SPORTS PERFORMANCE
RESEARCH INSTITUTE NEW ZEALAND
AN INSTITUTE OF AUT UNIVERSITY

"Rugby Codes Research News"

Communicating advances in evidence based knowledge and its practical application to the wider support network of rugby codes.

Issue 1 – August 2013

AUT SPRINZ at AUTMI
Rugby Codes Research Group
(RCRG)

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Who we are

The Rugby Codes Injury Prevention and Performance Group (RCIPP) was established in February 2010 based on the prior work in rugby related research of Professors Patria Hume and Will Hopkins and their postgraduate students – specifically Dr Ken Quarrie, Dr Simon Gianotti and Dr Doug King. Although injury prevention and strength and conditioning (S&C) was the original focus of the RCIPP, the advent of the RCRG means areas such as coaching, psychology, performance analysis, management and business will now be included. This exciting integrated approach means that knowledge across research areas will be combined allowing effective holistic advancement of practice within the rugby codes. The RCRG includes members from undergraduate to professorial level and national and international collaborators. We have a diverse team that includes epidemiologists, biomechanists, physiotherapists, medical doctors, an emergency nurse, professors, senior lecturers, lecturers as well as PhD, Masters, undergraduate exchange and BSR cooperative students. Our key members are group co-leaders, Dr Matt Brughelli, Dr Nic Gill and Dr Doug King as well as Professors Patria Hume, John Cronin and Mike McGuigan. We aim to provide the latest evidence based knowledge from the literature informing best practice within the rugby codes taking a comprehensive account of all supporting factions.


Prof. Mike McGugian


Dr Matt Brughelli


Prof. Patria Hume


Prof. John Cronin


Dr Nic Gill


Dr Doug King

Action statement

The key action points for how we intend to achieve our vision are:

- Key group members to meet bi-annually to discuss report structure and direction, research/review topics and funding.
- Produce a bi-annual research summary including new information from recent studies and information from older literature in a topic review to distribute to wider rugby codes support network.
- Liaise with NZRU, NZRL and support teams across the country regarding research and topic review directions.

- Source funding for research and reviews through promoting the research group's abilities and highlighting areas of need.

Past research and achievements

In mentoring the members of this emerging research team and with the support of the external collaborative partners and SPRINZ research associates, RCRG has established a profile outside the university for excellent research in rugby and is gaining recognition through external funding from organisations such as the IRB, UNC and NZ Warrior. Links with NZR and NZRL via the sport science and medicine committees has enabled industry led research questions to be developed and investigated by RCRG.

The RCRG has established strong relationships with the rugby community, both nationally and internationally, and have been recognised for our high quality research through publications, implementation of findings in regular rugby practices, and grants from significant bodies. Collectively RCRG have over 50 peer-reviewed journal articles published on rugby specific topics. RCRG members have presented at many conferences, including invited presentations at the World Injury Prevention Conference in Norway. Example papers are:

- Fuller CW, Sheerin K, Targett S. (2012). Rugby World Cup 2011: IRB Injury Surveillance Study. British Journal of Sports Medicine *doi:10.1136/bjsports-2012-091155.*
- King, D., P.A. Hume, & T. Clark. (2012). "Nature of tackles that result in injury in professional rugby league." Research in Sports Medicine **20**(2): 86-104.
- Gianotti, S., P.A. Hume, et al. (2008). "Interim evaluation of the effect of a new scrum law on neck and back injuries in rugby union." British Journal of Sports Medicine **42**(6): 427-430.
- Quarrie, K.M., S. Gianotti, P. A. Hume. (2007). "Effect of nationwide injury prevention programme on serious spinal injuries in New Zealand rugby union." British Medical Journal **334**: 1150-53.
- Argus, C.K., Gill, N.D., Keogh, J.W.L., McGuigan, M.R., & Hopkins, W.G. (2012). Effects of two contrast training programs on jump performance in rugby union players during a competition phase. International Journal of Sports Physiology and Performance, **7**(1), 68–75.

AUT Faculty of Health and Environmental Sciences Emerging Team Research Excellence Award

The RCRG received a $2000 Emerging Team Research Excellence Award in 2012 from the AUT Faculty of Health and Environmental Sciences, and the runner-up position for the University wide awards. The $2000 is being invested in RCRG member Scott Brown to attend the Sports Medicine New Zealand Conference in November 2013 to present research work as described in the abstract "Multi-disciplinary perspectives on the use of lower-extremity injury assessments for a rugby player's return-to-play" with co-authors Dr Matt Brughelli, Professor Patria Hume, Dr Doug King, Dr Nic Gill, Hamish Craighead and Stephen Kara.

IRB projects

The RCRG reputation for rugby research has led to the IRB commissioning Professor Patria Hume to manage several research projects the IRB have funded:

1) Injury epidemiology at the 2011 Rugby World Cup. Kelly Sheerin had a key role in the tournament injury surveillance study. In collaboration with Dr Colin Fuller (IRB) and Dr Steve Targett (NZR), injury data were collected for every game. The findings confirmed that rugby has a high incidence of injury especially during tackles. The IRB funded this study as part of their strategy to build on injury prevention methods.

2) IRB RugbyHealth 2012/2013 was launched by IRB at AUT in July 2012 with international media coverage for AUT www.rugbyhealth.co.nz. The project will describe any differences between 200 retired international/national level rugby union players from New Zealand to 200 age-matched retired community level rugby union players (rugby controls) and 200 age-matched retired non-contact sporting players (cricket and field hockey players) for general and neuropsychological health, balance, and brain corticomotor excitability. The multi-disciplinary project involves researchers from seven research institutes including the IRB, NZR, SPRINZ, AUT Health Rehabilitation Research Institute, AUT National Institute for Stroke and Applied Neuroscience, University of Otago and University of North Carolina at Chapel Hill. The NZRU Players Association (via Chief Executive Rob Nichol) and NZ Cricket Players Association (via Executive Manager Heath Mills) endorse the project and are helping with promotion of the study and recruitment of players. Key team members are Professor Patria Hume, Dr Martin Raftery, Dr Ken Quarrie, Dr Alice Theadom, Professor Stephen Marshall, Dr Doug King, Dr Matt Brughelli, Dr Gwyn Lewis, Dr Denise Taylor, Scott Brown, Peter Griffiths, Verna Stavric and Scott Winton.

