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Subspecies Mamil: A Rare Evolutionary Development?

In 1569 Italian Doctor and Scholar Girolamo Mercuriale (1530-1606) published what is often described as the original Sports Medicine text book. While distinct in appearance and language from modern sports medicine texts, Mercuriale was passionate about the use of exercise for promoting health and preventing illness and in that sense has many similarities to 21st century sports medicine. Heavily influenced by the Greek Philosopher/Doctor Aelius Galenus (Galen of Pergamon AD 129 – c200), Mercuriale felt that the preventative health benefits of exercise espoused by Galen had been lost over centuries, and took it upon himself to re-establish exercise as a tool for the physician.[1,2]

> "on gymnastic practices or exercise … the art of gymnastics, extremely favoured among the ancients, … you will find that nothing or extremely little has been transmitted, and only in a random and confused manner." (P21)[1]

Mercuriale takes a very systematic approach to his dissertation, first describing the use of exercise in ancient Greece, then carefully articulating the nature of various games and exercises before finally describing their medical benefits.[1,2] The renaissance period was a critical period in the development of the modern science of medicine, with the Galenic teachings ultimately superseded by empirical approaches to medicine. However, in the 500 years since Mercuriale first put quill to paper, the challenges of utilising exercise for health promotion have persisted.

In the late 19th century, intense competitive exercise was becoming so common place that concerns regarding the risks of strenuous exercise were being raised, with advocates of exercise for health having to defend the benefits of intense exercise.[3] By the turn of the 20th century, as well as large international competitive multi-sport events such as the Olympics having begun, numerous non-competitive "exercise for health" alternatives were being promoted globally. Authors and entrepreneurs such as Eugen Sandow (1867 – 1925) and Bernarr McFadden (1868 – 1955) were actively promoting a healthy mind in a healthy body, through commercialised promotion of their own exercise for health strategies, books and magazines.

> "Neither a successful mental life nor a successful accumulation of wealth can be achieved without a good foundation of physical life……Neglect the body and the whole of life becomes a failure" (P126)[4]

Eugene Sandow (who ultimately became known as the "Father of Body Building"), is not normally recognised as a leader in sports medicine, but on perusal of his textbook "Life is Movement", it is quickly apparent that he was perhaps ahead of his time in his approach to the prescription of exercise for health. Sandow recognised a place for competitive games and sport, but he also felt that they were not necessarily suitable for all and that it was more important to "lay down a physical foundation for life, and build up muscle and tissue and a healthy organism not for the mere performance of any particular game or sport or athletic feat, but as the finest insurance policy in the world against physical deterioration and disease". (P 393)[5] Indeed, while describing Doctors as a "health accountant", a subsection in "Life is Movement" is titled "Exercise should be prescribed like medicine" (P 345) under which he recommends that "Every student should be taught the prescription of … balanced physical movement".[5]

Seventy years on, it was New Zealanders who were among the first to legitimise exercise prescription for health, with the development of initiatives such as "The Green Prescription" (1998), designed for the prevention and treatment of chronic disease. Having survived its own evolutionary process (from a Sport and Recreation initiative, to currently sit with the Ministry of Health) over the last 16 years, the Green Prescription and its offspring "Active Families" (targeting children with a BMI over 25) remains an avenue for promoting exercise and health in NZ. Over the last 15 years the rest of the world has tried to catch up, with initiatives such as ACSM's "Exercise is Medicine", and numerous conferences dedicated to this "new" topic. However, New Zealand's easy access to the outdoors and widespread sporting facilities gives us a huge advantage over most countries. Why then, do our health statistics make such depressing reading?

According to the NZ Health Survey (2012/13) 31% of adults and 11% of 2-14 year olds in New Zealand are obese. Up to 68% of Pacific Island adults in NZ may be obese, with diabetes prevalence at 13% in the same group. This equates to 1.2 million obese individuals in our fine country. 15% of adults continue to smoke, and this may reach 36% in high risk groups, while 15% of adults drink alcohol "hazardously". In addition, 15% of the population suffers from some form of arthritis (including osteoarthritis) and 17% suffer from chronic pain.[6]

It has been well established that "The Green Prescription" can have a positive impact on activity levels, nutritional intake and motivation, with most participants showing positive health changes.[7,8] However, despite the best intentions, it appears that in 2013/14 there were only (roughly) 15,000 participants in the green prescription, and somewhere near 300 in the active families programme.[8,9] When one considers that 31% of adults, and more than 10% of children are obese (obesity is the most common reason for referral to "The Green Prescription"), these numbers don't match up.

