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Original research

The impact of neuromuscular electrical stimulation on recovery after intensive, muscle damaging, maximal speed training in professional team sports players

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ABSTRACT

Objectives: During congested fixture periods in team sports, limited recovery time and increased travel hinder the implementation of many recovery strategies; thus alternative methods are required. We examined the impact of a neuromuscular electrical stimulation device on 24-h recovery from an intensive training session in professional players.
Design: Twenty-eight professional rugby and football academy players completed this randomised and counter-balanced study, on 2 occasions, separated by 7 days.
Methods: After baseline perceived soreness, blood (lactate and creatine kinase) and saliva (testosterone and cortisol) samples were collected, players completed a standardised warm-up and baseline countermovement jumps (jump height). Players then completed 60 m × 50 m maximal sprints, with 5 min recovery between efforts. After completing the sprint session, players wore a neuromuscular electrical stimulation device or remained in normal attire (CON) for 8 h. All measures were repeated immediately, 2 and 24-h post-sprint.
Results: Player jump height was reduced from baseline at all time points under both conditions; however, at 24-h neuromuscular electrical stimulation was significantly more recovered (mean ± SD; neuromuscular electrical stimulation −3.2 ± 3.2 vs. CON −7.2 ± 3.7%; $P < 0.001$). Creatine kinase concentrations increased at all time points under both conditions, but at 24-h was lower under neuromuscular electrical stimulation ($P < 0.001$). At 24-h, perceived soreness was significantly lower under neuromuscular electrical stimulation, when compared to CON ($P = 0.02$). There was no effect of condition on blood lactate, or saliva testosterone and cortisol responses ($P > 0.05$).
Conclusions: Neuromuscular electrical stimulation improves recovery from intensive training in professional team sports players. This strategy offers an easily applied recovery strategy which may have particular application during sleep and travel.

1. Introduction

In sports such as soccer and rugby union, more competitions have increased the number of fixtures played each season. Soccer players may complete up to 60 fixtures during the season[1] and often with as little as 2 days of recovery between games.[2] Moreover, the growing fixture demand is concomitant with an increased frequency of travel between matches.

In soccer and rugby union, a single match can increase the circulating concentrations of intracellular proteins,[3–5] which is indicative of skeletal muscle damage.[3,4] For example, Cunniffe et al.[4] reported large increases in creatine kinase (CK) at 14 (∼+227%) and 38 h (∼+45%) after an international rugby union match. In addition, Thorpe and Sunderland[5] also found ∼84% and 238% increases in CK and myoglobin respectively, immediately after a soccer match. Muscle damage, together with an associated

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muscle soreness, has been shown to persist for ~72 h post-match.[6] The induction of skeletal muscle damage is also likely to impair neuromuscular function (NMF).[7,8] Twist et al.[7] reported reductions in NMF and increases in CK and muscle soreness 24 and 48 h post-match in professional rugby league players. The associated muscle damage may also coincide with changes in the hormones testosterone and cortisol.[4,8] West et al.[8] found decreases (-26%) and increases (+56%) in testosterone and cortisol concentrations, respectively, at 12 h following a professional rugby union match; this disruption to the hormonal milieu was also still evident at 60 h post-match.

Given the increased fixture demand placed on professional players, it is evident that optimising post-match recovery is important such that players can compete at their peaks during successive matches. Strategies used to enhance athlete recovery include cold water immersion, contrast water therapy, active recovery and compression garments (for review[9]). However, an important limitation in the application of many of these recovery strategies is that they are restricted by time, equipment and space. Post-match routines, such as media commitments, may reduce time available for recovery stategies,[9] and there are often limited facilities available during away fixtures, when compared to playing at home. Additionally, competition will often involve evening kick off matches, with subsequent travel the following morning, thus making these strategies redundant during this period. Consequently, there has been a growth in the use of compression garments to aid athlete recovery.[10] However, compression garments have been reported to be uncomfortable and negatively affect athletes' sleeping patterns due to increased body temperature.[11] In some cases have been shown to reduce levels of muscle soreness without improvements in either physical performance or clearance of CK.[10,12] Thus, given the need for a rapid recovery, alternative strategies which can be readily implemented immediately following competition, regardless of sleep and travel, are required.

