COACHING ADVICE THAT REDUCES LOADS ASSOCIATED WITH BIOMECHANICAL PREDICTORS OF ILIOTIBIAL BAND SYNDROME

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It has been previously described that the normalized hip adduction moment correlates significantly with the risk of developing iliotibial band syndrome. To advance this research we developed coaching advice that would result in reducing the peak hip adduction moment. Five marathon runners were assessed to determine their normal kinematic and kinetics while running. Runners were then coached to run their normal speed but while lowering their upper bodies by ~1 inch (2.54cm). The runners reduced their peak adduction moments by 21.8% ($p<0.05$), while their speeds did not change significantly. This advice also produced a significant increase in knee flexion angle at ground contact (8.6° to 18.7° $p<0.01$). Another positive result of this coaching advice was the significant reduction in three peak normalized ground reaction forces: braking (3.2%BW), vertical (24.1%BW), and resultant (24.0%BW).

KEY WORDS: injury prevention, iliotibial band syndrome, distance runners, kinetics, hip adduction moment

INTRODUCTION: This research tests whether biomechanically derived coaching suggestions have the potential to reduce the risk of iliotibial band syndrome (ITBS) injuries in distance runners. ITBS is considered by distance runners to be their nemesis. We have previously identified the peak normalized hip adduction moment as a predictor of ITBS in marathoners (MacMahon et al., 2000).

ITBS commonly presents with friction between the iliotibial band (ITB) and the lateral epicondyle. The zone of interaction between these two structures is ~10° wide and centered upon 30° of knee flexion (Orchard, et al., 1996). Muscular activity associated with tension in the ITB occurs in the first half of stance phase (Mann et al., 1986). Weakness in these hip abductor muscles, gluteus medius and tensor fascia latae, is associated with ITBS (Fredericson, et al., 2000). When active, these muscles are involved in overcoming the hip adduction moment. The simultaneous occurrence of large hip adduction moments and low knee flexion angles conspires to cause this injury. Higher speeds favorably increase heel-strike knee flexion. Unfortunately for most distance runners high speeds are not an option and hence the prevalence of the injury in this population. For example, in an internal lab review of 80 gait tests of marathoners we found the knee flexion angle at heel-strike was well below 15°.

An increase in heel-strike knee flexion would be beneficial, because it would reduce the period of interaction of the ITB with the lateral epicondyle (Orchard et al., 1996). Reducing the adduction moment would likewise serve the runner well by reducing the associated ITB tension.

Directly suggesting to runners to reduce their peak normalized hip adduction moment is not a reasonable approach. We took a different tact and designed coaching advice a runner would consider. If runners could utilize this advice to produce biomechanical benefits, then it could be passed on to coaches who could implement it to help their runners prevent future injuries.

Suggesting to athletes a change in their form is generally considered tricky business because any change in form introduces the potential for a compensatory injury. Therefore our objective was to identify the least amount of productive input necessary.

To be sensitive to undesirable compensatory changes, we tested other kinetic variables for significant changes. In addition many other authors have published studies comparing runners with particular injuries against control groups (McClay & Manal, 1998, Messier et al., 1995, Orchard, et al., 1996). These data are good baselines for comparison with our coached runners.

Some coaches have been successful in creating injury prevention training programs. One excellent example targeted the prevalence of knee injuries in female athletes in which 1,263

high school athletes completing a pre-season neuromuscular training program, experienced significantly fewer knee injuries than a control group. (Hewett, 1999).
With a similar goal we targeted advice that would require a neuromuscular adaptation resulting in a reduced number of ITB injuries. In order to accomplish this we tested the following hypothesis - running form suggestions can significantly reduce the peak hip adduction moment.

METHODS: The five volunteers recruited were actively training for a marathon. All runners were pain free in the present season, although they had all suffered ITB injuries in past marathon seasons. Two of the runners had run 18 miles as their longest run and the other three runners had 14 miles as their peak distance. The protocol consisted of a one-mile treadmill warm-up, followed by walking and running trials. All runners had their right leg tested. Gait tests were performed using a previously described system developed by CFTC using 120Hz Qualisys cameras and a Bertec force plate (Andriacchi & Mikosz, 1997). The kinematics and joint kinetics were calculated for the hip, knee and ankle.
The running trials consisted of three normal runs followed by a series of coached trials. The final two coached trials involved the following advice:

1. Run in such a way that you lower yourself about 1 inch.
2. Maintain your normal running speed.

Trials were kept when the runner satisfied the above criteria. For each subject a normal trial and a speed-matched coached trial were chosen for comparison.
The peak hip adduction moment normalized by weight and height (%BWHT) for the normal and coached trials were used to test the hypothesis. To investigate the source of any changes - peak ground reaction forces were also tested. It is useful to test the ground reaction forces since reductions in the adduction moment can be affected by changes in either the associated resultant force or its moment arm. To further complement the peak hip adduction moment measure, both heel-strike knee flexion and peak stance-phase knee flexion were also tested.

METHODS-ANALYSIS: For all of the statistical analyses one-tailed pair-wise t-tests were used. A p-value of less than 0.05 was considered statistically significant.

RESULTS: The normalized peak external adduction moment was significantly reduced in the sample by 21.8%. During the normal trials the average peak moment was 8.4(%BWHT) and during the coached trials the runners reduced their peak moment to 6.6(%BWHT) (Figure 1). Neither speeds nor moments about the knee changed significantly ($p>0.05$).

