *altered FPA* group experienced a 1.8 ± 1.1 point reduction from week 0 in the primary pain outcome, NRS medial pain, which was greater than ($p=0.012$) the 0.8 ± 1.5 point reduction in the *consistent FPA* group (Fig. 1). The week 0 to week 6 changes in WOMAC pain and function scores were not significantly different between the groups ($p=0.385$ and $p=0.699$, respectively). The between-group difference in the primary kinetic outcome, reduction in KAM peak at week 6 compared to week 0 (Fig. 2a,b), was greater ($p=0.022$) for the *altered FPA* group ($8.2 \pm 12.7\%$) than the *consistent FPA* group ($0.5 \pm 8.4\%$). Twenty-one of the 22 subjects in the *altered FPA* group had a larger first KAM peak while walking naturally at week 0 and 16 of 22 maximally reduced their KAM peak by toeing-in which resulted in an average reduction at week 0 of $11.2 \pm 5.2\%$ ($p<0.001$). On average, the KAM moment arm at 50% stance for all subjects increased at week 6 compared to week 0 ($p=0.005$), which may have been caused by a 1.2 ± 2.8 cm ($p=0.008$) narrowing of stepwidth (Fig. 2c-f).

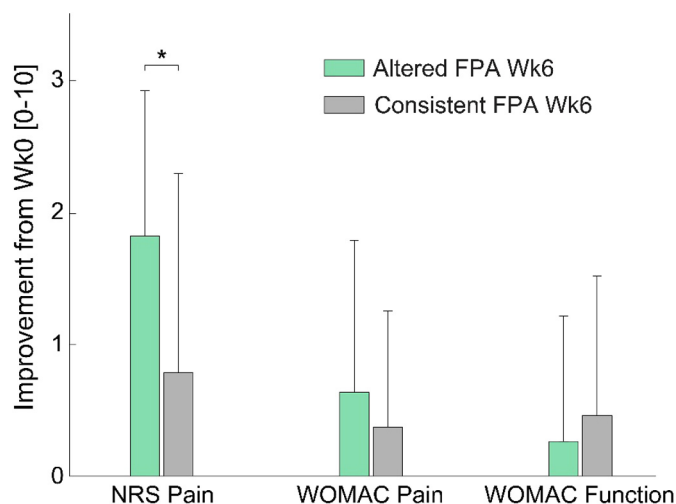


Fig 1. Improvement in pain and function from week 0 to week 6. The WOMAC subscores are displayed on a 0-10 range for comparison with NRS. (* $p<0.05$)

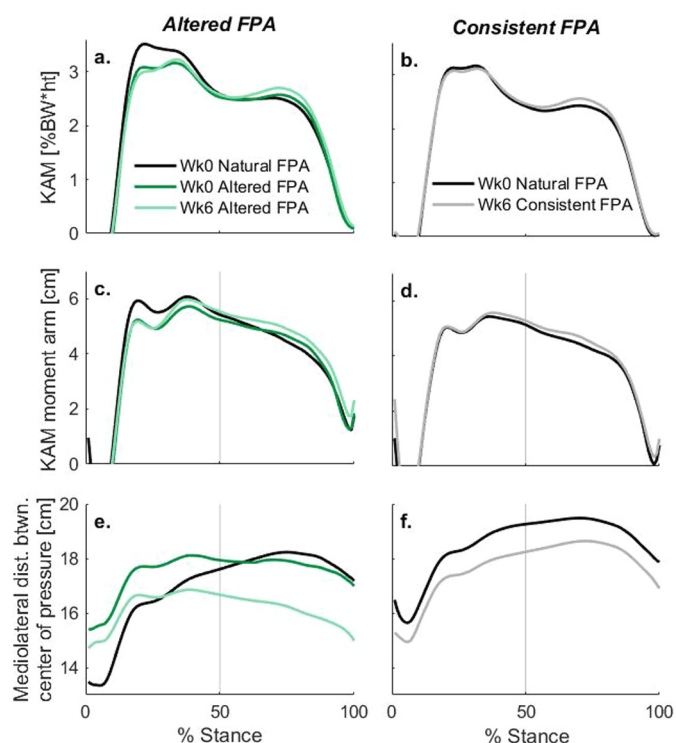


Fig 2. The KAM, KAM moment arm, and mediolateral distance between center of pressure for the *altered FPA* (a,c,e) and *consistent FPA* (b,d,f) groups. Only the 16 subjects in the *altered FPA* group who toed-in are shown for clarity. Compared to week 0 natural FPA, the first KAM peak is reduced with toe-in at week 0 as well as week 6 in the *altered FPA* group (a). Subjects in both groups increased their midstance KAM moment arm (c,d at 50% stance) and narrowed their stepwidth (e,f at 50% stance) at week 6 compared to the same FPA at week 0.

Conclusions: Gait retraining that reduces the peak KAM improves NRS pain by more than sham gait retraining in the short-term. An average increase in midstance KAM moment arm among all participants corresponded with a narrowing of stepwidth after 6 weeks of gait training. This may be due to increased comfort walking on the treadmill over time. Further work is necessary to evaluate the long-term durability of KAM and pain reductions. Nonetheless, personalized FPA modifications appear to be a promising conservative intervention for mild to moderate medial KOA.