The physiological determinants of recovering repeated-sprint ability in team-sport athletes

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Introduction

Short sprints (< 6 s) have been identified as important components in team-sports, and may be critical to a team's success(1). Rather than being distributed at regular intervals throughout the course of a game, sprints are unpredictable and often occur in bouts(2). A bout of repeated-sprints has been characterised by a decline in sprint performance from the first to the last sprint(3) and it would appear that an athlete's repeated-sprint ability (RSA) is limited by a complex network of processes, which include phosphocreatine (PCr) depletion, H+ accumulation, an increase in extracellular K+ concentration and other factors affecting the excitation-contraction coupling process. However, despite the requirement of team-sport athletes to engage in more than one repeated-sprint bout during the course of a game(4), the mechanisms associated with the recovery of RSA are unknown. The purpose of this study was to investigate those physiological and metabolic factors that are related to recovering RSA.

Methods

Nine, well-trained, female soccer players (mean ± SD: age 27 ± 7 y; height 168 ± 4 cm; mass 60.5 ± 5.3 kg; VO2max 50.0 ± 3.9 ml·kg⁻¹·min⁻¹) performed a graded-exercise test to determine their VO2max and lactate threshold (LT). Each participant then completed a series of seven main repeated-sprint trials (MT1-7) on separate days, where each MT involved two bouts (B1 and B2) of 5 x 6-s maximal cycle sprints. The five sprints within each bout were separated by 24 s of active recovery, cycling at 75% aerobic threshold. MT1-5 employed different passive recovery periods between B1 and B2, so as to determine the least time required to recover RSA (RSAOPT). In MT6, the between-bout passive recovery period was standardised at 5-min; the proportion of total work (Wtot) recovered in this trial (from B1 to B2) was reported (REC5). Expired air was collected in MT7 during sprints 1 and 5 of both bouts and throughout the optimal between-bout passive recovery period. During the last MT, muscle biopsies were taken from the vastus lateralis at rest, immediately and 5 min post B1, and again at the individually established RSAOPT to determine ATP, PCr, La- and H+ concentrations.

Results

The mean time for RSAOPT was 10.7 ± 1.2 min (range 9 to 13 min). After 5 min, participants had recovered RSA to 97.7 ± 4.0% of B1. Neither RSAOPT nor REC5 were significantly correlated with Wtot during B1 (r = 0.44 and r = 0.29; P = 0.24 and P = 0.45, respectively). During the passive recovery period between B1 and B2, oxygen consumption was 1.22 ± 0.16 L·min⁻¹ over the first 5 min of recovery (VO2REC5) and 0.80 ± 0.07 L·min⁻¹ over the total optimal recovery period (VO2RSAOPT). VO2max correlated significantly with both VO2REC5 (r = 0.94; P < 0.01) and VO2RSAOPT (r = 0.78; P = 0.02). From rest to post exercise there was a significant decrease in both blood and muscle pH (pHbl: 7.45 to 7.29; pHm: 7.14 to 6.92; P < 0.01), as well as an increase in blood La- concentration ([La-]bl: 1.0 to 11.4 mmol·L⁻¹; P < 0.01). While neither blood or muscle pH recovery (∆pHbl, 5 min post B1) related to REC5, there was an association between REC5 and the change in [La-]bl during the first 5 min of recovery following B1 (Table 1). Despite the disturbances caused during exercise, pHbl at RSAOPT was not significantly different from rest (p = 0.14). Muscle ATP, PCr and La- are currently being analysed.

Table 1: Correlations between REC5 and RSAOPT and a number of physiological and metabolic measures; *P < 0.05

<table>
<thead>
<tr>
<th></th>
<th>VO2max</th>
<th>LT</th>
<th>Wtot in B1</th>
<th>Post-ex [La-]</th>
<th>Post-ex pHbl</th>
<th>∆pHbl 5 min post B1</th>
<th>∆pHm 5 min post B1</th>
<th>∆[La-]bl 5 min post B1</th>
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</thead>
<tbody>
<tr>
<td>REC5</td>
<td>r =</td>
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<td>-0.29</td>
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<td>0.48</td>
<td>0.99</td>
<td>-0.03</td>
<td>-0.94</td>
</tr>
<tr>
<td></td>
<td>P =</td>
<td></td>
<td>0.35</td>
<td>0.87</td>
<td>0.45</td>
<td>0.01*</td>
<td>0.27</td>
<td>0.96</td>
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<tr>
<td>RSAOPT</td>
<td>r =</td>
<td></td>
<td>0.65</td>
<td>0.07</td>
<td>0.24</td>
<td>0.58</td>
<td>0.14</td>
<td>-</td>
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</tbody>
</table>

Discussion/Conclusion

The results of this study show that a group of trained, female, team-sport athletes are able to recover RSA almost completely in 5 min. Unlike results following single-sprint exercise, performance during B2 is not affected by performance during B1. Consistent with results from other studies(4), it appears that LT may give an indication of the ability to recover RSA while VO2max is not a strong predictor of RSA recovery. A strong association between VO2max and both VO2REC5 and VO2RSAOPT does not appear to enhance recovery of RSA. The relationship between REC5 and post exercise [La-] suggests that a greater anaerobic contribution during B1 may negatively affect the recovery of RSA. Since pH recovery is almost complete at RSAOPT, it may be associated with the recovery of RSA. However, the lack of association between REC5 and pH recovery 5 min post B1 may indicate, similar to recent evidence, that H+ accumulation does not affect the recovery of force. The completion of the muscle analysis (for ATP, PCr and La- data) should provide further explanation as to the physiological mechanisms contributing to the recovery of RSA.

References