ARE STRUCTURAL AND GAIT BIOMECHANICS INDICATIVE OF TIBIAL STRESS FRACTURE RISK?

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INTRODUCTION

The Royal Marine (RM) Commando training course is believed to be the longest basic infantry training course in the world. Tibial stress fracture is one of the most common injuries in this population [1]. Lower limb structure, joint range-of-movement, gait kinematics and kinetics have all been associated with this injury in different populations, however conclusions are ambiguous. The intensity, frequency and duration of the physical stress experienced during RM training may exacerbate potential risk factors not identified in other populations. The aim of this study was to identify biomechanical differences between RM Commando recruits with, and without tibial stress fracture history.

METHODS

Twenty RM recruits; ten with tibial stress fracture history and ten controls participated in the study. All recruits had failed to complete the full 30-week commando training course due to injury or illness. Recruits were passed fit to return to training at the time of assessment. Measures of lower limb structure and range-of-movement were taken by a state registered podiatrist. Barefoot and shod running gait kinematics (120Hz; Peak Performance Technologies Inc., CO), and ground reaction forces (960Hz; AMTI, MA) were collected. Coordinate data were reconstructed using the procedures of Cole et al [2]. Movement data were referenced to a standing neutral trial.

All data were analyzed using the Wilcoxon signed rank test for matched pairs ($P \leq 0.05$). Twelve tibia with stress fracture history were identified in the injury group, each of these limbs were paired with a limb from the control group. Recruits were matched for the number of weeks of the full training course they completed prior to injury or illness.

Table 1: Selected measures of lower limb structure, barefoot (BG) and shod (SG) running gait (mean ± SD; * p<0.05).

		Tibial stress fracture	Controls
Medial hip rotation (deg)		26.6 ± 5.5	32.1 ± 10.1*
GRF impact peak time (sec)	BG	0.012 ± 0.004	0.017 ± 0.007*
	SG	0.028 ± 0.005	0.026 ± 0.005
Peak subtalar eversion (deg)	BG	5.5 ± 3.3	4.6 ± 4.7
	SG	6.0 ± 3.5	7.3 ± 3.5

RESULTS AND DISCUSSION

The reduced passive medial rotation of the hip (p<0.05; Table 1) observed in the stress fracture group is suggestive of greater hip retroversion, this is consistent with previous findings [3]. Hip retroversion is believed to result in limited subtalar pronation during gait [4], however this is not supported by the running gait data. During standing hip retroversion results in a supinated foot [4]. This may have masked differences in gait kinematics between the experimental groups because of the defined neutral position employed.

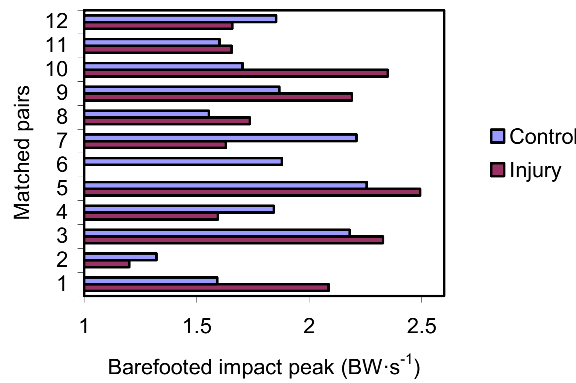

Figure 1: Individual (subject paired) GRF impact peaks.

The vertical ground reaction force (GRF) impact peak occurred significantly earlier in the tibial stress fracture group during barefoot running (p<0.05; Table 1), but not during shod running (p>0.05). Large variation in measured variables within the study groups contributed to no other significant differences between the groups. Figure 1 illustrates the variation observed in barefoot impact peak values, this is typical of many of the other variables measured. Evidently no cut-off point can be identified between individuals at high and low risk of tibial stress fracture.

CONCLUSIONS

Limited medial rotation of the hip is associated with tibial stress fracture injury. This may be related to increased retroversion of the hip and subsequent implications upon gait. The vertical GRF impact peak time may also be important in tibial stress fracture development, however findings were not consistent between barefoot and shod conditions.

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