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Original research

Profiling the time-course changes in neuromuscular function and muscle damage over two consecutive tournament stages in elite rugby sevens players

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ABSTRACT

Objectives: Many International Rugby Board (IRB) sevens competitions require that two tournament stages are played over consecutive weekends, but the impact this has on player physical performance and recovery is lacking. We examined the influence of two consecutive tournaments on neuromuscular function (NMF) and muscle damage in rugby sevens players.
Design: Ten elite international rugby sevens players completed this observational study over 2 tournaments, separated by 5 days, during the IRB sevens series.
Methods: On the morning of day 1 and 2, of both tournament 1 (T1) and 2 (T2), players performed countermovement jumps (CMJ; jump height [JH]) and capillary blood samples (creatine kinase [CK]) were collected. After the last match of each day, further capillary samples were collected. Additional, CMJ were performed 12 and 60 h post-T1.
Results: Player JH decreased from day 1 to day 2 during T1 (mean ± SD; −6.0 ± 5.4%; $P = 0.016$), was reduced at 12 (−26.1 ± 5.0%; $P < 0.001$) and 60 h post-T1 (−7.1 ± 4.8%; $P = 0.003$) and remained lower, at am day 1 of T2 (−8.0 ± 6.0%; $P = 0.007$), when compared with day 1 of T1. Player JH was lower on day 1 and 2 of T2, compared with T1 ($P < 0.05$). CK concentrations were greater than baseline at all time points during each tournament ($P < 0.001$); no between tournament differences in CK responses existed ($P = 0.302$).
Conclusions: A single sevens tournament reduces NMF such that players are not fully recovered by the start of the second competition stage, however CK returns to baseline in-between and shows the same pattern across two consecutive tournaments.

1. Introduction

Rugby union sevens is increasing in popularity, and in 2009 it was added to the 2016 Rio de Janeiro Olympic games. Rugby union sevens competitions differ dramatically from other team sports, including the traditional 15 a-side game, in that they are usually played over a 2 day tournament weekend, with matches consisting of two 7 min halves, with a 2 min half-time interval,[1] on a full dimension rugby union field. A tournament usually consists of 3 group stage matches on the first day, each separated by ~3 h, and depending on results, up to three on the second day of the tournament. In addition, the international rugby union sevens series (the world professional competition) also requires two stages (i.e. 2 tournaments) to be played on consecutive weekends.

During a sevens match, players can spend ~75% of the game at heart rates above 80% of maximum[2] while also covering a total of ~1581 m, with ~9% of this distance covered through maximal sprinting, with average sprint distances of ~18 m[2]; while in rugby union 15-a-side games this intensity represents ~2% of the overall game demands.[3] These great physiological demands, which are heavily reliant on large contributions from high-intensity, stretch-shortening cycle based movements, combined with physical collisions, may also result in an increased appearance of intramuscular protein/enzymes in the blood,[4] which are indicative of skeletal muscle damage.[5] For example, Takashi and colleagues[4] reported an ~18% increase in serum creatine kinase (CK) after a

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single rugby union sevens match, and a further increase (~42% above baseline) after the second match of the day.

The induction of skeletal muscle damage is also likely to impair neuromuscular function (NMF).[6] For example, Twist et al.,[6] reported reductions in NMF (countermovement jump performance) and concomitant increases in CK and muscle soreness 24 and 48 h post-match in professional rugby league players. Similarly, West et al.,[7] demonstrated that NMF may be reduced for up to 60 h post-match in professional rugby union players. Profiling the recovery time-course after intense contacts sports/training types, e.g.[7–9], is important for coaches, as these data can help inform post-match recovery strategies and training programme design.

Given the intense demands of rugby union sevens competition, and evidence of increases in markers of skeletal muscle damage after just 1 day of competition,[4] sevens players may be susceptible to reduced NMF over the course of a tournament weekend. Furthermore, as there are occasions where the players may need to compete again 5 days later, there is potential that players may enter a subsequent tournament having not fully recovered from the preceding stage. However, currently there is no information available to confirm or refute these hypotheses. Therefore, the aim of this study was to examine the influence of two consecutive tournament weekends on NMF and muscle damage in elite international rugby union sevens players.

2. Methods

With approval from the Swansea University Research Ethics Committee, 10 elite International Rugby Union Sevens players (mean ± SD, age: 26 ± 5 years; height: 1.83 ± 0.08 m; body mass: 86.1 ± 10.0 kg) participated in the study. All players had at least 3 years of (monitored/recorded) training history. All were informed of the potential risks associated with the study prior to giving their informed consent. This observational study was conducted during the last two stages of the eight stage, 6 month competition period of the International Rugby Board (IRB) world seven series. The last two stages were played within the United Kingdom (London and Edinburgh) and were separated by 5 days.