3) IRB Regulation 12 protective equipment update started in June 2013. The IRB is committed to investigating players' clothing and equipment, in particular in respect of IRB Regulation 12 and IRB Law 4. The IRB has requested a review of whether regulation 12 and law 4 can be updated as a result of a review of technical specifications and test methodologies for products suitable for playing rugby by those who are visually impaired, have hearing disabilities or require prosthetics. Key team members are Professor Patria Hume, Dr Grant Searchfield, Professor Brendan Burkett, Professor Frances Joseph, Peter Griffiths and Scott Brown.

Past students

In 2001 Dr Ken Quarrie worked alongside his colleagues at NZRU and ACC to establish the RugbySmart programme. Through RugbySmart, compulsory courses for coaches and referees of all grades of contact rugby in New Zealand were established, along with other injury prevention strategies. RugbySmart is still underway and evolving today. Ken completed his PhD at AUT in 2008 (supervised by Will and Patria); *RugbySmart: the development, delivery and evaluation of a nationwide injury prevention programme.* He assessed the effects of an integrated approach to examining player performance and injury risks in professional NZ rugby, focusing on cervical spine and spinal cord injuries. His research resulted in several internationally peer reviewed publications as well as alterations and improvements to the RugbySmart programme.

Dr Simon Gianotti continued to build on work Ken had established, when he also undertook his PhD at AUT (supervised by Patria and Will); *The FREED framework for community sports injury prevention implementation in New Zealand.* Simon manages the Road and Sport team at ACC, giving a close connection between the rugby research group and the injury prevention strategies ACC are constantly working towards with rugby. As a result of the PhD studies the team published internationally on spine injury, new scrum techniques and laws and side-line management of concussion. Simon and Patria developed the side-line concussion check (SCC), a wallet card for non-medical coaches and side-line managers to help assess concussion and advise action in the first 48 hours of a player injury. This tool was incorporated into the Sports Concussion Assessment Tool (SCAT) for medically trained personnel. The SCC is now used nationally as a part of RugbySmart and aspects have been implemented internationally by the IRB as a part of their Rugby Ready injury prevention scheme.

In 2010 Dr Doug King submitted his thesis *Injuries in rugby league: Incidence, dominance, influences and return to play decisions*, (supervised by Patria) which also formed part of LeagueSmart with NZRL. Doug worked with ACC to analyse commonalities of injuries within amateur rugby and the abilities of coaching management at assessing the readiness of an athlete to go back to play. The team found a significant lack of knowledge and training in coaching staff and identified higher risk tackles in order to work towards more reform in injury prevention in league. Doug is now embarking on his second PhD titled *Sports-related concussions in New Zealand: Costs, incidence, assessment, identification, knowledge and management,* (supervised by Matt & Patria). A key part of his research examines linear and rotational head accelerations associated with concussion in amateur rugby league and union, via new technology mouth guards instrumented with accelerometers.

In 2011-12 Joanna Reeves, an exchange student from the University of Bath, undertook a study on NZ Rugby Sevens flexibility, performance and injury (supervised by Patria, Kelly, Matt Wenham, Blair Mills; supported by NZRU 7's, and Industrial Research Limited). The reliability of passive lower limb flexibility in players was assessed using a new hand held dynamometer. Joanna's findings were presented at the 2012 International Society of Biomechanics in Sports annual conference in Melbourne.

Other students who have conducted rugby codes related projects, who have recently graduated at AUT include:

- Christos Argus (PhD) - Strength and power in elite rugby union players: Implications for training and performance.
- Aaron Randell PhD - Strength and power transference in rugby union players: Implications for training.
- Dan Smart (PhD) - Physiological profiling of Rugby Union players: Implications for talent development.
- Marty Beaven (PhD) - Hormone mediated strategies to enhance training & performance in rugby players.
- Taati Heke (MHSc) - The effect of two equal volume resistance training protocols upon muscle strength and hormones in strength-trained males.
- Michel Marnewick (MHSc) - Can a cross training program improve rugby skills in adolescent male rugby players?

- Adam Godfrey (MHSc) - The acute effects of rubber based resistance on repetition and total set kinetics and kinematics during the bench press exercise.
- Guy Mothersole (MHSc) – Eccentric strength training and implications to performance.
- Nick Webb (MHSc) - Assessing readiness for training in Rugby Union players.

Current students

Profiling, testing and assessment

- Travis McMaster (PhD) - Methods of assessing, monitoring and improving athletic performance.
- Caleb Dobbs (PhD) - Understanding and optimising vertical and horizontal force production for performance in team sport athletes.
- Teresa Ogden (MHSc) - Time motion analysis and physiological profile of elite NZ touch rugby players during competition.
- James De Lacey (MHSc) - The effects of tapering on force/velocity profiles and performance measures in professional rugby league players.
- Richard Swinbourne (PhD) - Sleep, Post Exercise Recovery and Performance in Athletes
- Albert Chang (PhD) - Isometric performance and its relation to dynamic performance in elite athletes.
- Craig Harrison (PhD) - The use of small-sided games in developing aerobic fitness in young athletes.

