

Case study

# The rehabilitation of a professional Rugby Union player following a C7/T1 posterior microdiscectomy

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## Abstract

Rugby Union is a popular international sport [Bathgate, A., Best, J., Craig, G., & Jamieson, M. (2002) with a high incidence of cervical injury. A prospective study of injuries to elite Australian rugby union players. *British Journal of Sports Medicine* 36, 265–269.] with a high incidence of cervical injury. The purpose of this case study was to explore the rehabilitation of a professional rugby union player following a cervical disc injury affecting the C8 nerve root and subsequent microdiscectomy. The isometric strength of the cervical musculature was measured using 1 Repetition Maximum (1RM). A 10-week rehabilitation programme was then commenced whereby the player performed periodised upper limb and Maximal Isometric Voluntary Muscle Contraction (IVMCmax) neck exercises with a graduated return to contact training and playing. Re-tests of the cervical musculature were performed after Phases 1, 2, 3 and 4 of the 10-week rehabilitation programme. The results show a dramatic improvement in the strength of the cervical musculature acting in the four directions of movement tested (cervical flexion, extension and left and right side flexion). The player returned to professional club rugby 16 weeks post-operation and returned to International duty 2 weeks later. At the time of writing this case study, the player had not missed any game time due to cervical symptoms. © 2005 Elsevier Ltd. All rights reserved.

**Keywords:** Cervical spine; Rugby Union; Maximal isometric voluntary muscle contraction; Rehabilitation

## 1. Introduction

Rugby Union is a popular international sport; second only to soccer as a football code (Bathgate, Best, Craig, & Jamieson, 2002). There are 92 members of the International Rugby Board (IRB) and participation has increased linked to the onset of professionalism in 1995 (Bathgate et al., 2002).

During contact sports such as Rugby Union, the cervical spine is repeatedly exposed to potentially injurious energy inputs (Torg & Ramsey-Emrheim, 1997; Torg, Guille, & Jaffe, 2002). Fortunately, this energy is usually attenuated by controlled spinal motion through the cervical musculature and the inter-vertebral discs (Torg & Ramsey-Emrheim, 1997). However, there are occasions when these forces are not ideally dissipated and injury occurs.

The exercises used for this case study were designed to maximally load the cervical musculature via isometric contraction, to avoid placing the cervical spine in a potentially injurious position by adding cervical motion, and especially axial compression. It has been demonstrated that the strength of the cervical musculature, relative to the mass of the head-neck complex, is approximately twice the strength of the lumbar musculature, again relative to body weight (Jordan, Mehlsen, Bulow, Ostergaard, & Danneskiold-Samsøe, 1999). Therefore, the cervical spine should be exposed to the overload principle when completing isometric exercises; simple anti-gravity exercises will not be sufficient for adequate neck training (Jordan et al., 1999). Previous studies have found that intensive neck strengthening exercises can decrease pain and increase neck range of movement and muscle performance (Bronfort, Evans, Nelson, Aker, Goldsmith, & Vernon, 2002; Jordan et al., 1999), whereas simple stretching exercises and gymnastic programmes have demonstrated questionable benefits (Jordan et al., 1999). One previous study highlighted the fact that the cervical musculature shows impressive strength capabilities and is able to withstand considerable resistance,

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Grip Strength (kilograms)			
	Pre-op	6 weeks post-op	16 weeks post-op
Left	6	32	61
Right	64	56	67

Fig. 1. The comparison of grip strength.

and therefore, successful rehabilitation is conditional upon an appropriate training stimulus (Jordan et al., 1999).

The following case study has been submitted with the written permission of the player involved. Player A is a professional rugby union loose head prop in the front row of the scrum. He presented to the clinic 1 week after sustaining an injury to his neck during scrummaging practice. The player reported feeling a sharp pain in his neck immediately on contact with the scrummaging machine. Within 2–3 min, the player began to feel pins and needles in his left antero-medial forearm and his fourth to fifth fingers.

A muscle strength assessment was made of both upper limbs, which showed general weakness in his left arm due to provocation of cervical discomfort. A Baseline™ hydraulic hand dynamometer was used to measure grip strength. This showed a marked deficit on the left (Fig. 1). It was surmised that the player had sustained a cervical disc injury affecting the left C8 nerve root, based on the player's symptoms and clinical assessment.

The player was referred to a neurosurgeon for assessment.

An MRI scan taken 1 week later revealed a lateral disc protrusion at C7/T1 compressing the left C8 nerve root and Player A underwent a posterior microdiscectomy 3 weeks later.

The neurosurgeon instructed the patient to rest with gentle range of movement exercises for the first 6 weeks until the player was reviewed again. After the 6-week review Player A returned to the clinic for his rehabilitation and a return to rugby programme.

