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Case study

Determining return-to-sport status with a multi-component assessment strategy: A case study in rugby

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A B S T R A C T

Background: The effectiveness of rehabilitation programmes are often distorted by the athlete's desire to return and can result in injury recurrence. Athletic assessments allow for objective and reliable measurements to track rehabilitation progress. This case study used a multi-component assessment strategy to assess a rugby player's lower-extremity strength and symmetry as a primary determinate of their return-to-sport status.
Case description: A professional rugby league player was assessed for lower-extremity isokinetic strength and sprint kinetics pre- and 10-weeks post-rehabilitation programme following two consecutive knee injuries involving surgical intervention.
Outcomes: Pre-testing analysis showed clinical and functional strength deficits in the injured leg as high as 34% compared to the non-injured leg. Pre- to post-testing showed: increases in peak torque (49%) and decreased asymmetries by 50%; unilateral horizontal force increased (injured: 50%, non-injured: 19%) during sprinting; force production asymmetries decreased up to 18%.
Discussion: The rugby player showed clinical and functional strength deficiencies return to normal ranges following a rehabilitation programme. A return-to-sport decision was made by the athlete's supporting health team based on the sizeable asymmetry decreases and return-to-normative ranges for knee and hip strength and sprint kinetics. The athlete returned to the 2013 National Rugby League season without any major injuries.

1. Background

Injury rates in professional rugby league are among the highest in elite team sports with rates most commonly reported between 196 and 278 injuries per 1000 h (Alexander, Kennedy, & Kennedy, 1979; King, Hume, Milburn, & Gianotti, 2009). The largest percentage of all injuries in rugby league occur at the lower-limb; most commonly including soft-tissue injuries at the knee such as anterior cruciate ligament sprains and bi-articulate hamstring muscle strains (King et al., 2009). Since these injuries can be severe and debilitative, rehabilitation programmes have been established to return an athlete to sport as quickly as possible while obtaining the desired effects of the programme. Unfortunately, inadequate rehabilitation programmes can result in clinical and functional deficits lasting several years following the initial injury, and thus prolong the risk of re-injury (Carling, Le Gall, & Orhant, 2011; Myer, Paterno, Ford, Quatman, & Hewett, 2006). Instabilities, muscle imbalances and functional deficits can directly affect re-injury risk and athletic performance; especially in sports that involve sprinting, changing direction and kicking like rugby. It should be noted that re-injury has been defined as an injury to the same site over a short period of time (i.e. $<$ 2 months (Carling et al., 2011)), or to an original site in the lower-extremities over a prolonged period (Croisier, Forthomme, Namurois, Vanderthommen, & Crielaard, 2002). To gain better insight into tracking rehabilitation progress, athletic assessments have become a staple in modern sport at the elite level and are frequently used for assessing injury/re-injury risk and for tracking athletic performance (Brown, Brughelli, Griffiths, & Cronin, 2014; Clanton & Coupe, 1998; Croisier et al., 2002).

In the past, indistinguishable similarities in muscular properties between injured and non-injured muscles made early detection of risk-factors in healthy athletes a daunting task (Proske, Morgan, Brockett, & Percival, 2004). In recent time however, an increase in knowledge of the hamstring injury has allowed for more effective assessments to recognize and properly treat injured athletes (Ahmad, Redler, Ciccotti, Maffulli, Longo, & Bradley, 2013). Assessment tools such as dynamometry and force plate instrumented

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treadmills are commonly used to detect adaptations of strength and power in athletes. While not as impactful on their own as they are when combined, a multi-component assessment strategy can illuminate a clear depiction of an athlete's return-to-sport status (Mendiguchia & Brughelli, 2011). The proper analysis and interpretation of these assessments are therefore vital to the health of the athlete and the longevity of their career. Although several authors (Heiderscheit, Sherry, Silder, Chumanov, & Thelen, 2010; Mendiguchia & Brughelli, 2011; Myer et al., 2006; Sherry, Best, Silder, Thelen, & Heiderscheit, 2011) have commented on the value of a multi-component approach, including reliable and objective assessments (i.e. clinical and functional assessments), few have been implemented in the literature. This case study sought to use a multi-component assessment strategy to assess an athlete's lower-extremity strength and symmetry pre- and post-rehabilitation as a primary determinate of their return-to-sport status.

2. Case description

A 28-year-old male professional rugby league player (body height = 1.8 m, body mass = 98 kg) presented for a complete athlete assessment package. The athlete played on the starting side for a National Rugby League team for the previous eleven years and five years on an international representative team for New Zealand.

