QUADRICEPS-HAMSTRING MUSCLE SYNCHRONY DURING LANDING MOVEMENTS: IS IT AFFECTED BY MOVEMENT DIRECTION?

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INTRODUCTION

One of the most frequent non-contact mechanisms of isolated injury to the anterior cruciate ligament (ACL) occurs when landing from a jump, particularly when players land and rapidly decelerate their forward progression [1]. Past research has suggested that to protect the ACL from injury, athletes should land with more vertical rather than horizontal momentum and use run-on steps where possible [1]. Although appropriate muscle activation patterns that control the lower limb at initial contact (IC) have been suggested to protect the ACL, little is know as to how or whether these patterns change with different movement types and with different post-landing strategies. Therefore, the purpose of this study was to assess whether quadriceps-hamstring muscle synchrony are affected by different landing movements and/or the need to decelerate abruptly or not.

METHODS

Thirty-six athletes (mean 23.6 years, range 19-30) involved in landing sports and with no history of knee joint injury volunteered to participate in the present study. All subjects underwent laboratory-based assessment of their landing technique when performing two landing movements (vertical mark, horizontal stride) and two post-landing strategies (rapid deceleration at IC, run-on after IC).

During the five trials per condition, electromyographic (EMG) data were sampled (1000 Hz; bandwidth, 0-340 Hz) for the rectus femoris (RF), vastus lateralis (VL), biceps femoris (BF) and semitendinosus (S) muscles of each subject's dominant lower limb using a Noraxon Telemyo system. Following zero offset removal, raw EMG signals were filtered using a fourth order zero-phase-shift Butterworth high pass filter (f_c = 15 Hz). The filtered muscle activity data were then full-wave rectified and low pass filtered (f_c = 20 Hz) and the resultant linear envelopes were screened with a threshold detector (7% of maximum amplitude) to determine the temporal aspects of each muscle burst with respect to IC. IC was confirmed against ground reaction force data collected (1000 Hz) using a Kistler force platform.

RESULTS AND DISCUSSION

Two-way repeated measures ANOVA results indicated that, although there was no main effect of post-landing strategy on muscle activity, there was a significant main effect of movement type on quadriceps-hamstring muscle synchrony (Figure 1). That is, RF and VL were activated significantly earlier and S and BF were activated significantly later when subjects performed the vertical mark compared to the horizontal stride (Figure 1). When striding, a horizontally directed movement, subjects appeared to follow the typical sequential recruitment pattern of hamstrings followed by quadriceps activation. This pattern is suggested to protect the ACL by maximizing the efficacy of the hamstring muscles to produce posterior tibial drawer [2]. In comparison, when subjects performed the vertical mark, the thigh muscles showed a more simultaneous activation pattern, indicating greater co-contraction and preparation of the lower limb to absorb a more vertically directed ground reaction force and prevent collapse of the lower limb during landing. Interestingly, these two muscle activation strategies used during the two different movement types were unchanged regardless of the post-landing strategy to be performed.

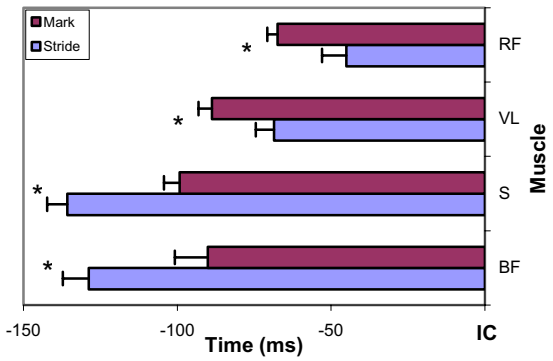

Figure 1: Quadriceps and hamstring muscle synchrony when subjects performed the mark and stride movements (IC = initial contact; * indicates $p < 0.05$).

CONCLUSIONS

It was concluded that, although the direction of landing movement may alter quadriceps-hamstring muscle synchrony at IC, the movement to be performed after landing did not influence this muscle synchrony. However, research is warranted to determine whether the quadriceps-hamstring muscle synchrony noted for the vertical mark was more advantageous in terms of preventing ACL injury relative to the strategy used during the horizontal landing. Furthermore, whether unanticipated post-landing strategies, relative to anticipated strategies, could alter the quadriceps-hamstring muscle synchrony in a way that could predispose the athlete to ACL injury requires investigation.

REFERENCES

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2. Kain, et al. *Am J Sports Med* **16,** 147-152, 1988.

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