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Case study

High-intensity stepwise conditioning programme for improved exercise responses and agility performance of a badminton player with knee pain

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A B S T R A C T

Objective: To examine the effect of a high-intensity stepwise conditioning programme combined with multiple recovery measures on physical fitness, agility, and knee pain symptoms of an injured player.
Design: A single case study.
Setting: University-based conditioning training laboratory.
Participants: One 26-year-old male world-class badminton player (height, 190.0 cm; weight, 79.3 kg; left dominant hand; playing experience, 16 years; former world champion) with patellar tendinosis and calcification of his left knee.
High-conditioning stepwise conditioning programme: The player received seven conditioning sessions over three weeks. During the programme, there was a gradual increase in training duration and load across sessions while cold therapy, manual stretches and massage were administered after each session to minimise inflammation.
Main outcome measures: The training outcome was evaluated with three different testing methods: standard step test, badminton-specific agility test, and tension-pain rating.
Results: The conditioning programme reduced knee pain symptoms and improved actual performance and cardiopulmonary fitness during the agility task. The player was able to return to sport and compete within a month.
Conclusions: A high-intensity stepwise conditioning programme improved the physical fitness while sufficient recovery measures minimised any possible undesirable effects and promoted faster return to elite level competition.

1. Introduction

Badminton is an intense sport that requires fast and sudden movements. A professional player is expected to perform a large number of jumps, lunges, and rapid directional changes (Kuntze, Mansfield, & Sellers, 2010; Manrique & Gonzalez-Badillo, 2003). These movements produce high magnitudes of loads on the lower extremities of the player which have the potential to result in injury (Robinson & O'Donoghue, 2008; Shariff, George, & Ramlan, 2009). Patellar tendinosis is a very common injury in badminton (Muttalib, Zaidi, & Khoo, 2009; Yung, Chan, Wong, Cheuk, & Fong, 2007). This injury can lead to decreased participation time (Ferretti, Conteduca, Camerucci, & Morelli, 2002; Sarimo et al., 2007) and level of performance (Brody & Thein, 1998), which can significantly affect the player's sports career. Traditionally, a low-intensity training programme is prescribed to athletes with knee injuries in order to maintain joint mobility, promote tissue healing, and minimize inflammation or development of pain. Eccentric muscle training and stretching exercises for the quadriceps are examples of low-intensity training used for players with injuries to the knee (Bennett & Stauber, 1986; Brody & Thein, 1998). However, such training programmes usually results in a long duration of

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rehabilitation time, which ranged from 5.9 to 23 months as presented in previous studies (Ferretti et al., 2002; Sarimo et al., 2007). To enable the players to return to competition, they should then receive additional training with high-intensity exercises (e.g., endurance, interval, resisted and agility training) to further develop muscle strength, power, physical activities and agility. To the minds of many sport trainers and medical practitioners, it is questioned whether a high-intensity training programme can be implemented in the earlier stage of the rehabilitation period to reduce the rehabilitation time.

It has been questioned whether early implementation of high-intensity training exercises offer the same rehabilitation outcomes as low-intensity training, meanwhile developing the strength and skills required in competition. Elite sport performance requires a mixture of good agility as well as fitness with superb aerobic, anaerobic, and muscular capabilities. High-intensity training exercises with a variety of endurance, agility, interval, and/or resisted training protocols have been suggested to improve exercise responses including agility, endurance and muscle power (Harrison & Bourke, 2009; Helgerud, Engen, Wisloff, & Hoff, 2001; Kovacs, 2007; Newberry & Bishop, 2006; Robbins, 2010; Weston, Helsen, MacMahon, & Kirkendall, 2004). However, little has been known about their effects on athletes with knee injuries. There was a single-subject study which showed that an athlete with injury to the knee improved his agility performance after the administration of a high-intensity training programme which involved a series of agility drills and plyometric exercises (Newberry & Bishop, 2006). However, the athlete involved in that study had different knee problems, which required surgical menisectomy and chondroplasty.