Injury prevention and recovery

- Scott Brown (PhD) - Risk factors for ACL injuries in rugby: Influence of gender, leg dominance and previous injury during cutting manoeuvres.
- Ben Reynolds (MHSc) – A comparison of two forms of eccentric hamstring training.

Business, management and coaching

- John Alder (PhD) - Enhancing cultural capital in High Performance Sport: What does it mean to play rugby league for New Zealand?

With the advent of the AUT Sports Business Research Group we hope to see new additions to the business and management side of things soon – watch this space!

AUT SPRINZ Sports Business Research Group

The Sports Business Research Group (SBRG), led by AUT Sport Management Lecturer Dr Richard Keith Wright, is the latest addition to the Sports Performance Research in New Zealand's (SPRINZ) multi-disciplinary research community. The group was created to provide a place for likeminded professionals from all over the globe to reveal and review their personal explorations into the overlapping socio-cultural and socio-economic issues that influence the everyday production and consumption of sports and recreation-related business activity. The group is open to all research active educators with an interest in increasing sport participation and/or improving sporting performances through the study of organisational capacities and individual businesses-related capabilities. More importantly, it also offers administrators and athletes (past and/or present, professional and/or amateur) of all ages, abilities and allegiances the opportunity to embark on their own postgraduate research journey, looking into an area of particular personal or professional interest to them or their company. The long-term goal is "To create of a community of critical scholars supplying quality research-based recommendations that enhance the professional business capabilities/capacities of individuals and organisations responsible for managing and marketing the supply of, and demand for, sport and recreation-related resources (people, products, projects and places)". For further information, please contact Richard.wright@aut.ac.nz.

JB Morin visit in November 2013

Throughout November we have the privilege of welcoming Professor Jean Benoit (JB) Morin from France at AUT. JB obtained his MSc in Sport Science at the University of Besançon, France, and then a PhD in Human Locomotion and Performance in 2004 at the University of Saint-Etienne, France (supervised by Professor Alain Belli), in collaboration with the University of Udine, Italy (Professor Pietro diPrampero). He has been assistant professor at the Sport Science Department of the University of Saint-Etienne and member of the Laboratory of Exercise Physiology since 2005. JB's field of research is mainly human locomotion and performance, with specific interest into running biomechanics and maximal power movements (sprint, jumps). He teaches Locomotion and Sports Biomechanics, and strength training and assessment methods. Various collaborations include French sprinter Christophe Lemaitre and his group/coach, as well as the French Soccer Federation research group. In this group, one of JB's roles is to teach professional coaches about sprint mechanics and training for acceleration. JB played competitive soccer for 10 years, practiced and coached track and field (middle distance and 400mhurdles) for 8 years, played basketball for 5 years and has been a competitive cyclist (road and mountain bike) for 4 years (and he still loves it!).

In addition to collaborating on various research projects JB will also be active at the SPRINZ Strength and Conditioning conference on 14-15th November. On the Thursday he will deliver a presentation on 'Sprint running mechanics and training: New concepts, new perspectives' at AUT Akoranga campus (room AF114) with discussion afterwards. On the Friday at AUT Millennium Institute he will run a 75 minute workshop entitled 'Force-velocity profiling in sprint and jump- Innovative simple methods'. In this workshop the concepts of force-velocity (F-V) profile in jumping and sprint running will be explained, and simple field methods will be taught and demonstrated. These methods will allow coaches to measure each individual athlete's F-V profile and mechanical power output, on the basis of loaded squat jumps or countermovement jumps and maximal 40 m sprint, respectively. The simple field methods used to compute athletes' actual "vertical" and "horizontal" F-V profiles and optimal profiles will be demonstrated as the measurements are performed, and delegates will be able to use them afterward in their own training and testing practice. Devices used will be standard squat loads and barbell, light beam or mat system (e.g. Optojump) to measure flight time during jumps, and radar gun or GPS or photocells to record either athletes' position or velocity as a function of time during the sprints. Details about the conference and registration can be found at www.sprinz.ac.nz.

SPRINZ Strength and Conditioning Conference November 2013

The SPRINZ S&C conference will be Thursday 14th and Friday 15th November 2013. It will be a fantastic opportunity to hear from world leading practitioners and the latest research in the field. You can sign up at www.sprinz.ac.nz.

Day one - Thursday 14th November

- 9:30 – 10:30 *Registration: AH Sport and Fitness Centre*
- 10:30 – 11:30 *Gold Nuggets: One year of global conferences in one hour* - Mike McGuigan (ASCA), John Cronin (NSCA), Nigel Harris (ACSM), Will Hopkins (ECSS).
- 11:30 – 12:30 *Sprint running mechanics and training: New concepts, new perspectives* – JB Morin
- 12:30 – 1:30 *Lunch*
- 1:30 – 3:00 *Case studies: Injury prevention integration: Prevention vs performance* - Hip and groin: Dayle Shackel, Bryan Stronach (NZ Cricket) Ankles and knees: Sharon Kearney, Stephen Hotter (HPSNZ)
- 2:45 – 3:15 *Afternoon tea*
- 3:30 – 5:00 *Considerations for the assessment and training of lower body power* - Jeremy Sheppard
- 6:00 *Networking and dinner at Gengys*

Day two - Friday 15th November
Workshop Options: Note choice during online registration

8:30 – 9:45
Isometric testing and training - Mike McGuigan - SPRINZ Strength and Conditioning Clinic
Jump training methods to develop lower body power - Jeremy Sheppard - Lifting Zone
Strongman implement training - Paul Winwood - Indoor Track

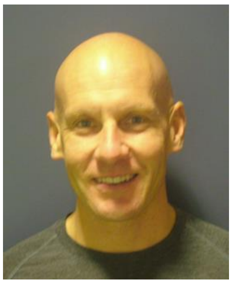
10:15 - 11:30
Power band training - Matt Kritz - HPSNZ Athlete Zone
Eccentric training - Angus Ross - SPRINZ Strength and Conditioning Clinic
Force-velocity profiling in sprint and jump - JB Morin - Indoor Track
Olympic weightlifting technique - Adam Storey - Lifting Zone

