Prospective Study of the Biomechanical Factors Associated with Patellofemoral Pain Syndrome

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INTRODUCTION

Patellofemoral pain syndrome (PFPS) is the leading cause of knee pain in runners. Despite the high incidence of PFPS, the etiology of this injury is not well-understood. Most of the focus on PFPS has been on factors directly associated with patellofemoral joint. However, abnormal mechanics of joints proximal and distal to the knee may also contribute to this injury.

At the hip, increased adduction, as well as internal rotation may alter the patellofemoral contact area, thereby adversely affecting patellar stress. In support of this, cadaveric studies revealed that increased hip adduction (Huberti et al. 1984) and internal rotation (Lee et al, 2003) both resulted in increased stress on the lateral patellar facet. With the repetitive loading of running, this can lead to PFPS. Increased hip motions may place greater demands on the hip musculature leading to greater joint moments in these individuals as well.

At the rearfoot, abnormal eversion has been suggested to contribute to PFPS. Tiberio (1987) hypothesized that if eversion is prolonged into the second half of stance, tibial internal rotation would also be extended. However, relative tibial external rotation is necessary for knee extension to occur. As the tibia is coupled tightly with the talus, it cannot externally rotate at this time. Thus, the femur must increase its internal rotation to obtain the necessary knee external rotation needed for knee extension to occur. This internal rotation of the femur and associated external rotation of the knee increases the Q-angle and can lead to abnormal patellofemoral joint loading (Huberti et al.1984).

To date, there are no prospective studies of mechanics proximal and distal to the knee in runners who develop PFPS. Therefore, the purpose of this study was to compare running mechanics in a group of female runners who later went on to develop PFPS to a group of healthy controls. It was hypothesized that runners who go on to develop PFPS would exhibit greater hip adduction, hip internal rotation, less knee internal rotation and greater time to peak rearfoot eversion. Additionally, we hypothesized that the PFPS group would exhibit greater hip abduction and hip external rotation moments.

METHODS

These data are part of a larger, ongoing study of injuries in female runners. Thus, females between the ages of 18-45, running a minimum of 20 mpw and free from current injury were recruited for the study.

Upon entry into the study all subjects underwent an instrumented gait analysis. Retroreflective markers were placed on the lower extremities. Subjects then ran along a 25m runway at 3.7m/s striking a forceplate (Bertec OH, USA) at its center. Kinematic data were captured using a 6-camera motion capture system at 120Hz (Vicon, Oxford metrics, UK). Kinetic data were captured at 1080 Hz using a force platform. Five running trials were collected. Joint angles and moments during the stance phase were

calculated using visual3D software (Visual 3D, C motion, MD, USA).

To date, 13 female runners have gone on to develop PFP on 15 knees. All injuries were confirmed by a medical professional. They were compared to a control group of 15 age and mileage matched uninjured runners Variables of interest were compared between groups using an independent t-test.

RESULTS AND DISCUSSION

Discrete variables of interest and joint angular curves are presented in Table 1 and Figures 1-2 respectively.

Table 1 Variables of Interest

	PFP	CON	P
Peak Hip Add (Deg)	12.1	8.1	0.007
Peak Hip Abd Mom (Nm)	-1.3	-1.3	0.896
Peak Hip Int Rot (Deg)	4.5	3.0	0.47
Peak Hip Ext Rot Mom (NM)	-0.04	-0.02	0.07
Peak Knee Int Rot (Deg)	0.01	1.9	0.39
Time to Peak Ev (% stance)	51.3	51.4	0.94

As hypothesized, hip adduction was significantly greater in the PFPS group (Fig 1). The greater hip adduction seen may increase the loading on the lateral patella (Huberti et al. 1984). With greater hip adduction we were surprised hip abduction moment was not greater as well. However, it is possible that differences in neuro-muscular factors, such as timing of activation are more important. The PFPS group was in greater hip internal rotation throughout stance, although this was not significantly different. However there was a trend towards greater hip external rotation moment in the PFPS group.

At the knee, the PFPS group exhibited greater external rotation (Fig 2). However this was not significantly different between groups. There was no difference in the time to peak rearfoot eversion between groups (Fig 2). While contrary to Tiberios theory, these results are similar to the retrospective findings of Duffey et al. (2000).

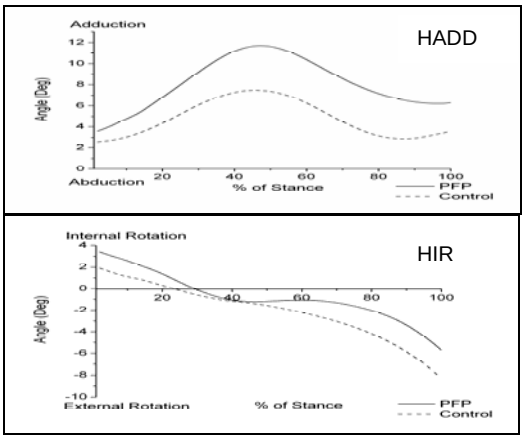

Figure 1 Hip Add (top) and B: Hip Int rot (bottom)

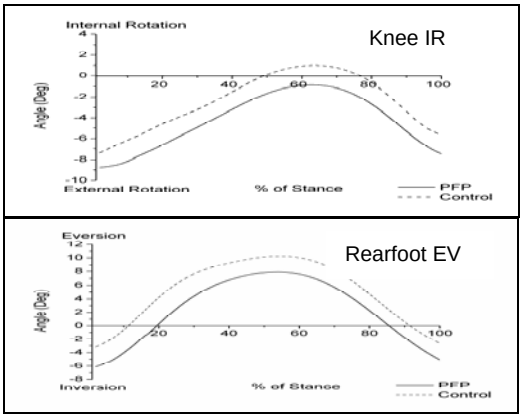

Figure 2 Knee IR (top) and RF EV (bottom)

SUMMARY/CONCLUSIONS

Based on these preliminary results, proximal factors may have a greater impact in the development of PFPS than distal ones. Also frontal and transverse plane mechanics of the knee may be controlled by the hip. This suggests that interventions should focus on proximal factors.

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ACKNOWLEDGEMENT

Supported by Dept of Defense grant DAMD17-00-1-0