The observational window and measurement protocol is presented in Table 1; this was a typical training week for this team between tournaments. A standardised warm-up was performed prior to every game, which involved jogging, running, sprinting, contact, dynamic stretching and skill based drills. This warm-up was replicated before every match, during both tournaments, allowing for the players to be in the tunnel 6 min prior to the start of each match. Capillary blood samples for the subsequent measurement of plasma creatine kinase (CK) were collected from the players upon arrival at the competition venues (~10 am) and immediately after the last match of each day's play (Table 1). Countermovement jumps (CMJ) were performed on a portable force platform (processed for peak power output [PPO] and jump height [JH]) 10 min before the start of the first match on days 1 and 2, of both tournaments, and at the time points of 12 and 60 h after the last match at tournament 1 (Table 1). In that five day period tactical, technical and weight training sessions were carried out, of which only two sessions were optional. The only recovery modality used was a 20 min swimming pool recovery session, which involved swimming and stretching underwater on the day after T1. While in camp, all players were in a controlled setting, with prescribed meals and supplementation; players were also requested to replicate sleeping patterns.

For the measurement of CMJ PPO and JH, testing was completed on a portable force platform (Type 92866AA, Kistler, Germany). To isolate the lower limbs, participants stood with arms akimbo.[10] After an initial stationary phase of at least 2 s in the upright position, for the determination of body mass, participants performed a CMJ, dipping to a self-selected depth and then exploding upwards in an attempt to achieve maximum height. Participants landed back on the force platform and kept their arms akimbo throughout the movement. Players were required to complete 3 maximum jumps with 1.5 min rest between efforts. PPO and jump height were calculated as previously described.[10] The vertical component of the ground reaction force (GRF) during the CMJ was used in conjunction with the participants' body mass to determine instantaneous velocity and displacement of his centre of gravity.[10] Instantaneous power was determined using the following standard relationship: Power (W) = vertical GRF (N) × Vertical velocity of centre of gravity ($m.s^{-1}$)

Whole blood was collected via fingertip puncture using a spring-loaded disposable lancet (Safe-T-Pro Plus, Accu-Chek, Roche Diagnostics GmBH, Germany). A 120-μL sample was collected in a capillary tube and immediately centrifuged (Labofuge 400R, Kendro Laboratories, Germany) at 3000 rpm for 10 min for the extraction of plasma, which was subsequently stored at −20 °C. The plasma samples were left to thaw before 6 μL was used in the analysis of CK (CK using a semi-automated analyzer (COBAS MIRA; ABX Diagnostics, UK). Sample testing was carried out in duplicate and the mean coefficient variation (CV) for CK assays was 1.6%.

Statistical analysis was performed using SPSS software (version 16; SPSS Inc., Chicago, IL), with significance set at $P \leq 0.05$. Time-course changes from tournament 1 to tournament 2 were assessed using one-way repeated measures ANOVA, with bonferroni adjusted pairwise comparisons. Within and between tournament responses were examined using repeated measures ANOVA on two levels (time × tournament), with bonferroni adjusted paired-samples *t*-test used to examine between tournament differences. Where significant differences have been identified, 95% confidence intervals are presented for an estimation of the population mean difference. Data are presented as mean ± SD.

3. Results

The impact of tournament 1 on the NMF recovery time course leading in to tournament 2 is presented in Fig. 1. There was a significant time effect ($P < 0.001$; Partial-eta^2 = 0.400) in the players CMJ PPO from AM day 1 of tournament

Table 1
Sampling time-course throughout the study period.

Sample point	Tournament 1				Recovery					Tournament 2			
	Day 1		Day 2		Day 1	Day 2	Day 3	Day 4	Day 5	Day 1		Day 2	
	AM	PM	AM	PM	Post 12	–	Post 60	–	–	AM	PM	AM	PM
Creatine kinase	10:00	20:00	10:00	16:00	–	–	–	–	–	10:00	19:00	10:00	16:00
CMJ	10:00	–	10:00	–	08:00	–	08:00	–	–	10:00	–	10:00	–
Activity AM	Match Play (x3)		Match Play (x2)		PR	–	–	WT	O-WT	Match Play (×3)		Match Play (×2)	
Activity PM					Trav	O-WT	–	FS-T	FS-T				

PR: pool recovery (20 min); Trav: travel to tournament 2, 4.5 h train journey; O-WT: optional weight training session; WT: compulsory weight training session; FS-T: field based, tactical-technical rugby session.