12:30 – 1:45
Isometric testing and training - Mike McGuigan SPRINZ Strength and Conditioning Clinic
Jump training methods to develop lower body power - Jeremy Sheppard - Lifting Zone
Strongman implement training - Paul Winwood - Indoor Track

2:15 – 3:30
Power band training - Matt Kritz - HPSNZ Athlete Zone
Eccentric training - Angus Ross SPRINZ Strength and Conditioning Clinic
Force-velocity profiling in sprint and jump - JB Morin - Indoor Track
Olympic weightlifting technique - Adam Storey - Lifting Zone

3:45 – 5:00
Sport-specific sessions

Profile of keynote speaker – Jeremy Sheppard

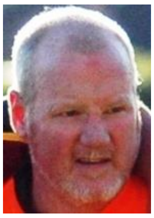


After 20 years working with Olympic sports, particularly elite volleyball, Jeremy is now the Head of Strength and Conditioning and Sport Science Manager at the Hurley Surfing Australia High Performance Centre, where he oversees the physical preparation of athletes nationally in the Elite Athlete Program. Prior to this he worked as Senior Strength Scientist with Australian Volleyball Federation and Australian Institute of Sport, and strength and conditioning coach at the Queensland Academy of Sport, Canadian Sport Institute, Greek Athletics, and for professional athletes in the US, Canada, and Europe. He has consulted widely to teams in the Australian Football League, National Rugby League, National Football League, and for professional volleyball players and teams in Sweden and Russia. Jeremy is credentialed in strength and conditioning (ASCA, NSCA), Olympic weightlifting (AWFm Canadian Weightlifting), and Performance Nutrition (ISSA). Alongside his coaching career he has been an active researcher in the area of volleyball, jump training, and strength and power assessment, resulting in more than 50 abstracts and manuscripts and 10 book chapters. Jeremy currently resides in Cabarita Beach, New South Wales, with wife Tracey and son Jake.

Recent research

The summaries of the recent research papers by members of the RCRG have been provided by each of the authors. For further information contact the lead author.

Concussions in Amateur Rugby Union Identified with a Rapid Visual Screening Tool



D. King, M. Brughelli, P. Hume and C. Gissane. *Journal of the Neurological Sciences* 326(1-2): 59-63, 2013

Background

Rugby by nature involves high frequencies of collisions[1] with potential concussion and/or mild traumatic brain injury a concern for players in both codes.[2,3] A widely used test to assess concussion on the side line is the Sports Concussion Assessment Tool (SCAT) or the SCAT2, and updated version of the SCAT, which takes approximately 20 min to complete.[4] A shorter assessment that can be completed on the field immediately would greatly benefit medical teams allowing them to make informed decisions more quickly.

The King-Devick (KD) side line test is a rapid concussion assessment tool taking around 2 minutes to complete. It assesses oculomotor (eye movement) function and uses numbers and charts that become harder and harder to read coherently. Poor oculomotor function has been reported as an effective indicator of mild traumatic brain injury.[5] Therefore Dr Doug King and his team used both the KD side line test, along with the SCAT2, over the course of a domestic season with an amateur Rugby Union team to assess its effectiveness in diagnosing concussion and/or mild traumatic brain injury.

Methods

The KD side line test (http://www.kingdevicktest.com) involves players reading a series of numbers from left to right as quickly as possible without making mistakes. The lower the time, the better score and vice versa. The SCAT2 (http://www.scat2.org) is combination of tests including the Post-Concussion Symptom Scale (PCSS), modified Maddock's questions, cognitive assessment and neurological screening. Two KD side line tests and the PCSS were completed by the club's premier team pre-competition to establish base line scores using an IPad2 or IPod-Touch. All players also provided a written record of their past concussion history.

Any players who were seen to take direct head blows, be unsteady on their feet or rise slowly from a tackle were assessed on field with the KD and the SCAT2 post-match. Assessment and management of players diagnosed with concussion was identical to Dr King's previous study in amateur Rugby League[3] and followed IRB guidelines. The effect of fatigue on the KD was also investigated by players taking the KD after a repeated high intensity endurance test (RHIET) six 70-m sprints departing every 30 s.

Results

During the season 37 players (mean ± SD age; 22.0 ± 4.0 yr) took part in in 24 games giving an average total match time of 478.8 hr. More players reported concussions in the past 3 years (81.1%) and during their lifetime (94.6%) than didn't. There was an average 4.0 ± 2.8 concussions for those reporting having had a concussion in the previous 3 years. There was also a learning effect between the first and second baseline KD tests ($p<0.001$). Five concussions were witnessed with a further 17 concussions being diagnosed by the KD.

Witnessed concussions recorded, on average, a significantly longer KD on the day of injury (5.5 ± 2.4 s; $p=0.063$) than unrecognised concussions (4.4 ± 0.9 s; $p<0.001$) when compared with their baseline KD. There was no significant correlation between SCAT2 and KD scores ($r=0.190$; $p=0.197$). Unrecognised concussions identified with the KD recorded on average fewer symptoms (16.1 vs. 6.8; $p=0.288$), lower symptom severity (8.8 vs. 42.4; $p=0.153$) better balance examination (5.2 vs. 12.8; $p=0.074$) and better immediate (13.7 vs. 13.0; $p=0.379$) and delayed (4.2 vs. 2.6; $p = 0.418$) memory scores than witnessed concussions, There was a decrease in KD score time by 1.2 s (range of 0.1-3.9 s) at 2 minutes after the RHIET.