NZ has a proud and deserved reputation as an outdoor, exercising nation, and one that "punches above its weight" in international sport. Middle aged men in Lycra (MAMILs), exercise classes and boot camps are seemingly everywhere on our streets, beaches and gyms, reflecting

the latest incarnation of a booming fitness industry, thus making the above statistics seem incomprehensible. Yet I am clearly biased (I'm not sure if it's a reporting bias, an exclusion bias, a selection bias or some other cognitive bias – I'm sure there must be a term for this) in my perceptions, as our national statistics do not support the notion of NZ being a nation of exercisers. Perhaps MAMILs are not as common as they appear to be.

The promotion of exercise for health has a long history, and Sports Medicine in NZ has played an important role in establishing exercise as a means of health generation. However, despite our great progress, there remains much to be done if we are going to translate the well-established evidence on the benefits of exercise on health, into sustainable benefits for our population.

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ADDENDUM

The Man Who Knew Too Much

In Issue 41(1), the editorial described a superficial evaluation of the merits of genetic testing for predicting future performance in athletes. For those of you who may not have made the SMNZ conference to see the results of this unscientific assessment of the predictive merits of genetic testing of athletes, the following table illustrates the (vastly generalised) outcomes of the genetic testing that was performed. To summarise, the results illustrated without exception that our punter, our trier, our wannabe, our weekend warrior, our dreamer of sporting glory, was found to have the preferred genetic profile when compared with a double Olympic Gold Medallist.

This of course, "proves" nothing (there are some obvious weaknesses in this study design!), but should encourage us to carefully consider the merits and risks of spending $300 on a genetic test for performance prediction.

That an individual's genetic make-up is important to sporting success is undeniable, and yet reducing performance to genetics alone remains an inappropriate oversimplification. Furthermore, genetic testing is a serious business, and should not be taken lightly. In other fields of medicine, when undergoing genetic evaluations (such as for conditions like Huntingtons Disease), a formal psychological evaluation and support structure is required to be in place, prior to any testing taking place. Direct to the consumer marketing of genetic tests, does not provide such support.

The unexpected and unintended consequence of this outcome is that our "punter" has been cast as an "underachiever", not living up to his genetic "potential". The unstated implication is that this reflects an underlying lack of psychological, physical or mental application to developing his "natural" talent. Our punters long held mantra in the face of his repeatedly "average" athletic performances was that "the mind is willing but the body is weak", which is no longer applicable given his new found understanding of his "genetic potential" (assuming he were to believe the genetic results of course). What impact this cognitive dissonance may have on his long term athletic performance (and engagement in sport) remains to be seen.

The scientific basis for the genetic profiling of potential or current athletes to predict future capability, injury profile or preferred event, typically remains limited to low quality association studies, with limited or no predictive ability. The marketing of these genetic tests direct to the consumer, without any direct medical or counselling involvement challenges many of the standards of good practice, and has the appearance of 21st century snake oil.

Profile	Olympic Gold	Punter
Power		x
Endurance		x
Recovery		x
Injury Risk		x

Figure 1: Summary of preferred genetic characteristics for performance, relative to each other. Preferred characteristics marked with x.

ICC CRICKET WORLD CUP 2015

In 2015 New Zealand will be co-hosting the Cricket World Cup, and many SMNZ members will be involved. The World Cup will be a great opportunity for us to illustrate both what a great sporting country NZ is, and the quality of our sports medicine services. In recognition of this event, the British Journal of Sports Medicine, Sport Health, the Journal of Science and Medicine in Sport and the NZJSM have been collaborating to publish Cricket specific issues, which will appear over the next few months. Reflecting this collaboration, we include two interesting case reports related to cricket players in this issue, and I would like to thank John Orchard for his support in raising the profile of Sports Medicine in Cricket in this way.

Ultimately, I look forward to a great event, and a successful NZ cricket team. Good Luck all!

