KINEMATICS OF RUNNERS WITH AND WITHOUT PATELLOFEMORAL PAIN DURING PROLONGED TREADMILL RUNNING

[1] Tracy A. Dierks, [1,2]Irene Davis, [1]Kurt T. Manal, and [3]Joseph Hamill
[1]University of Delaware, Newark, DE, USA; [2]Drayer Physical Therapy Institute, Hummelstown, PA, USA; [3]University of Massachusetts, Amherst, MA, USA; email: tdierks@udel.edu, web: http://www.udel.edu/PT/davis/index.htm

INTRODUCTION

It has been suggested that abnormal lower extremity kinematics during running are related to patellofemoral pain (PFP). Specifically, during the first half of stance when the knee is loaded, excessive internal rotation of the femur may result in lateral patellae maltracking [1,2]. Similarly, the patellofemoral joint may also be influenced by excessive knee valgus, which may be partly due to increased femoral adduction [1]. Also, it has been reported that PFP is associated with weak hip abductors and external rotators [3]. Therefore, these abnormal femoral motions may become more exaggerated in an exerted state, such as at the end of a prolonged run. Conversely, PFP has also been associated with decreased knee flexion during functional activities, which is thought to reduce the loads on the patellofemoral joint [1]. Further, the coupling that occurs between the knee and the foot may result in a decrease in rearfoot eversion as well [2].

While abnormal kinematics are believed to be related to PFP, few studies have examined the relationship between kinematics and PFP during running. Furthermore, no studies have investigated kinematics in a PFP group while running with pain and in an exerted state. Therefore, the purpose of this study was to compare the lower extremity kinematics of runners with PFP to uninjured runners over the course of a prolonged run. It was hypothesized that runners with PFP would display larger angular peaks for motions at the hip and that they would increase more than the uninjured group by the end of the run. It was also expected that the PFP group would exhibit smaller peaks at the knee and the rearfoot and that these values would decrease by the end of the run, whereas the uninjured group would display increases.

METHODS

Twenty runners with PFP and 20 healthy, uninjured runners participated in the study. All were between the ages of 18 and 45 and ran a minimum of 10 miles per week. The PFP group consisted of runners who experienced anterior knee pain for a minimum of two months when running. The tested limb in the PFP group was the side with the most painful knee, while the uninjured group was chosen randomly.

Three-dimensional kinematic data (120 Hz) were collected while subjects performed a prolonged run on a treadmill at a self-selected pace. The prolonged run ended when one of three events occur: 1) 85% of the subject's heart rate maximum was reached, 2) a score of 17 was reached on a rating of perceived exertion scale, and 3) for the PFP group, a score of 7 was reached on a visual analog scale for pain. Twenty consecutive footfalls were collected at the beginning and at the end of the run. For each subject, the peak angular values for rearfoot eversion, tibial internal rotation, knee flexion, knee internal rotation, knee adduction, hip adduction, and hip internal rotation were determined for each stance phase and then averaged. A 2-way repeated measures ANOVA (group x time) was used to determine differences for each kinematic variable ($p \leq 0.05$).

RESULTS AND DISCUSSION

The expectation that the PFP runners would display changes different from the uninjured runners in their peak values throughout the run was not supported. No interactions were found for any of the kinematic variables. As expected, the main effect for peak knee flexion was different between the two groups, with the PFP group exhibiting less knee flexion than the uninjured group (Table 1). The observed decreased knee flexion may be a compensatory strategy that was adopted to reduce knee pain because increased knee flexion will increase patellofemoral compressive forces, thus producing greater pain. For the main effect of time (begin to end), peaks for eversion, tibial internal rotation, knee internal rotation, and hip adduction all significantly increased from the beginning of the run to the end (Table 1), which is consistent with the literature [4]. This suggests that, regardless of group, as runners progress from a non-exerted to an exerted state, there is an increase in peak motions. While the majority of these observed increases were only between one to two degrees, both groups changed by approximately the same amount. In the PFP runners, these small increases may have been enough to bring them to their pain threshold, as 13 of 20 runners ended the run due to pain.

CONCLUSIONS

Based on the results of this study, runners with PFP exhibited less knee flexion than uninjured runners, which may be a mechanism to guard against pain. With the exception of knee flexion, both groups displayed similar peak angles at the beginning and end of the prolonged run. By the end of the run, these peak angles typically increased in a similar fashion between the two groups.

REFERENCES

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Table 1. Peak angles (deg) for patellofemoral (PFP) and uninjured (UNJ) runners at the beginning and end of the run. Standard deviation in ( ).

	Eversion		Tibial Internal Rotation		Knee Flexion		Knee Adduction		Knee Internal Rotation		Hip Adduction		Hip Internal Rotation	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
PFP	6.4^	7.7^	9.3^	10.9^	42.2*	42.6*	3.1	3.0	2.1^	2.8^	11.6^	12.3^	8.2	8.2
	(3.6)	(4.0)	(3.8)	(4.2)	(6.2)	(6.6)	(4.2)	(4.7)	(4.0)	(4.3)	(2.7)	(2.6)	(4.9)	(5.4)
UNJ	7.6^	9.2^	9.2^	10.7^	46.3*	46.3*	1.5	1.4	3.6^	4.8^	11.9^	12.5^	6.6	7.2
	(3.5)	(3.8)	(3.7)	(4.5)	(5.3)	(5.5)	(3.3)	(3.5)	(5.3)	(5.4)	(3.4)	(3.8)	(4.5)	(4.1)

*Significant group effect. ^Significant time effect.