PREDICTING CHANGES IN KNEE ADDUCTION MOMENT DUE TO LOAD-ALTERING INTERVENTIONS FOR MEDIAL COMPARTMENT KNEE OA FROM PRESSURE DISTRIBUTION

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INTRODUCTION

Current interventions for the treatment of medial compartment knee OA aim to reduce the knee adduction moment to decrease the load transferred through the medial compartment of the knee when walking. The most frequently used non-invasive load-altering interventions are footwear modifications [1,2] and bracing [3,4]. Thus, it seems logical that changes in the adduction moment could be predicted by changes in foot contact patterns. The purpose of this study was to test the hypothesis that changes in knee adduction moment due to load-altering interventions for medial compartment knee OA can be predicted from pressure distribution during walking.

METHODS

Fifteen physically active adults (6 male, 9 female; age: 31.9 ± 5.9 yrs; height: 1.74 ± 0.10 m; mass: 70.7 ± 15.9 kg) without pain or previous injury in their lower extremity participated in this study after giving written consent in accordance with the Institutional Review Board. Subjects performed 3 walking trials at self-selected slow, normal, and fast speeds in each of 3 shoes with identical uppers: 0° valgus (control); 4° valgus; and 8° valgus. Kinematic and kinetic data were collected using an 8-camera optoelectronic system and reflective markers [5]. Pressure distribution data were collected synchronously using a pressure mat placed on the force plate level with the walkway. First and second peak knee adduction moments were calculated for each trial. The pressure region was divided into four zones, medial and lateral heel and forefoot, respectively (Figure 1). The ratio between the medial and lateral maximum force values were calculated for the heel and the forefoot regions. Average values for each shoe, speed, and subject were calculated. Non-parametric statistics were used to determine the success rate in predicting changes in knee adduction moments compared to the control shoe from pressure distribution.

RESULTS AND DISCUSSION

In general, interventions designed to reduce the knee adduction moment during walking were successful. The 4° valgus shoe reduced the 1st and 2nd peak knee adduction moment for 35 and 42 of 45 total subject × speed cases (77.8
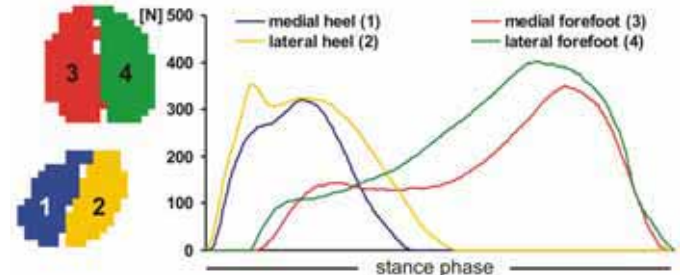

Figure 1: Force curves for one representative trial for the four zones of the foot taken from the pressure mat.

and 93.3%), respectively. The 8° valgus shoe reduced the 1st and 2nd peak knee adduction moment for 43 and 42 subject × speed cases (95.6 and 93.3%), respectively.

These results suggest that there are multiple ways to respond to the intervention. The ratio between the medial and lateral maximum force values successfully predicted changes in the 1st peak knee adduction moment at a greater rate for the 8° valgus shoe than for the 4° valgus shoe (Table 1). The strong prediction of changes in the knee adduction moment from the force ratio indicates that the more severe intervention (8° valgus shoe) dominated the mechanism of altering the load for most subjects, whereas with the 4° valgus shoe the mechanism of altering load was influenced by other factors such as limb alignment or upper body movement. Thus, interventions that alter load only slightly could have substantial variations in their load-modifying capacity since other factors may play an important role in the way subjects adjust their gait. A validation of these observations is required for patients with medial compartment knee OA.

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Table 1: Rate of success of predicting changes in the 1st peak knee adduction moment compared to flat control shoe using a pressure mat. Correct positive: predicted and measured reduction; correct negative: predicted and measured increase; false positive: predicted reduction, measured increase; false negative: predicted increase, measured reduction.

Prediction	4° valgus shoe						8° valgus shoe					
	Slow speed		Normal speed		Fast speed		Slow speed		Normal speed		Fast speed	
Correct positive	11	(73.3%)	9	(60.0%)	11	(73.3%)	14	(93.3%)	15	(100.0%)	14	(93.3%)
Correct negative	0	(0.0%)	0	(0.0%)	1	(6.7%)	0	(0.0%)	0	(0.0%)	0	(0.0%)
False positive	3	(20.0%)	3	(20.0%)	3	(20.0%)	1	(6.7%)	0	(0.0%)	1	(6.7%)
False negative	1	(6.7%)	3	(20.0%)	0	(0.0%)	0	(0.0%)	0	(0.0%)	0	(0.0%)
Total Correct	**11**	**(73.3%)**	**9**	**(60.0%)**	**12**	**(80.0%)**	**14**	**(93.3%)**	**15**	**(100.0%)**	**14**	**(93.3%)**