A response to: Towards a "Grand Unifying Theory of Sports Medicine" (AKA "Guts Me")

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INTRODUCTION

A 'Unified Theory for Biology' is thought to be near impossible due to the huge complexity found in biological systems.[6] Commenting on this in a 2013 issue of the New Zealand Journal of Sports Medicine, Dr Hamilton propounded the lack of a grand unifying theory in sports medicine: "In the 50 years since physicists postulated and discovered the game-changing, impossible-to-fathom but unifying theory of everything Higgs Boson, what progress has Sports Medicine made – do we have a Sports Medicine equivalent of the Higgs Boson?".[4] While we may never have a 'Higgs Boson' in sports medicine, a new perspective on old data could help synthesise areas of research that are still subject to much debate. Here I introduce several key ideas from Systems Theory (ST) and apply them to the Lactate Threshold (LT) concept. A ST perspective is helpful in bringing different hypotheses together into a more unified and mechanistic description of patterns reported in the literature. While ST has been applied to complex problems in biochemistry and evolution,[14,9] its use in physiology has been limited (although see [15]).

To state my case I begin with a quick recap of the LT, and then outline key ideas from ST. These include the importance of scale, hierarchy, feedback cycles and complex interactions. I then take a new look at LT data, and propose that the uncoupling of physiological feedback cycles under increasing exercise stress is an important determinant of an athlete's endurance capacity. By using the LT concept as a template, I hope to show how systems theory can be used to compare clinical studies and potentially synthesise areas of theory in sports medicine.

The lactate threshold – a recap

The LT is correlated with performance success in endurance sports such as cycling, triathlon and marathon running.[7] Defined as "the highest oxygen uptake that can be achieved during exercise before a systemic increase in blood lactate concentration occurs",[2] it is used to prescribe training zones for athletes (a 10-beat heart rate window that sits just below the LT) where maximum gains from training can be made without overtraining. The test is used in sports-testing laboratories around the world for athletes from regional to the elite level. However, there is still debate on the exact mechanisms that both lead to a non-linear increase in blood lactate[3,12] and the validity of the LT test as an accurate training tool.[1] These issues are important as the prescription of incorrect training zones increases the probability that an athlete over-trains, especially young athletes who are still learning how their bodies respond to training.[11]

What scale is that?

The core ideas of ST include scale, hierarchy, feedback cycles and a focus on complex interactions. These ideas help to frame thinking and enable comparison between different case studies. Scale separates the dynamics or components of a system and structures them hierarchically – this spatial structuring then provides a framework to clarify how each level of a system fits together.[8] In the LT problem, scale builds a picture of how drivers fit together to regulate lactate (Box 1). While current research suggests that blood lactate accumulation in trained athletes is due to a reduction in metabolic clearance rate (MCR) as the removal of endogenous lactate becomes limited, the exact mechanisms are thought to require further investigation.[12] Using ST, we can take the multiple hypotheses and different case studies on lactate and its related dynamics already present in the literature, and use them to build an understanding of how drivers at different scales fit together mechanistically. Once this picture is clear, feedback cycles can then be used to describe how the system works.

Scale also calls into question what the current 4mmol LT test[5] can accurately predict. While the test is essential to our understanding of mean or 'population-scale' lactate dynamics, due to the range of cellular to multi-tissue processes that it aims to capture, inaccuracies are possible at the individual scale that may lead to incorrect training zones being prescribed for an athlete.

Box 1: Scaled drivers of lactate accumulation.

- **CELL SCALE:** Anaerobic conditions in the cell
- **CELL SCALE:** Lactate is a by-product of glycogenesis
- **CELL SCALE:** Facilitated diffusion by mono carboxylate transporters (MCT)
- **CELL SCALE:** Transmembrane lactate anion and H^+ gradients
- **WITHIN-TISSUE SCALE:** Increased glycolytic fibre recruitment with increasing exercise intensity
- **WHOLE-TISSUE SCALE:** The oxidative capacity of the muscle is exceeded, even though oxygen delivery is adequate
- **WHOLE-TISSUE SCALE:** Lactate production vs use by tissues as fuel
- **MULTI-TISSUE SCALE:** That lactate accumulation is due to reduced hepatic clearance
- **MULTI-TISSUE SCALE:** Elevated circulating adrenaline stimulates muscle glycogenolysis and lactate production
- **MULTI-TISSUE SCALE:** Noradrenaline affects cardio dynamics and regional blood flow

Feedback cycles and a new look at old data

The concept of feedback allows us to look at the complex interactions that regulate lactate. This is important as traditionally dynamics have been studied in isolation. Negative feedback keeps the dynamics of a system within set bounds (i.e. homeostasis) while positive feedback amplifies a response through the system. Feedback cycles are then 'coupled' to each other across and between different scales, and work in synchrony.[8] Therefore, below the LT negative feedback controls ventilation frequency and the delivery of oxygen, carbon dioxide and lactate within and between cells and tissues, with all of these processes acting in synchrony to power work. The 'threshold' point (seen as an exponential increase in lactate) is then due to positive feedback and a 'falling out of sync' between aerobic and anaerobic processes.