The athlete's past two-year medical history included two major injuries to the left leg (non-dominant leg; preferred stance or support leg while kicking) and an assortment of minor injuries to the right leg (dominant leg; preferred kicking leg). The first major injury consisted of a 2011 season-ending anterior cruciate ligament rupture in the left knee requiring surgery and accounted for 27 weeks away from competitive play and 25 missed games; 88 weeks (1 year and 8 months) prior to our assessment. The anterior cruciate ligament surgery consisted of a contralateral (right) patellar tendon graft immediately following the injury. The second major injury consisted of a 2012 season-ending patellar tendon rupture in the left knee requiring surgery accounting for 16 weeks away from competitive play and 14 missed games; 29 weeks (<7 months) prior to our assessment. All minor soft-tissue injuries occurred in 2012 before the patellar tendon rupture and included a lateral femoral condyle contusion to the left knee missing two games, a lateral ligament sprain to the right ankle missing one game and a biceps femoris strain on the right leg missing one game. All injuries occurred during match play and were a mix between contact/non-contact and first-half/second-half injuries.

A rehabilitation programme using general guidelines (Sherry & UW Health Sports Medicine Physician Group, 2011, pp. 1–6) was given by the supporting team's medical staff following the most recent surgery on the patellar tendon. This rehabilitation programme consisted of five phases wherein the main goals of each phase were: (I) 5–14 days, control pain and inflammation and work up to 30° passive range of motion; (II) 2–6 weeks, control pain and inflammation, continue passive range of motion and begin weight-bearing activities; (III) 6–12 weeks, control pain and inflammation, progress mobility and strength to full active range of motion; (IV) 12–16 weeks, complete weight-bearing and progress strength, begin neuromuscular strength and gait re-training; and (V) 16–24 weeks, begin jogging/running and sport specific activities. After progressing the athlete through a rehabilitation programme, wherein he had returned to light practicing conditions, the athlete was assessed to determine his return-to-sport status.

Upon initial completion of the testing it was discovered that the athlete did not fall within 10% of the upper or lower normative range for sport or position established by our group (Brown et al., 2014) nor did he pass the required criteria in order to return-to-sport based on previous literature (Mendiguchia & Brughelli, 2011). As such, it was recommended to the team to proceed with an additional programme aimed at increasing unilateral muscular strength and reducing asymmetries between limbs (Brughelli, Nosaka, & Cronin, 2009). All aspects of the research were thoroughly explained to the athlete and team staff and written informed consent was obtained prior to commencement as part of the contractual arrangements with the New Zealand Warriors. All procedures used in this case study were reviewed by the Auckland University of Technology Ethics Committee and received full ethical approval for human participant research (12/332).

2.1. Laboratory testing protocol

This case study comprised isokinetic testing to determine hip and knee strength and symmetry, and sprint kinetic testing to determine unilateral functional strength and symmetry. Testing was performed pre- and 10-weeks post-rehabilitation programme following a regeneration phase aimed to increase single-joint and functional strength, and reduce strength deficits and asymmetries (Heiderscheit et al., 2010; Mendiguchia & Brughelli, 2011). Rehabilitation and testing took place during the athlete's off-season/pre-season and testing sessions followed a 24 h rest day and preceded training on that day. Testing sessions lasted approximately 2 h and occurred at the same time of day (~9:00 AM).

Testing sessions were performed by the same researcher and followed an identical protocol as described in detail elsewhere (Brown et al., 2014; Brughelli, Cronin, & Chaouachi, 2011). In short, the athlete was secured to a Humac Norm dynamometer (Lumex, Ronkonkoma, NY, USA) to assess isokinetic concentric knee (Fig. 1A) and hip (Fig. 1B) extensor and flexor strength on each leg at 100 Hz. The athlete was either set in an upright seated position for testing at the knee or in a supine position for the hip where gravity and limb mass adjustments were made accordingly. The "zero angle" was set at full leg extension during knee actions, and full hip extension during hip actions. A familiarisation process involved instructing the athlete to perform three trials of the movement at a self-perceived 50, 70 and 100% of maximum effort. Testing followed with five extension and five flexion actions at a fixed velocity of $60^\circ\ s^{-1}$. Strong verbal encouragement was provided through all tests and appropriate rest was given between trials and limbs.

Subsequent to isokinetic testing, the athlete was tested on a non-motorised instrumented treadmill (Woodway Force 2.0, Woodway USA, Inc., Waukesha, WI, USA) to assess bi-lateral sprint kinetics (Fig. 1C). As previously described (Brughelli et al., 2011), force instruments were calibrated and zeroed. A horizontal strain-gauge was attached to the athlete's waist via a non-elastic tether. Starting in a sprinter's stance with the right foot back, the athlete was asked to build up in speed over a 4 s period to a maximum velocity and then to maintain that velocity for an additional 5 s. Real-time sprint performance was shown to the athlete and strong verbal encouragement was provided to increase the likelihood of maximal effort. Ten steps were analysed during the maximum velocity phase.

2.2. Outcome measures

Data were processed using a custom LabVIEW programme (Version 11.0, National Instruments Corp., Austin, TX, USA) to fit the torque-angle curves with a 4th order polynomial to identify peak torque and angle of peak torque using the average of the last four repetitions for the final value. Another custom LabVIEW programme was used to assess the ten steps during maximum velocity sprinting. The ten steps were separated by left and right legs based on counting the first recorded step as the right leg and then