Hamstring to Quadriceps Strength Ratio
Pre and Post Muscular Fatiguing

Jolaolu M. Jimoh*, Kerryn Opat
Faculty: Jeremy Patterson

Department of Human Performance Studies, College of Education

Abstract. The quadriceps and hamstring muscles are the two primary movers of the knee during exercise, and due to their antagonistic relationship, the strength ratio (H:Q) is important for efficient knee mechanics. Fatigue is a factor that may alter the strength ratio, predisposing the active person to injury. This study examined the effect of fatigue on the H:Q ratio in 12 subjects that were tested on an isokinetic dynamometer, before and after inducing fatigue on a cycle ergometer during a 30 sec sprint. The H:Q does not significantly change within subjects, and between ergometers. Fatigue did not affect quadriceps but hamstrings strength declined, which may predispose it to injuries.

1. Introduction

The Hamstring to Quadriceps Strength Ratio (H:Q) is used to evaluate torque and muscle strength generated by the leg muscles. The strength ratio (H:Q) is calculated by comparing the concentric outputs of the hamstring to the concentric outputs of the quadriceps. The ratio assists clinicians in assessing muscle balance and knee functional ability [1]. Decreased activation of hamstrings relative to quadriceps has been implicated as a potential mechanism for increased lower extremity injury [2]. Quadriceps to Hamstring strength ratio (H:Q) is believed to be an important factor in physical ability and health. If this ratio is altered, it may predispose the knee and leg to injuries. Therefore, understanding the effect of fatigue on H:Q is important not only in rehabilitative process, but also functional capacity or ability to do work.

2. Experiment

Coupled VS. Uncoupled Crank Systems

Two cycle ergometers were used in this study, a Monark 828E with standard coupled crank arms (CCA) and a Revmaster Lemond with uncoupled crank arm (UCCA) attached. Uncoupled cranks use an independent-clutch design allowing each leg to pedal independently (i.e., the cranks are not fixed together) [3]. Unlike normal cranks, uncouple cranks use a clutch design forcing the cyclist to produce rotational force throughout 360° of the pedal stroke. Cyclists using uncoupled crank must pull up with each leg on every pedal stroke [3,4]. 360° of force production by the UCCA can condition the hip and knee flexors to facilitate an adaptation of neuromuscular recruitment, improving pedal stroke efficiency.

The test protocol included a warm-up/familiarization period for 1min using the UCCA. The pretest included 2 practice reps and 10 max reps on an isokinetic dynamometer that measures torque.

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comparison of peak torques and H:Q ratio in coupled and uncoupled cranks.</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Pre-Q peak torq. (NM)</td>
</tr>
<tr>
<td>Post-Q peak torq. (NM)</td>
</tr>
<tr>
<td>Pre-H. peak torq. (NM)</td>
</tr>
<tr>
<td>Post-H peak torque (NM)</td>
</tr>
<tr>
<td>Pre-H:Q</td>
</tr>
<tr>
<td>Post H:Q</td>
</tr>
</tbody>
</table>
Following the pretest, subjects performed a fatiguing activity, involving a 30sec sprint on UCCA. The posttest was also 10 more maximal repetitions on the isokinetic dynamometer. Peak torque of the hamstrings and quadriceps were used to calculate H:Q for pre- and post-fatigue.

3. Discussion and Significance

The analysis showed no significant decrease in pre-and post- quadriceps peak torque in both cranks systems (p = >0.05), suggesting that both cycle did not affect quadriceps strength. Nor was there any significant decline in quadriceps’s power within subjects after inducing fatigue. In fact, there were slight increases in quadriceps strength. In contrast, hamstrings strength was significantly reduced across the subjects and between coupled and uncoupled cycle ergometers. Pre H:Q was not significantly different to post H:Q values, therefore the decrease in post H:Q is too small for all subjects. Decrease in H:Q in coupled and uncoupled cranks were too small to be significant. There is no different in changes in H:Q of coupled and uncoupled cranks.

4. Conclusions

This study suggests that the H:Q does not significantly change within the subjects or between coupled and uncoupled arm cranks. Interestingly, it was also observed that strength of quadriceps was not affected by fatigue. Quadriceps strength increased slightly after riding both ergometers. These findings did not support the study hypothesis that fatigue and exercise will have an effect on H:Q and that the effect would be different between types of crank arms. This may be due to small sample size (n =12) and or short test time (30 seconds). In addition, the small H:Q in our findings may be a result of using the traditional $H_{con}:Q_{con}$ instead of a more functional eccentric: concentric method.

5. Acknowledgment

We are thankful to Dr. Kaelin Young for helping with the statistical analysis and his constructive advice during the course of this research.

6. References