A rehabilitation programme was devised, whereby the player commenced a general cardio-vascular fitness programme at the club with his specific post-operative rehabilitation devised and supervised at the clinic.

A 10-week programme was structured to include four phases of rehabilitation with an integrated return to contact and playing.

The grip test was also repeated which showed a marked improvement in the player's left grip; Left grip 32 kg; Right grip 56 kg (Fig. 1).

The rehabilitation programme at the clinic included neck and upper limb exercises in order to stabilise the shoulder girdle, improve grip strength and strengthen the muscles acting on the cervical spine. Maximal Isometric Voluntary Muscle Contraction (IVMCmax) rehabilitation techniques were used in order to load the cervical spine in a neutral position so as not to compromise any nerve roots via spinal

motion. The rehabilitation objectives of the IVMCmax rehabilitation programme was to:

- Produce maximal motor unit stimulation, using training over load from an isometric exercise that would result in improved strength and endurance.
- Translate and retain these gains for the chosen sport and position.

The main difference between an isometric exercise via a pulley system and the IVMCmax rehabilitation techniques using a dynamometer is the load. With a pulley system the player wears a head harness attached to a pulley weighted with a specific recordable load (i.e. 5 kg). However, using the dynamometer, the load becomes variable; the load applied is directly proportional to effort. The more the player tries to resist the movement of the lever arm, the greater the load applied. Therefore, the player is encouraged to resist the dynamometer maximally on each repetition to make this an IVMCmax exercise. The dynamometer exercises are extremely safe to use because if the player experiences pain or other adverse symptoms, then he/she simply stops resisting the lever arm and the movement stops, therefore withdrawing the load being applied. By comparison, with a pulley system if the load is too heavy or the player experiences pain, then the assistance of a spotter is required to manually reduce the load. However, in the first week of training, pulley exercises were used in favour of the dynamometer in order to develop the player's technique where a known load was used (which was kept purposely light). Technique acquisition in this phase was vital in order to ascertain that the player could sustain a pain free isometric contraction without losing form. This development of technique could then be translated to the dynamometer exercises, which would then become maximal.

## 2. Rehabilitation

### 2.1. Phase 1 (week 7 post-op)

During the first week of training, the emphasis was on technique acquisition. The player's symptoms and irritability were closely monitored and technique was supervised, particularly during the cervical exercises to ensure that they remained isometric.

- Phase 1: Technique acquisition: 1 week
- Medium volume—low intensity: 3 sets × 12 reps × 50% 1RM—recovery between sets 30 s
- RPE 10
- CR10 < 2
- Four sessions per week

The player would warm-up first using the seated Versaclimber™ followed by four shoulder exercises (examples

are included in the list below) and three isometric neck exercises.

- Dumb-bell shoulder shrugs with front and rears
- Dumb-bell bent over barrels
- Dumb-bell short lever lateral raise
- Dumb-bell biceps curls
- Seated row (using a low pulley system)
- Pulley system, posterior head harness, dumb-bell squat
- Pulley system, lateral head harness, trunk side flexion with contra-lateral dumb-bell shoulder shrug
- Pulley system, posterior head harness, seated back extension

Initially, the player used a head harness attached to a pulley system so a specific load and not a maximal load could be applied with close monitoring of his symptoms. The player’s symptoms needed to be assessed for irritability before commencing maximal stimulation. The Borg scales of Rate of Perceived Exertion (RPE) and Pain Scale (CR10) were used during training (Borg, 1998).

The player’s neck was tested at the end of Phase 1 using 1 Repetition Maximum (1RM). Coincidentally, Player A had been previously tested at the clinic prior to injury, which gave a good baseline comparison. Fig. 2 shows the comparison between the pre-injury test and the 7-week post-op test.

Tests for isometric neck strength were made using a HUR Performance Recorder 8100 (PR 8100)<sup>™</sup> pre calibrated according to the manufacturers instructions before testing (see Picture 1). A Celtron STC-500 kg Force Transducer<sup>™</sup> was placed in series between the fixed body anchorage point and a metal handle, using metal linkages. The PR8100 was switched on, in the test position, to initially record the force

present within the system (weight of the apparatus, etc.). This was subsequently eliminated by recalibrating the scale to zero. The HUR performance recorder<sup>™</sup> was securely attached to the player’s head via a head harness, with the player’s body stabilized sitting on a Cybex 6000<sup>™</sup> seat and secured by its seat belt. The test was performed, and recorded, using the PR8100 and subjecting the neck to manual controlled linear incremental loading (1RM), in the absence of pain or neural symptoms (which would have stopped the test). The player’s head was held in the neutral anatomical position at all times during testing, with the peak isometric torque being recorded at the point of deviation from the longitudinal axis, with reciprocal system unloading to avoid injury.

