INTRALIMB COORDINATION IN FEMALE RUNNERS WITH TIBIAL STRESS FRACTURES

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INTRODUCTION

Tibial stress fractures are a common injury suffered by female runners. Studies looking at traditional kinematic or kinetic (such as ground reaction forces) differences between injured and uninjured populations during running have been unsuccessful at determining a causal factor associated with the injury [1]. The nature of differences that exist between groups may better be captured using dynamical systems techniques that capture the spatio-temporal dynamics of gait [2]. Dynamical systems analysis techniques have been shown to be more sensitive to subtle differences in human movement analyses. For example, gait variability as measured through continuous relative phase (CRP) has been shown to decrease in subjects with patellofemoral pain relative to an asymptomatic group [3].

The purpose of this study was to examine changes in gait variability in asymptomatic female runners who had previously suffered from a tibial stress fracture (TSF) compared to a control group (CTRL) of mileage matched female runners. It was hypothesized that the TSF group would have a significant difference in CRP variability between the stress fractured limb and the contralateral limb while the CTRL group would have no difference in CRP variability between limbs.

METHODS

Fifteen female runners with a unilateral retrospective tibial stress fracture and 15 mileage matched control subjects were recruited for this study. All volunteers were female, rearfoot strikers who ran at least 20 miles per week and were free of any lower extremity injuries at the time of data collection.

Subjects ran along a 25 m runway at a speed of 3.65 m/s (± 5%). Three-dimensional kinematic data (120 Hz) were collected using a six-camera high-speed motion capture system. Five trials were collected for both the left and right limbs. For each subject, the profiles of the ankle, knee and hip sagittal view angles were interpolated to 100% of stance.

Bilateral hip, knee and ankle 3-D angles were calculated over each stride. Variability in intralimb coordination was assessed through measures of CRP for the hip-knee and knee-ankle coupling of both the involved and contralateral limb of the TSF subjects and the right and left limbs of the CRTL subjects. CRP variability was defined as the average standard deviation of CRP across each stride.

Effect size (ES) was calculated to express differences relative to the pooled standard deviation. Cohen (1988) proposed that ES values of 0.2 represent small differences; 0.5, moderate differences; and 0.8+, large differences.

RESULTS AND DISCUSSION

In the control group no effect was observed between the right and left limb in either the hip-knee or knee-ankle œupling (ES<0.1). In the TSF group, CRP variability decreased in the involved limb relative to the contralateral limb in the hip-knee (ES=.26) and the knee-ankle coupling (ES=.87) (Figure 1).

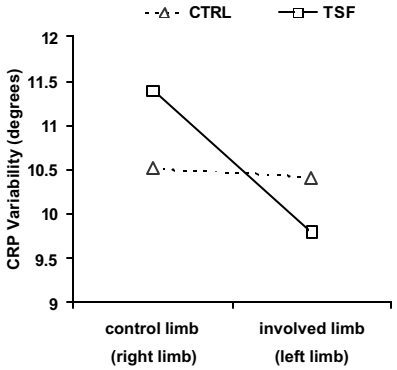

Figure 1: Mean CRP variability in the knee-ankle coupling for involved and contralateral limbs of TSF group and right and left limbs of the CTRL group.

Although the largest effect in the TSF group was observed in the knee-ankle coupling, a small effect was also observed in the hip-knee coupling, showing that a distal injury may also affect more proximal coordinative patterns. The results from both the TSF and CTRL groups support the hypothesis. It has been proposed that reduced CRP variability indicates a less flexible or less adaptable movement pattern [2, 3]. A less flexible pattern may exacerbate the injury or cause further injury to a TSF runner.

CONCLUSIONS

While the results of this study support the hypothesis that reduced CRP variability and thus less flexible/adaptable patterns are indicative of an injured condition, it is still not evident whether this less flexible pattern is a cause or a result of the injury. Although prospective studies are needed to determine cause-effect of this phenomenon, this study adds to a growing body of literature that suggests CRP variability may be a functional adaptation utilized to cope with the injury.

REFERENCES

1. Bennell K, et al., *Med Sci Sports Exerc* **36,** 397-404, 2004.
2. van Emmerik REA, et al., *J Appl Biomech* **20**, 396-420, 2004.
3. Hamill J, et al., *Clinical Biomech* **14**, 297-308, 1999.
4. Cohen, J., Erlbaum, New Jersey, 1988.

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