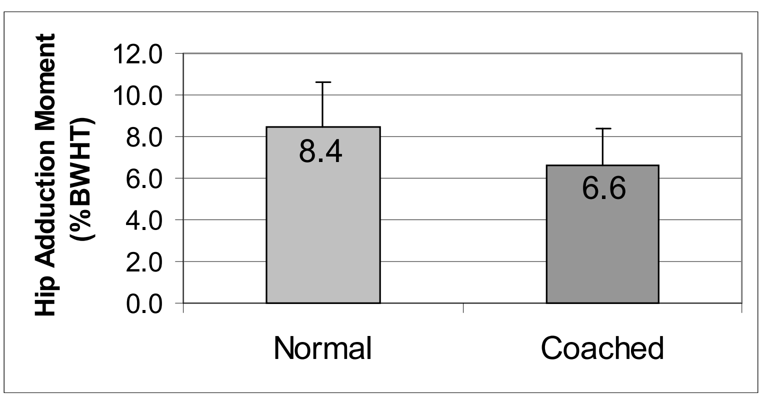

Figure 1 - The average peak normalized hip adduction moment for 5 runners with their normal and coached running styles ($p<0.05$).

Three of the peak ground reaction forces were also reduced significantly. The peak braking, vertical and the resultant forces were reduced by 12.4%, 9.8%, and 9.7% respectively. The reductions in ground reaction forces are implicated in the reduction of the peak hip adduction moment.

Table I Average Peak Ground Reaction Forces (n=5) (%BW)

Trials	Medial	Lateral	Braking	Acceleration	Vertical	Resultant
Normal	6.7	9.3	26.1*	30.6	246.0*	246.2*
Coached	4.6	8.4	22.9*	33.3	221.9*	222.2*
% Change	-31.3	-9.7	-12.3	8.8	-9.8	-9.7

* $p<0.05$

The kinematic measure, knee flexion angle at heel-strike, was significantly increased. When running in the coached style, runners increased their heel-strike knee flexion angle from 8.6° to 18.7° (Figure 2). This will aid the runners in reducing the exposure of the ITB to the lateral epicondyle. The peak stance-phase knee flexion angle did not change significantly.

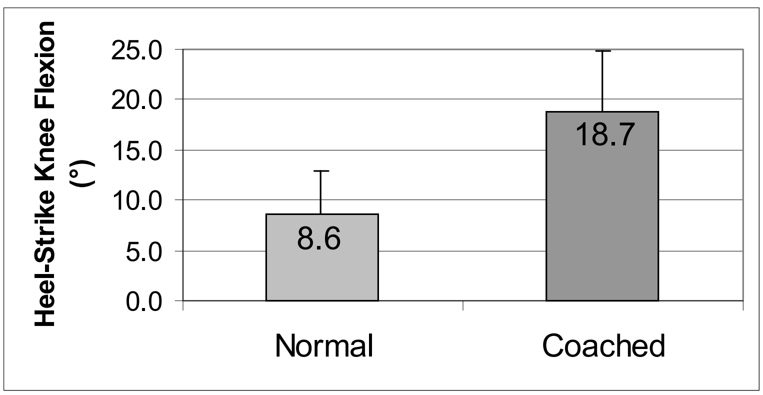

Figure 2 - The average heel-strike knee flexion angle for 5 runners with their normal and coached running styles (p<0.01).

DISCUSSION: Coaching the runners to lower their bodies by ~1 inch (2.54cm) significantly reduced the peak hip adduction moment. The changes in adduction moment are comparable to values that predict who would and who would not suffer from ITBS. From a prospective study, the mean of runners who were bound for ITBS was 8.5(%BWHT) and those who ended up injury-free was 6.4(%BWHT) (MacMahon, et al., 2000). Coaching such as that used in this project reduced the runner's moments from 8.6(%BWHT) to 6.6(%BWHT). Runners who accomplish similar results should expect to subsequently prevent the occurrence of ITBS.

We have identified coaching advice that may reduce the incidence of ITBS in runners. The impact on the distance running community may be substantial. In an epidemiological study over 29% of marathoners were found to suffer ITBS in a training season (MacMahon, et al., 2000).

The peak adduction moment has two degrees of freedom. Changes in the moment may originate in either the moment arm or the associated resultant force. Therefore the three peak ground reaction forces significantly reduced in the coaching trials are implicated as the mechanism by which the adduction moment was reduced.

This coaching also successfully produced favorable increases in heel-strike knee flexion. Since fatigue has been found to correlate with heel-strike induced loading, this combination of kinematic and kinetic changes may also reduce fatigue (Mizrahi, et al., 1997). By definition, overuse injuries result from exposure to large loads; therefore, this may also reduce the occurrence of other overuse injuries as well. Considering the combination of these benefits, runners prone to ITB injuries should employ this advice to reduce their risk of a recurrence.

However, the normal and coached heel-strike knee flexion angles were below the 21.4º reported in a study of runners who were actively suffering ITBS (Orchard, et al., 1996). On the other hand, in a study of healthy runners, researchers found an average heel-strike knee flexion of 9º (McClay & Manal, 1998). The increased flexion reported in the injured runners may have been a compensatory response to reduce the interaction between the ITB and lateral epicondyle. In a comparative study of the kinetics of normal and ITBS injured runners, reduced peak braking forces correlated with injury (Messier et al., 1995). It is reasonable to assume that this was also a compensatory mechanism in the injured runners and that reduced loading in uninjured runners should not be considered a pathway to injury.

Runners can reduce the friction between their ITB and the lateral epicondyle and enjoy the decreased risk of ITBS injuries by lowering their upper bodies during running.

CONCLUSION: Coaching marathon runners to lower their upper bodies while running can improve kinematic (greater heel-strike knee flexion) and kinetic (lower peak hip adduction moment) variables found to associate with developing ITBS. Runners prone to ITBS injuries should adopt this technique to reduce their risk of recurrence. Runners beginning marathon training should adopt this style to help prevent ITBS injuries.

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