REDUCING LOWER EXTREMITY LOADS THROUGH GAIT RETRAINING USING REAL-TIME FEEDBACK METHODS

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INTRODUCTION

Stress fractures are a common injury associated with the repetitive loads encountered during running and marching in basic combat training (BCT). A recent study of U.S. Army recruits found that 30% of the injuries sustained in BCT were stress fractures. Stress fractures are costly in terms of time and money. Rehabilitation time is 8 to 10 weeks (Hauret et al., 2001), and recruits who are discharged because they cannot complete their training cost the Army approximately $10 M per year.

Prospective and retrospective studies have shown that subjects who sustain a tibial stress fracture have higher tibial shock than those who do not sustain a stress fracture (Milner et al., 2006; Davis et al., 2004). The rapid deceleration of the tibia at heel strike can lead to high strain rates in the bone which are suspected of being a cause of stress fractures (Fyhrie et al., 1998). Therefore, reducing these loads may result in reducing stress fracture risk.

Acute changes in lower extremity loads during running are possible in a single session of training with visual feedback (Crowell et al., 2005). However, long term retention of these changes has not been studied. Therefore, the purpose of this pilot study was to determine whether a longer period of training would result in reductions in loading that would be evident one month after training.

METHODS

This is an ongoing study in which five subjects (3 females, 2 males) have participated to date. All subjects were between 20 and 34 years of age, ran at least 10 miles per week, and exhibited tibial shock greater than 8.9 g. Baseline three-dimensional kinematic and kinetic data were collected as subjects ran through the laboratory at 3.7 m/s (±5%).

For the retraining sessions, subjects ran on a treadmill at a self-selected pace. A uniaxial accelerometer was attached to the distal tibia on the side that had the highest shock, noted in the baseline data collection. Visual feedback of their tibial shock was provided on a monitor placed in front of them as they ran. Subjects were instructed to maintain their shock levels under 6 g as indicated by a line placed on the monitor.

The time for which subjects ran started at 10 minutes and increased to 30 minutes for the final sessions. Subjects were restricted from running outside the retraining sessions. Subjects received constant visual feedback for the first half of their sessions. The feedback was progressively removed over the remaining sessions such that subjects had three minutes of feedback in their final session. Immediately after the last
retraining session, kinematic and kinetic data were collected again. Then they ran on their own for four weeks and returned for a follow-up data collection. The first two subjects underwent retraining for 12 sessions over 4 weeks. However, because of the ease with which these subjects reduced their loading, the protocol was shortened to two weeks (8 sessions) for the remaining three subjects.

RESULTS

All subjects reduced their peak tibial shock from baseline at both post training and at 1 month follow-up (Figure 1).

DISCUSSION

As expected, both the four week and two week protocol resulted in reductions in lower extremity loading that were maintained over the one month follow-up period. Feedback was only provided on tibial shock, which exhibited the greatest reduction from baseline. However, retraining also significantly reduced the other three loading variables. The reductions in loading that the subjects achieved during this study likely reduce the strain and strain rates on their tibias, and thereby decrease their risk of stress fractures. Further analysis is underway to identify the kinematic strategies used by the subjects to reduce their lower extremity loading.

CONCLUSIONS

Based on these preliminary results, subjects are able to reduce their lower extremity loading by retraining with real-time visual feedback. These changes were maintained at one-month follow-up.

REFERENCES


Table 1. Lower extremity loading and changes for the group.

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Post-training</th>
<th>1 month follow-up</th>
<th>Change (Baseline to Follow-up)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tibial Shock (g)</td>
<td>10.8</td>
<td>5.8</td>
<td>5.2</td>
<td>-52 %</td>
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<tr>
<td>Inst. Load. Rate (BW/s)</td>
<td>84.7</td>
<td>58.6</td>
<td>54.8</td>
<td>-35 %</td>
</tr>
<tr>
<td>Impact Peak (BW)</td>
<td>1.6</td>
<td>1.3</td>
<td>1.2</td>
<td>-29 %</td>
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<td>Avg. Load. Rate (BW/s)</td>
<td>69.8</td>
<td>47.5</td>
<td>47.6</td>
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