The cervical 1RM test taken at the end of Phase 1 showed marked weakness of the cervical musculature, most significantly in the direction of left-side flexion; the side of injury (Fig. 2).

2.2. Phase 2 (weeks 8–10 post op)

At week 2, dynamometry was introduced in order to commence the IVMCmax exercises. Player A showed no signs of symptom irritability from Phase 1. Initially, side flexion was used. Side flexion was introduced first for two reasons. Firstly, to assess the player’s response to IVMCmax techniques by using only one direction of movement at a time; comparison could also be made by his symptom response, if any, when loading the left side compared with the right. Secondly, to try to correct the asymmetry of the side flexors by over loading these muscle groups before adding the other directions. The dynamometer was positioned in series with the head

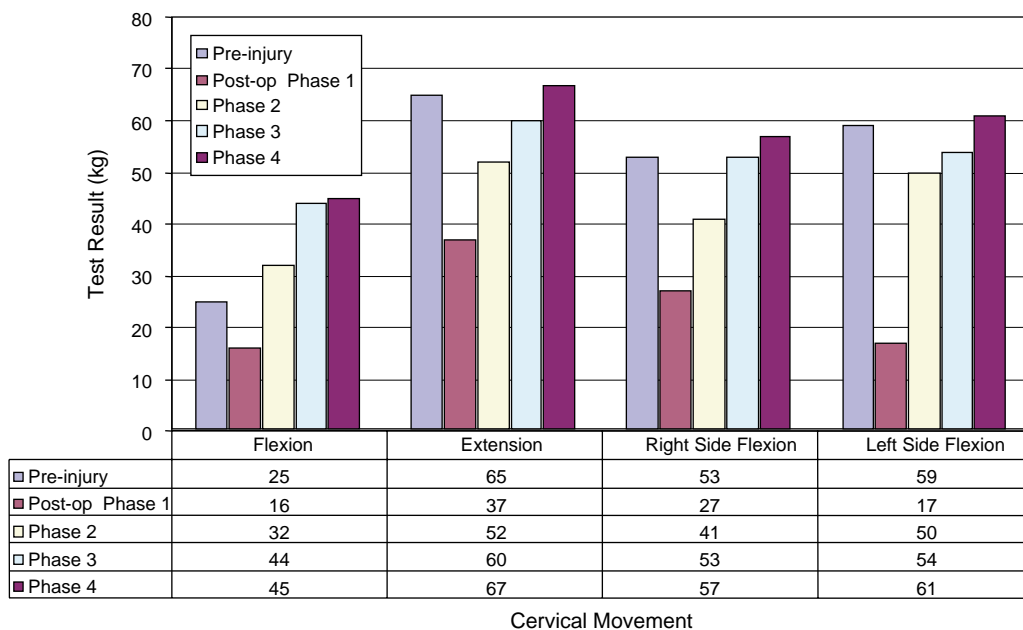


Fig. 2. The results of 1RM tests taken pre-injury and for Phases 1, 2, 3 and 4 of the rehabilitation programme.



Picture 1. The HUR Performance Recorder 8100 (PR 8100)<sup>TM</sup> connected to the Celtron STC-500 kg Force Transducer<sup>TM</sup> used for cervical muscle testing.

harness and pulley (Picture 2). The aim of this exercise was to maximally load the side flexors via movement of the dynamometer lever arm whilst the player kept their head and neck in neutral. The system has a patient cut out switch that suspends the dynamometer action when pressed as an additional safety measure.

- Phase 2: 3 weeks
- High volume—medium intensity: 6 sets  $\times$  12 reps  $\times$  50–60% 1RM—recovery between sets 30 s
- RPE 12+
- CR10 < 3
- Four sessions per week

Note, the percentage of 1RM volume and intensity prescribed does not apply to the dynamometer exercises, these are all maximal.

Examples of additional exercises used in Phase 2 include:

- Dynamometer steering wheel (grip)
- Dumb-bell triceps press
- Dumb-bell inclined biceps curls
- Dynamometer pulley system left lateral head harness isometrics (repeat with right). Picture 2.

The Cervical 1RM test was repeated at the end of Phase 2 (Fig. 2) which showed improvement in all directions. It was interesting to note the significant improvement on left side flexion. Player A on initial pre-injury testing was stronger on the left side, which may be related to his position in the scrum as a loose head prop. Following injury, the left C8 nerve root was compromised causing muscular weakness. However, once this neural



Picture 2. The player using the dynamometer to stimulate IVMCmax for right side flexion.

compression had been surgically removed and a training stimulus applied, cervical strength appeared to return to this pre-injury bias, in other words the left side flexors returned to being stronger than the right side flexors (Fig. 2).