So what? … Conclusions and practical applications

- **The KD was able to identify 17 meaningful head injuries where players had not shown or reported any signs or symptoms of a concussion.**
- **The rate of concussion in this study is of concern with ten-fold increase from previous literature[2,6] (46 per 100 match hours vs. per 1000 match hours).**
- **The improvement in KD time post exercise suggests the KD is not negatively affected by physical fatigue and is therefore a suitable assessment tool during a game.**
- **Further study should have more than one KD test available post-match to make it easier for all players to undergo the test.**

See the links below for the media coverage Dr King's research has attracted.

http://www.radionz.co.nz/national/programmes/ninetonoon/audio/2549914/mitigating-the-impact-of-sports-related-head-injuries.asx
http://www.stuff.co.nz/dominion-post/sport/club-sport/8505658/Hi-tech-mouthguards-help-players
http://www.momsteam.com/king-devick-new-concussion-screening-tool-may-dramatically-improve-detection-rate-sports-sideline

Electrostimulation's Enhancement of Recovery During a Rugby Preseason

C.M. Beaven, C.Cook, D.Gray, P.Downes, I.Murphy, S.Drawer, J.R. Ingram, L.P. Kilduff and N. Gill. *International Journal of Sports Physiology and Performance* 8: 92-98, 2013.

Background

Rugby preseason programs with a high volume of anaerobic, aerobic and resistance training have been shown to elicit positive adaptations but also increases in perceived fatigue in elite rugby union players.[7] Compression garments have been shown to be as effective as cycling and contrast water-therapy strategies after competitive rugby matches using interstitial creatine kinase (CK) as an indicator of recovery[8] and have been reported to decrease perception of pain after intense exercise.[9] Electrically stimulated muscle contractions have also been shown to activate the skeletal-muscle pump and enhance venous return by up to 95%.[10] As a consequence of its demonstrated ability to promote limb blood flow, electrostimulation has been assessed as a recovery strategy after exercise and has been shown to be more beneficial than both water-aerobic exercises and passive rest in reducing muscle pain in young soccer players.[11]

Monitoring psychometric variables has been suggested to detect early warning signs of overtraining more readily than various physiological or immunological markers,[12] with self-reported ratings of well-being providing an efficient means of monitoring both overtraining and recovery.[13]

Thus, the aim of this study was to assess the effectiveness of compression garments and an electrostimulation device (OnPulse) at assisting in recovery of professional rugby players during a preseason training period using psychometric, plasma CK, and salivary testosterone and cortisol monitoring.

Methods

Sixteen professional rugby players (age 25 ± 3 yr, height 188.1 ± 7.1 cm, body mass 104.0 ± 12.3 kg) volunteered to participate in this study. The players were assigned to groups (n = 8) matched as closely as possible by player position for each of 2 treatments (compression garment only or a concurrent combination of an electrostimulation device with the compression garment). The recovery interventions were randomly assigned in a crossover design over 2 × 2-week blocks that comprised the first 2 blocks of the 6-week preseason training period. A third 2-week block comprised a reduced volume compared with the first 2 blocks but involved 2 rugby games. The participants were instructed to wear their allocated treatment overnight if possible but for a minimum of 3 hr immediately after the completion of the final training session each day, Monday to Friday, and after the 2 rugby games.[14]

Full-length lower-body compression garments (Adidas Tuned TechFit, UK) were individually fitted for each player. The electrostimulation device (OnPulse, FirstKind Ltd, UK) has a pulse current of 27 mA with 7 user-adjustable pulse widths and a repetition rate of 1 Hz. Questionnaires were completed throughout the training blocks to assess subjective measures of sleep quality, energy level, mood, and enthusiasm using tailored 5-point Likert items. Saliva samples were collected at 8 am before training on Mondays, Tuesdays, Thursdays, and Fridays to assess cortisol and testosterone levels and calculate the testosterone-to-cortisol ratio. Blood samples were collected via finger prick, and samples were taken across the training blocks and before and 36 hours after matches to assess plasma CK using an enzyme-linked immunosorbent assay.

Results

On average, treatment duration was 11.3 ± 1.9 hours for compression and 8.4 ± 3.4 hours for the combined treatments. Total training volumes in blocks 1 and 2 were similar ($p>0.05$); however, session ratings of perceived exertion showed a greater loading at high intensities in block 1 (60.8%) than in block 2 (43.7%). Substantial benefits of the combined treatment over compression were seen in the average perceptions of energy (effect size (ES)=0.86) and enthusiasm (ES=0.80). The average cumulative total of the 4 Likert items was greater in the combination treatment than in the compression treatment (ES=0.50), with a 77% likelihood of a beneficial effect and a 5% likelihood of a negative effect. The range for average morning levels for salivary testosterone was 97.8 to 153.7 pg/mL and for cortisol was 2.51 to 6.45 ng/mL. Testosterone levels decreased across block 1 (from 139.2 ± 37.7 to 114.6 ± 22.1 pg/mL; $p<0.05$) and block 2 (from 157.7 ± 51.1 to 133.2 ± 32.9 pg/ mL; $p=0.08$). Cortisol levels also decreased across block 1 (from 5.15 ± 1.71 to 3.40 ± 1.63 ng/mL; $p<0.01$) but not block 2 (from 6.33 ± 2.32 to 6.13 ± 1.99 ng/mL; $p>0.05$). No significant differences in hormone data were observed between the treatments. Lower

CK levels were observed 36 hours after rugby matches when the combination treatment was compared with the compression treatment (ES 0.61; $p=0.08$).