Endurance running, interval running, and resisted running are common high-intensity training exercises to build up aerobic, anaerobic and muscular capabilities of athletes (Harrison & Bourke, 2009; Helgerud et al., 2001; Robbins, 2010; Shelbourne, Henne, & Gray, 2006; Tumia & Maffulli, 2002). Endurance running is used to promote adaptations of the cardio-respiratory and neuromuscular systems for better regulation of the metabolism system. Interval running is used to enhance aerobic fitness and sport performance. Resisted running increases muscular endurance, strength and anaerobic fitness by extending the body's physical limit. All these capabilities are prerequisite to all competitive sports. However, it should be noted that the design and ultimate objective of these training exercises should be specific to different types of sport (Chen, Lam, Mok, Yeung, & Hung, 2010). For badminton, each game lasts for at least 45 min and the player's performance requires highly intense anaerobic activity with short rest between points (Manrique & Gonzalez-Badillo, 2003). Considering badminton is primarily physically demanding in nature and requires a high level of agility and anaerobic activity, the endurance, interval, and resisted running exercises should be included in a conditioning programme for any injured elite badminton player.

While there was supporting (Newberry & Bishop, 2006) and opposing views (Foster, 1998; Schlumberger, 2002) on whether high-intensity training exercises should be implemented in the early stage of rehabilitation, a gradually increased training load with sufficient recovery measures might allow injured players to achieve high-intensity training earlier. Appropriate recovery measures would help to diminish inflammation and promote the healing process (Murgier & Cassard, in press; Waterman et al., 2012). It was hypothesized that the use of a gradually increased training load based on cardiopulmonary responses during and after the training (Kovacs, 2007; Robbins, 2010) together with appropriate recovery time between training sessions would reduce the rehabilitation time, while preparing the player more quickly for high-level competitions (Robbins, 2010). Therefore, the purpose of this study investigated the effects of a high-intensity conditioning programme combined with stepwise training load and multiple recovery measures on pain, agility, and the general physical fitness (aerobic, anaerobic and muscular capabilities) of a world-class badminton player with patellar tendinosis.

2. Methods

2.1. Player

One 26-year-old male world-class badminton player (height, 190.0 cm; weight, 79.3 kg; left dominant hand; playing experience, 16 years; former world champion) complained that he was unable to complete a full practice session and compete due to a pain in the left knee. He stated having a gradual onset of pain in the knee over a period of one year. He also suggested that the injury was caused by an intensive training load. Medical report by a certified orthopaedic surgeon found that a persistent and recurrent moderate pain in his left knee during knee extension and diagnosed that as left patellar tendinosis (or Sinding–Larsen–Johansson Syndrome). The diagnosis was confirmed by magnetic resonance imaging (MRI) scans, which indicated a tissue calcification and thickening around the middle portion of the patella tendon. Additional physical examination, which was conducted by a certified physiotherapist (NSC-CPT'D athletic trainer and one of the authors in this study), revealed some focal tenderness at the medial edge of the proximal patellar tendon and soft tissue injury around the patella. This study was approved by the Ethics Committee at the Hong Kong Polytechnic University.

2.2. Evaluation

Perceived knee pain, symptoms of patellar tendinosis, agility performance, and cardiopulmonary fitness were evaluated before and after administration of the conditioning programme. The knee tendinosis was examined by the same orthopaedic surgeon together with the physical examination and MRI scans. Knee pain intensity was rated on a 4-point scale (0 = none, 1 = mild pain, 2 = moderate pain and 3 = severe pain) by the player (Chen et al., 2010). An agility test was performed by counting the number of cones when performing a badminton-specific agility movement protocol within 30 s. The player was instructed to start at the middle of the court and then reach as many cones as possible in accordance with the movement course (Fig. 1). The movement course of the agility protocol was commonly used for training in his badminton team and therefore was used as evaluation in this study to minimize the need of long familiarization by the player. The agility test was performed before and after the conditioning training programme, and the agility score was counted as the greater number of cones (or maximum covering distance) from the two measures.

In order to determine the cardiopulmonary fitness of the player, heart rates were measured using a heart rate monitoring system (Polar, Kempele, Finland) after performing relatively low physical demanding standard step test and high physical demanding agility test to investigate the recovery heart rate (Marley & Linnerud, 1976; Robbins, 2010). The standard step test (Astrand and Rhyming) required the player to step up and down on a 0.40 m bench for 5 min following some auditory tones at the rate of 90 steps per minute (Marley & Linnerud, 1976). Then, the step-recovery heart rate was measured at 20 s after the completion of the step test, which replicated Astrand and Rhyming's step test used in Marley and Linnerud's study (1976). Heart rates were also measured at 0 s, 30 s, 60 s, 120 s, 150 s, and 180 s, respectively after the