### 2.3. Phase 3 (11–13 weeks post op)

During Phase 3 of rehabilitation, neck extension and flexion were introduced using the dynamometer as the player continued to show no signs of irritability.

- Phase 3: 3 weeks
- Medium volume—medium/high intensity: 5 sets  $\times$  6 reps  $\times$  60–75% 1RM—recovery between sets 60 s
- RPE 16+
- CR10 < 4
- Four sessions per week

Additional exercises used include:

- Dumb-bell wings
- Dumb-bell waves
- Dumb-bell alternate front raise
- Dynamometer head harness, neck dead lift
- Dynamometer pulley system left lateral head harness neck isometrics (repeat with right)
- Dynamometer head harness seated trunk flexion with neck isometrics

Player A commenced tackle bag contact at the club in the sixth week of rehabilitation (12 weeks post-op). The player then spent 4 weeks integrating back into club training and rugby specific skill training, leading to scrummaging practice.

Player A was once again re-tested at the end of Phase 3. Fig. 2 shows Player A's continued improvement. Cervical flexion recorded a higher result than pre-injury. This may be due to specific strengthening in this direction which was not developed pre-injury.

### 2.4. Phase 4 (14–16 weeks post op)

Phase 4 consisted of the strength phase of rehabilitation with an introduction to power training. The dynamometer exercises remained the same as in Phase 3 apart from the addition of a side flexion exercise using a crash helmet instead of the head harness in order to allow for switches between right and left side loadings.

- Phase 4: 3 weeks
- Low volume—high intensity: 4 sets  $\times$  5 reps  $\times$  75–85% 1RM—recovery between sets 120 s
- RPE 17+
- CR10 < 4
- Four sessions per week

Additional exercises include:

- Single dumb-bell snatch
- Dumb-bell hang clean
- Dumb-bell hang high pull.

Player A made his debut as a second half substitute in the Powergen semi-final 16 weeks post-operation and returned to International duty as a substitute in the six nations championship 2 weeks later. Player A continued to attend the clinic regularly for maintenance training, and was given a neck-training programme for integration into club training.

Player A was re-tested at week 10 (16 weeks post-op) which showed that the cervical musculature was stronger on 1RM testing after 10 weeks of rehabilitation than pre-injury (Fig. 2). Grip strength was also repeated, which showed a continued improvement in left grip strength (Fig. 1).

Player A has continued to maintain international status and was a member of the squad, which returned victorious from the 2003 Rugby World Cup. At the time of writing this article, Player A has not missed any playing time due to cervical symptoms.

## 3. Discussion

The results of this case study appear to indicate that the use of IVMCmax rehabilitation techniques via dynamometry can strengthen the cervical musculature in order to allow a player to return to competitive rugby following posterior microdiscectomy. The IVMCmax regime was specifically developed at the clinic to minimise anterior, posterior and lateral compression component forces to the cervical column during exercise loading. It has been reported that head impact velocities as low as 3.1 m/s were sufficient to cause cervical injury (Winkelstein & Myers, 1997). Therefore, the cervical spine does not need to be stressed in an extreme of movement for injury to result.

The player on pre-injury testing demonstrated good isometric strength of his cervical musculature. However, numerous studies investigating the association between the neck extensors and flexors generally attribute a ratio of 1.7–1 (Jordan et al., 1999). On pre-injury testing Player A had a ratio of 2.6–1, compared with a ratio of 1.48–1 at the end of Phase 4 of the rehabilitation programme. Whether this ratio was a contributing factor to cervical injury is questionable but nonetheless interesting to note.

A further interesting point indicated by the results was that Player A improved the strength of the right side flexors and extensors by 30 kg each (comparison of Phases 1 and 4 results), the flexors by 29 kg and the left side flexors by 44 kg. Whether this similarity in kilogram improvement is coincidental or indicative of the expected improvement using IVMCmax rehabilitation techniques over a 10-week period needs further investigation. However, the mean

percentage improvement in cervical muscle strength was 257% for the four directions of cervical movement, which is certainly an impressive gain in 10 weeks (post-injury or otherwise).

Whilst this case study examined a post-operative training regime following a C7/T1 microdiscectomy, it is the opinion of the authors that these IVMCmax exercises should be integrated into Rugby Union Club training. A sport and position specific periodised cervical strengthening regime may help to prevent injury as well as being utilised once injury has occurred. Rehabilitation programmes using IVMCmax techniques have been used extensively at the clinic for a number of different sports, most notably motor racing, with encouraging results, however, further research is required to substantiate these initial findings.

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