VARIABLES ASSOCIATED WITH THE INCIDENCE OF LOWER EXTREMITY STRESS FRACTURES

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INTRODUCTION

Overuse injuries are common among competitive runners with stress fractures (SF) being one of the most serious overuse injuries. SF are among the top 5 cited running-related injuries and females are twice as likely to experience a SF as their male counterparts. The etiology of SF is multifactorial in nature but is related, in part, to some combination of bone structure, peak forces, loading rates, as well as lower extremity running mechanics. Therefore, the purpose of this investigation was to examine differences in ground reaction force (GRF), tibial acceleration, bone structure, and kinematic variables between competitive female distance runners who had sustained a previous lower extremity SF and uninjured control subjects. It was hypothesized that peak tibial acceleration, vertical GRF loading rates, and lower extremity stiffness would be greater in the injured runners and area moment of inertia of the tibia and knee flexion excursion would be lower. In addition, those variables which were different would contribute significantly to the prediction of which runners had sustained a SF.

METHODS

Subjects consisted of 8 females with a history of at least one lower extremity SF and 8 females with no SF history who served as a control group (CON). All subjects were between ages 18-35 and ran between 30-80 miles per week. These subjects are part of a larger ongoing study investigating factors associated with SF in women runners. GRF and tibial acceleration data were recorded from 5 running trials. Three radiographs of the distal lower extremity were used to calculate the tibial area moment of inertia (Milgrom et al., 1989). Variables of interest included peak positive tibial acceleration (PPA), peak vertical GRF (VGRF), instantaneous loading rate (ILR), stiffness (STF), knee flexion excursion (KFlex) and tibial area moment of inertia in the anterior/posterior plane (I_{AP}). Independent t-tests were used to assess differences between groups. A backward, stepwise statistical regression analysis was used to determine the factors that best predicted which subjects had previously suffered a SF.

RESULTS AND DISCUSSION

Of the 8 total SF, 5 were tibial, 2 were fibular and 1 was metatarsal. Results indicated that both PPA and ILR were significantly ($p<0.05$) greater in the SF group (Table 1). Although not significant ($p>0.05$), a trend towards greater stiffness and reduced knee flexion excursion in the SF group was also observed (Table 1). Williams et al. (2001) also reported a significantly higher load rate and great stiffness in a group of runners with high arch feet and a greater incidence of stress injuries. However, Crossley et al. (1999) reported no significant differences in GRF variables between SF and control subjects.

Other investigations have reported that bone geometry was significantly different between SF and control groups (Crossley, 1999; Milgrom, 1989). However, in the present investigation, the SF group exhibited similar tibial I_{AP} values as compared with the control group (Table 1). A small subject population may account for discrepancies between previous studies and the results of this investigation.

The results indicate that PPA and ILR explained 46% of the variance ($p=0.01$) in predicting subjects who had previously suffered a SF. ($y = 3.50 + -0.12PPA + -0.01ILR$). None of the remaining variables entered into the regression equation. However, it is possible that these results may change as more subjects are analyzed during this ongoing study.

SUMMARY

These data suggest that 1) subjects who had previously suffered a lower extremity SF demonstrated greater GRF loading rates, shock, and stiffness and reduced knee flexion excursion as compared with noninjured controls and 2) kinetic measures can be used to predict which subjects had previously sustained a SF.

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Table 1: Mean (SD) and p-values of selected variables for SF and CON groups.

	PPA (g)	ILR (BW/s)	STF(kN/m)	KFlex (°)	I_{AP}
SF	8.23 (1.08)	119.20 (27.97)	9.32 (1.53)	29.76 (5.70)	11016 (3175)
CON	6.50 (1.56)	90.44 (15.28)	8.30 (0.54)	33.40 (3.91)	11457 (4098)
p value	0.02	0.04	0.09	0.14	0.81

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