So what? … Conclusions and practical applications

- **A combination of electrostimulation and compression garment treatment was more effective (moderate to large effect sizes) than compression garment treatment alone in eliciting positive self-report measures of energy and enthusiasm in professional rugby players.**
- **Electrostimulation was also associated with reduced CK levels after rugby matches which indicates an increased rate of recovery.**
- **Further study should investigate recovery during differing exercise intensities and under more controlled conditions.**
- **The effects of posture on venous blood return as a result of electrostimulation should also be investigated.**

Lower-extremity Isokinetic Strength Profiling in Professional Rugby League and Rugby Union

S. R. Brown, P.C. Griffiths, J. B. Cronin and M. Brughelli. *International Journal of Sports Physiology and Performance.* (Published ahead of print).

Background

While rugby league and rugby union contain similar fundamental skills such as tackling, passing, catching etc., they differ in their technical[15] and physical demands.[16] For example Rugby league forwards and backs generally play and train, on defence and offence, at mid to high-speeds in an upright position[15] whilst Rugby union forwards are generally involved in strength dominated and relatively low speed action such as front-on tackling. It is therefore logical to assume that these differences in demands at specific joints and joint angles would lead to unique force producing attributes between codes and positions.

Profiling lower-extremity strength and power of rugby league[17] and rugby union[15] players is of interest to strength and conditioning coaches for injury prevention and performance purposes. To our knowledge, only one study[18] has compared strength profiles between rugby codes using isokinetic testing. Unfortunately, no profiling of hip strength has been reported. There is a need for strength profiling of elite players of both codes and positions at the knee and hip, as this will aid in understanding how the requirements and characteristics of players of both codes differ as well as guiding specific conditioning practices to better effect.

Methods

Thirty-two professional male rugby league (mean ± SD: age = 23 ± 3 yr, height = 184 ± 6 cm, mass = 101 ± 11 kg) and rugby union (mean ± SD: age = 25 ± 3 yr, height = 186 ± 7 cm, mass = 103 ± 12 kg) players volunteered as participants for this research. Each participant completed the testing in one session (~2 hr) and each code completed the testing over the course of three days; where testing occurred at the same time of day. Testing for both codes took place during their respective off-season following a rest day (~24 hr) and prior to training on that day.

Following the warm-up, participants were secured to a Humac Norm dynamometer (Lumex, Ronkonkoma, NY, USA) to assess isokinetic concentric knee and hip extensor and flexor strength on each leg at 100 Hz. The dynamometer was set up in two separate positions using a standardized protocol for knee and hip actions[19]. In both positions, gravity adjustments were made by determining the combined effects of leg mass and the passive muscle tension using the HUMAC software. The leg that the player preferred to kick the ball was defined as the dominant leg.[20]

Each leg was tested at a fixed angular velocity of $60°\cdot s^{-1}$ for five extension and five flexion actions.[21] Familiarization required three movements at an individually perceived 50, 70 and 90% of maximum exertion at each position. Investigators provided strong verbal encouragement during each trial to maximize the participants' effort across trials.[19] Participants were given appropriate rest between trials (>2 minutes) in order to prevent the effects of fatigue.

Results

During isokinetic strength testing, rugby union forwards produced significantly greater peak knee flexion torque in the dominant (+44 N·m; effect Size (ES)=1.81; p<0.001) and non-dominant (+35 N·m; ES=2.02; p<0.001) legs compared to rugby league forwards. Rugby union forwards also produced greater (+35 N·m; ES=0.71; p=0.047) peak torques than rugby league forwards during knee extension in the dominant leg. Rugby league backs demonstrated greater peak hip extension torque in the dominant (+ 71 N·m; ES=0.83; p=0.019) and non-dominant (+58 N·m; ES=0.77; p=0.001) legs compared to rugby union backs. When peak torques were further analysed as knee flexion/hip extension ratios, rugby union ratios for forwards and backs in the dominant (ES=1.49; p<0.001 and ES=1.72; p< 0.001 respectively) and non-dominant (ES=2.26; p<0.001 and ES=1.62; p<0.001 respectively) legs were greater as compared to rugby league players.

So what? … Conclusions and practical applications

- **Rugby Union players were stronger in knee flexion possibly due to game specific technical demands of scrummaging, rucking, mauling and pick-and-goes all requiring great lower limb strength and power while the hip and knee joints are held in flexed positions.**
- **Rugby League players were stronger in hip extension possibly due to game specific technical demands such as minimal scrummaging; tackles being made primarily to the upper-half or the body; reception and running with the ball generally from upright positions; and, sprint efforts commonly being preceded with backwards running.**
- **Rugby Union players had greater concentric hamstrings/quadriceps and knee flexion/hip extension ratios with the optimum ratio of hip extension/knee flexion peak torque currently unknown.**
- **Further study comparing both rugby codes is warranted to identify any reoccurring strength deficits that may predispose specific codes to posterior thigh and knee injury.**

The Development, Retention and Decay Rates of Strength and Power in Elite Rugby Union, Rugby League and American Football

D.T. McMaster, N. Gill, J. Cronin and M. McGuigan. *Sports Medicine* 43: 367-384, 2013.

Background

An athlete's strength and power will fluctuate in direct relation to the mode and quantity (i.e. frequency, intensity, volume and duration) of the training dose. Therefore, all of these factors must be considered when designing the various phases in an athlete's training programme. The combination of training modalities, quantity, tempo and rest periods prescribed during strength and power development (i.e. off-season and pre-season), maintenance (in-season) and detraining (immediate off-season) vary and are dependent on the specific goals at a particular point in time. The dose required to develop, retain and decay strength and power are high, moderate and minimal, respectively. The dosage required to develop strength is generally described as high frequency (3–5 weekly sessions per muscle group), moderate volume (3–6 sets 9 2–6 repetitions [reps] 9 load mass) and high intensity (85–100 % one-repetition maximum [1RM]) with a slower movement tempo due to the high-intensity loading and non-ballistic nature of strength training exercises; while power differs mainly in the intensity (20–70 % 1RM) and movement tempo (i.e. explosive-ballistic).[22-24]

