

# Individuals with medial knee OA can improve knee loads with gait retraining using plantar pressure-based auditory feedback—a longitudinal feasibility study

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**Objective:** The knee adduction moment (KAM) is a surrogate measure of the ratio of knee compartmental loads that associates with the progression of medial knee OA. Gait modifications have been developed to alter KAM, but a strategy to promote learning of these gait modifications is lacking. A wireless pressure-detecting shoe insole (OpenGo, Moticon) contained in a standardized flexible shoe (FlexOA, Dr. Comfort) and its smartphone app were employed to generate auditory feedback and facilitate gait retraining at home. We were to evaluate whether subjects can improve knee loads with feedback gait retraining. We hypothesized that KAM would reduce after 3 weeks of training, and the KAM reduction would remain after 3 weeks free of training.

**Methods:** Individuals with symptomatic medial knee OA were recruited and randomized into the feedback and record group [2:1] for the clinical trial (NCT02955225). Qualified subjects were assessed 4 times during 3 visits over 6 weeks (W0: BSL, Immed; W3, W6). For the feedback group, the insole sent real-time data from two lateral sensors to a smartphone for the generation of auditory feedback to cue a medial weight shift. A researcher supervised feedback gait retraining and assessed subjects' immediate response during W0. Subjects continued training at home for 3x5 min/day and 6 days/week until their W3 reassessment. For the second 3 weeks, the feedback group recorded pressure instead of gait retraining (washout) before final re-assessment (W6). The record group received the same equipment but used the equipment to record pressure. During all lab visits, clinical surveys were taken and 3D gait analyses were performed. Baseline assessment included subjects walking at comfortable pace in their own walking shoes with subsequent reassessments in the standardized shoes. Statistical analyses were performed using mixed linear models in SAS (University Edition, SAS Institute). The two groups were first analyzed together for group, time, and interaction effect. Each group was then analyzed for time effect, and significant time effect was examined post hoc via pairwise comparisons corrected by Tukey's method.

**Results:** Between October 2016 and December 2019, 653 individuals contacted the study. A total of 38 subjects participated with 5 individuals in the feedback group discontinuing after the baseline assessment. Considering the feedback and record group together, we found a significant time effect on KAM1 regardless of KFM and cadence that showed group and interaction effect, respectively (**Table 1**) while a group effect was not detected. For the feedback group, a significant KAM1 reduction of 7.3% was evident immediately post-feedback gait retraining at the group level. Continued with three weeks of feedback gait retraining at home, most individuals, especially those who demonstrated immediate response, were able to lower KAM1 even in the absence of auditory cues. After a washout of feedback, some subjects were able to recall a medial weight shift to reduce KAM1 whereas a few showed deteriorated performance. Changes in KAM1 over time of the record group did not meet statistical significance. Both groups improved in self-reported outcome measures improved over time.

**Table 1.** Evaluation of time effect on KAM1 and subsequent pairwise comparisons.

KAM1 [%BWxHT]	Feedback: $F = 4.47, p = 0.014$			Record: $F = 1.27, p = 0.350$			All: $F = 3.99, p = 0.016$		
	Diff.	$p^*$	95%CI*	Diff.	$p^*$	95%CI*	Diff.	$p^*$	95%CI*
Immed-BSL	0.23	<b>0.021</b>	[0.03, 0.43]	0.07	0.686	[-0.12, 0.26]	0.17	<b>0.022</b>	[0.02, 0.33]
W3-BSL	0.22	0.169	[-0.07, 0.51]	0.11	0.741	[-0.25, 0.47]	0.22	0.066	[-0.01, 0.45]
W6-BSL	0.20	0.323	[-0.12, 0.53]	0.14	0.337	[-0.10, 0.38]	0.14	0.384	[-0.10, 0.38]

**Conclusion:** Feedback gait retraining can improve knee loads of individuals with medial knee OA. A relatively longitudinal effect was shown by those who were able to lower KAM1 in the absence of auditory cues and post washout. However, not all individuals who continued feedback gait retraining were able to maintain lower knee loads. Continued investigations should attempt to identify responders and non-responders by comparing for example their characteristics, kinematics, compliance to training protocol, and so on.