Neuromuscular electrical stimulation (NMES) is an alternative recovery strategy that involves the application of surface electrodes to the common peroneal nerve to simultaneously stimulate the tibialis, peroneus longus and lateral gastrocnemius muscles and thus enhance blood flow.[13] NMES has been reported to reduce CK concentrations at 72 h post-eccentric contractions of the knee,[14] as well as reduce perceived soreness between daily soccer training sessions,[15] and when combined with a compression garment can improve physiological and psychological aspects of recovery in rugby players during preseason.[16] However, important limitations within the literature include the application of NMES for only 20–30 min post-exercise,[14] and participants self-selecting the NMES intensity, which could result in selecting an intensity not sufficient for augmenting blood flow.[15] Additionally, there is a lack of data on the application of NMES within highly trained athletes.

The aim of this study was to examine the impact of a neuromuscular electrical stimulation (NMES) device on the 24-h biochemical, hormonal, neuromuscular function and perceived soreness responses in professional rugby union and soccer academy players.

2. Methods

With university ethical approval, 28 male (mean ± SD, age 20 ± 4 years; height 1.80 ± 0.08 m; body mass 85.8 ± 18.7 kg) professional rugby (n = 12) and football (n = 16) academy players participated in the study. All were informed of the potential risks associated with the study prior to giving their informed consent.

The study followed a repeated-measures design, with each player completing a control and intervention trial separated by 7 days; with trials taking place at the same time of the day. Trials were carried out in a temperature controlled exercise physiology laboratory and adjacent indoor sprint track. The order in which the trials were completed was randomised and counter-balanced.

Players reported for the trials at 09:00 am after consuming their typical training day breakfasts (replicated across trials) and having refrained from caffeine; moreover, players had refrained from alcohol and strenuous exercise during the previous 24 h. Players were familiarised with trial procedures before beginning testing and were briefed that the purpose of the study was to investigate a new recovery method.

Players first provided a saliva sample and completed a muscle soreness questionnaire, before a fingertip capillary blood sample was collected. Following a standardised 5 min warm-up (which was replicated across trials) players performed baseline countermovement jumps (CMJ; processed for peak power output [PPO] and jump height [JH]). After all baseline measures were collected, players performed an additional 10 min warm-up before undergoing a maximal speed, sprinting session, which consisted of 6 m × 50 m sprints, with a 5 min recovery period between each effort. Each of the 6 m × 50 m sprints were recorded (Brower Timing System, Salt Lake City, Utah, USA). All measures were collected immediately after completion of the sprint protocol. After the post-sprint samples were collected, players in the experimental group were required to wear a neuromuscular electrical stimulation device (NMES; FireflyTM, OnPulseTM, FirstKind Ltd., UK), while those in the control group remained in normal attire (CON). Further measures were taken at 2 and 24 h post-sprint. Prior to the CMJ, players completed a 5 min warm-up with an emphasis on the lower body musculature associated with the CMJ. Prior to the sprint protocol, players performed a 10 min warm-which finished with 4 m × 50 m sprints of increasing intensity (ranging from 60 to 90% of maximum effort).

The NMES devices were worn for 8 h post-sprint, as recommended by the manufacturer. The device was applied to the peroneal nerve behind the knee, and delivered a frequency of 1 Hz and a current of 27 mA, at a pulse width of 140 μs, to the user. This intensity was chosen as it is strong enough to elicit visible contractions in the calf muscle, but not intense enough to cause discomfort.

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.[17] 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.[17] 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.[17] Instantaneous power was determined using the following standard relationship:

$$\text{Power (W)} = \text{vertical GRF (N)} \times \text{vertical velocity of centre of gravity (m s}^{-1}\text{)}$$

Whole blood was collected via fingertip puncture using a spring-loaded disposable lancet (Safe-T-Pro Plus, Accu-Chek, Roche Diagnostics GmbH, Germany). Five μL of whole blood was immediately used for the quantification of lactate (Lactate Pro, Akray, Japan).