Strength and power maintenance (i.e. retention) is much less investigated in elite rugby and American football, but generally the intensity and session volume are held constant and frequency is reduced (1–2 weekly sessions per muscle group).[25]During detraining (i.e. no structured training), the weekly decay rates of strength and power are of great interest, as they allow us to determine the minimum and maximum durations training can be ceased before another training stimulus is required. Studies utilizing resistance trained and untrained individuals indicate that large losses in strength occur in the first 1–4 weeks of training cessation; while there is almost no research on detraining and its effect on power.[26]

A large body of literature has focused on the neuromuscular and morphological adaptations and their influence on the development and decay of strength and power due to resistance training in non-athletes, recreational athletes and resistance trained individuals.[26-33] But there is a lack of research investigating the training, maintenance and detraining doses and their effects (i.e. development, retention and decay) on strength and power in elite athletes and, more specifically, rugby league, rugby union and American football. To date, no review has systematically assessed the effects of development, maintenance and detraining-based studies on the strength and power of elite football-code athletes. Therefore, the purpose of this study was to systematically review and assess the magnitude of the treatment effects (i.e. resistance training dosage) of resistance training, maintenance and detraining programmes on the changes in upper and lower body strength and power of American football players and elite rugby union and rugby league players.

Methods

A literature search using MEDLINE, EBSCO Host, Google Scholar, IngentaConnect, OvidLWW, ProQuest Central, ScienceDirect Journals, SPORTDiscusTM and Wiley InterScience was conducted. References were also identified from other review articles and relevant textbooks. From 300 articles, 27 met the inclusion criteria and were retained for further analysis. Study quality was assessed via a modified 20-point scale created to evaluate research conducted in athletic-based training environments. The mean ± standard deviation (SD) quality rating of the included studies was 16.2 ± 1.9; the rating system revealed that the quality of future studies can be improved by randomly allocating subjects to training groups, providing greater description and detail of the interventions, and including control groups where possible.

Percent change, effect size (ES=[Post- Xmean - Pre-Xmean)/Pre-SD) calculations and SDs were used to assess the magnitude and spread of strength and power changes in the included studies. The studies were grouped according to (1) mean intensity relative volume (2) weekly training frequency per muscle group; and (3) detraining duration. IRV is the product of the number of sets, repetitions and intensity performed during a training set and session. The effects of weekly training frequencies were assessed by normalizing the percent change values to represent the weekly changes in strength and power. During the IRV analysis, the percent change values were normalized to represent the percent change per training session. The long-term periodised training effects (12, 24 and 48 months) on strength and power were also investigated.

Results

Across the 27 studies (n=1,015), 234 percent change and 230 ES calculations were performed. Intensity relative volumes (IRVs) of 11–30 (i.e. 3–6 sets of 4–10 repetitions at 74–88 % one repetition maximum 1RM) elicited strength and power increases of 0.42 % and 0.07 % per training session, respectively. The following weekly strength changes were observed for two, three and four training sessions per muscle region/week: 0.9 %, 1.8 % and 1.3 %, respectively. Similarly, the weekly power changes for two, three and four training sessions per muscle group/week were 0.1 %, 0.3 % and 0.7 %, respectively. Mean decreases of 14.5 % (ES=-0.64) and 0.4 (ES=-0.10) were observed in strength and power across mean detraining periods of 7.2 ± 5.8 and 7.6 ± 5.1 weeks, respectively. The long-term training studies found strength increases of 7.1 ± 1.0 % (ES=0.55), 8.5 ± 3.3 % (ES=0.81) and 12.5 ± 6.8 % (ES=1.39) over 12, 24 and 48 months, respectively; they also found power increases of 14.6 % (ES=1.30) and 12.2 % (ES=1.06) at 24 and 48 months.

Table 4 Meta-analysis of short-term dose-response relationships: strength and power

Adaptations (n)	IRV	Volume x intensity			Overall			Percent change			
		Sets	Reps	% 1RM	Duration[a]	Frequency[b]	Percent change (ES)	1[c]	5[d]	10[d]	20[d]
Strength (549)	19.4 ± 7.4	3.8 ± 1.0	6.7 ± 2.2	80.0 ± 5.0	10.4 ± 4.3	2.5 ± 0.7	9.5 ± 7.3 (0.53)	0.42	2.1	4.2	8.4
Power (357)	19.3 ± 6.6	3.8 ± 0.8	6.4 ± 2.0	81.0 ± 5.0	9.7 ± 4.3	2.5 ± 0.6	2.0 ± 4.3 (0.42)	0.07	0.4	0.8	1.5

All values are represented as pooled means and standard deviations

[a] Length of included training study in weeks

[b] Number of training sessions per muscle group per week

[c] Mean percent change in strength or power per session

[d] Forecasted percent changes in strength and power across 5, 10 and 20 training sessions based on 1

% 1RM = percentage of one repetition maximum utilised; ES = mean effect size in strength and power; IRV = intensity relative volume of all included strength or power measures; Reps = repetitions

So what? … Conclusions and practical applications

- **Two to four resistance training sessions per muscle group/week can be prescribed to develop upper and lower body strength and power. IRVs ranging from 11 to 30 (i.e. 3–6 sets of 4–10 repetitions of 70–88 % 1RM) can be prescribed in a periodised manner to retain power and develop strength in the upper and lower body.**
- **Strength levels can be maintained for up to 3 weeks of detraining, but decay rates will increase thereafter (i.e. 5–16 weeks).**
- **The long term effects of periodised resistance training programmes on strength and power seem to follow the law of diminishing returns, as training exposure increases beyond 12–24 months, adaptation rates are reduced.**
- **The effect of explosive-ballistic training and detraining on pure power development and decay in elite rugby and American football players remain inconclusive.**
- **Further investigations using a wide spectrum of training doses, movement velocities and movement patterns during training and detraining phases are required. Any findings will directly influence off-season, pre-season and in-season loading parameters and the length of in-season and off-season unloading phases.**

References

1. Brooks JH, Kemp SP. Recent trends in rugby union injuries. Clin Sports Med 2008;27:51-73, vii-viii.
2. Brooks JH, Fuller CW, Kemp SP, Reddin DB. Epidemiology of injuries in English professional rugby union: part 1 match injuries. Br J Sports Med 2005;39:757-66.
3. King D, Clark T, Gissane C. Use of a rapid visual screening tool for the assessment of concussion in amateur rugby league: A pilot study. J Neurol Sci 2012;320:16-21.
4. Eckner JT, Kutcher JS. Concussion symptom scales and sideline assessment tools: a critical literature update. Curr Sports Med Rep 2010;9:8-15.
5. Heitger MH, Jones RD, Anderson TJ. A new approach to predicting postconcussion syndrome after mild traumatic brain injury based upon eye movement function. Conf Proc IEEE Eng Med Biol Soc 2008;2008:3570-3.
6. McIntosh AS, McCrory P, Finch CF, Wolfe R. Head, face and neck injury in youth rugby: incidence and risk factors. Br J Sports Med 2010;44:188-93.
7. Argus CK, Gill N, Keogh J, Hopkins WG, Beaven CM. Effects of a short-term pre-season training programme on the body composition and anaerobic performance of professional rugby union players. J Sports Sci 2010;28:679-86.
8. Gill ND, Beaven CM, Cook C. Effectiveness of post-match recovery strategies in rugby players. Br J Sports Med 2006;40:260-3.
9. Davies V, Thompson KG, Cooper SM. The effects of compression garments on recovery. J Strength Cond Res 2009;23:1786-94.
10. IO WM, Lepar GS, Morrissey MC, Cywinski JK. Effect of neuromuscular electrical stimulation on foot/ankle volume during standing. Med Sci Sports Exerc 2003;35:630-4.
11. Tessitore A, Meeusen R, Cortis C, Capranica L. Effects of different recovery interventions on anaerobic performances following preseason soccer training. J Strength Cond Res 2007;21:745-50.
12. Kentta G, Hassmen P. Overtraining and recovery. A conceptual model. Sports Med 1998;26:1-16.
13. Foster C. Monitoring training in athletes with reference to overtraining syndrome. Med Sci Sports Exerc 1998;30:1164-8.

14. Lo KR, Hurst SM, Atkinson KR, Vandenbogaerde T, Beaven CM, Ingram JR. Development and validation of a sensitive immunoassay for the skeletal muscle isoform of creatine kinase. Journal of Science & Medicine in Sport 2010;13:117-9.
15. Gamble P. Physical preparation for elite-level rugby union football. Strength Cond J 2004;26:10-23.
16. Austin D, Gabbett T, Jenkins D. Repeated high-intensity exercise in professional rugby union. J Sports Sci 2011;29:1105-12.
17. Gabbett T, Kelly J, Pezet T. Relationship between physical fitness and playing ability in rugby league players. Journal of Strength and Conditioning Research 2007;21:1126-33.
18. Newman MA, Tarpenning KM, Marino FE. Relationships between isokinetic knee strength, single-sprint performance, and repeated-sprint ability in football players. Journal of Strength and Conditioning Research 2004;18:867-72.
19. Montgomery MM, Shultz SJ. Isometric knee-extension and knee-flexion torque production during early follicular and postovulatory phases in recreationally active women. Journal of Athletic Training 2010;45:586-93.
20. Brophy RH, Silvers HJ, Gonzales T, Mandelbaum BR. Gender influences: the role of leg dominance in ACL injury among soccer players. Br J Sports Med 2010;44:694-7.
21. Li RCT, Wu Y, Maffulli N, Chan KM, Chan JLC. Eccentric and concentric isokinetic knee flexion and extension: A reliability study using the Cybex 6000 dynamometer. British Journal of Sports Medicine 1996;30:156-60.
22. Baker D, Nance S, Moore M. The load that maximizes the average mechanical power output during jump squats in power-trained athletes. Journal of Strength and Conditioning Research 2001;15:92-7.
23. Berger RA. Optimum Repetitions for the Development of Strength. Res Quart 1962;33:334-8.
24. Stone MH, Obryant H, Garhammer J. A Hypothetical Model for Strength Training. J Sport Med Phys Fit 1981;21:342-51.
25. Tan B. Manipulating resistance training program variables to optimize maximum strength in men: A review. Journal of Strength and Conditioning Research 1999;13:289-304.
26. Hakkinen K. Neuromuscular adaptation during strength training. Physical Rehabilitation Medicine 1994;6:161-98.
27. Burton A. Muscle plasticity: response to training and detraining. Journal of Physiotherapy 2002;88:398-408.
28. Folland JP, Williams AG. The adaptations to strength training : morphological and neurological contributions to increased strength. Sports Med 2007;37:145-68.
29. Mujika I, Padilla S. Muscular characteristics of detraining in humans. Med Sci Sports Exerc 2001;33:1297-303.
30. Larsson L, Ansved T. Effects of long-term physical training and detraining on enzyme histochemical and functional skeletal muscle characteristic in man. Muscle Nerve 1985;8:714-22.
31. Komi PV. Training of muscle strength and power: interaction of neuromotoric, hypertrophic, and mechanical factors. Int J Sports Med 1986;7 Suppl 1:10-5.
32. Leveritt M, Abernethy PJ, Barry BK, Logan PA. Concurrent strength and endurance training. A review. Sports Med 1999;28:413-27.
33. Aagaard P. Training-induced changes in neural function. Exerc Sport Sci Rev 2003;31:61-7.