I propose that the uncoupling of physiological feedback cycles under increasing exercise stress is what defines an athlete's endurance capacity, in addition to the physiological changes that occur with training that are already well described in the sports science literature. This 'uncoupling' can be seen in the variation of breath data (Figure 1), which is often overlooked in favour of the

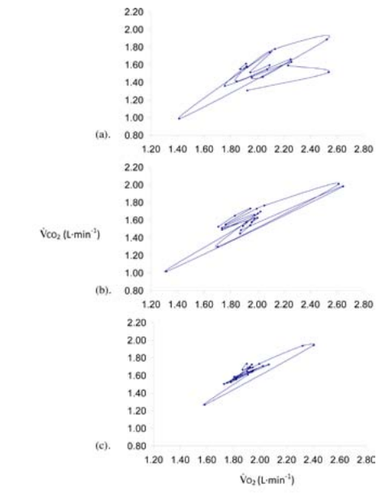

Figure 1: Breath-by-breath CO2 vs. O2 data during a three minute protocol ramped lactate test. Test subject was a competitive regional-level Canterbury road cyclist. Data taken from stage one at 100 watt (W) power output for: (a) minute one, (b) two (c) and three. Data points are joined to clearly illustrate the coupling (relationship) between these two parameters. The damping effect seen is hypothesised to represent negative feedback between the different physiological processes occurring in aerobic metabolism, which bring the athlete to a stable work output.[10]

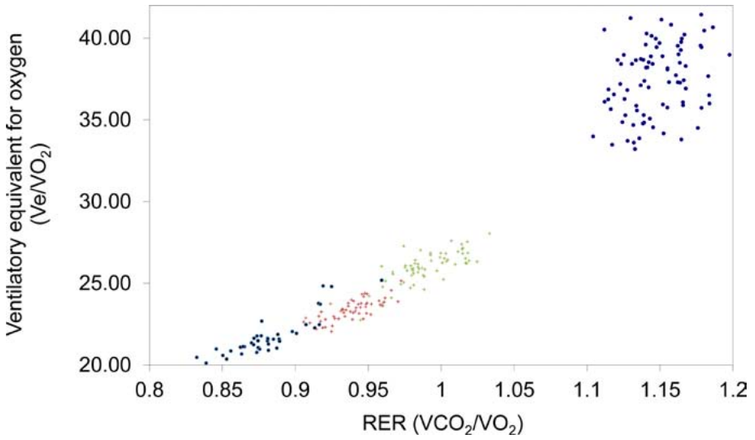

Figure 2: Breath-by-breath respiratory data for the final two minutes of exercise during a five minute protocol ramped lactate test. The ventilatory equivalent for oxygen (E · O2-1) is plotted against the respiratory exchange ratio (RER). The test subject was a competitive regional-level Canterbury road cyclist. Blue 100 W; Orange 140 W; Green 180 W and Purple 220 W. 220 W represents the power output above the athlete's LT and the 'un-coupling' of physiological processes, as represented by increased scatter in the data. [10]

clarity that means provide. Highly trained athletes are therefore able to regulate feedback more quickly and keep dynamics within a smaller range around a desired state. This occurs through the up-regulation of aerobic metabolism feedback pathways, which can be used to supply energy at higher workloads with less reliance on glycolysis. The LT then becomes the point at which energy supply and 'sink' pathways become completely un-coupled (sink processes are those related to MCR, as described in Box 1). Overall this uncoupling leads to an increase of data scatter, due to a loss of physiological control and the ability to do work (Figure 2).

CONCLUSION

Systems theory may provide a set of ideas that can be used to compare clinical studies and synthesise areas of theory in sports medicine. As demonstrated using the LT question; scale, hierarchy, feedback cycles and complex interactions provide a framework to synthesise the multiple hypotheses that describe and predict lactate dynamics, and ground them in a set of theoretical principles. These basic principles could be applied to other complex problems in sports medicine and help to draw together clinical observations. ST also has the potential to generate new hypotheses, for example; it is hypothesised that fitness includes the development of tighter coupling between linked physiological processes, which is reflected as variance in the appropriate data. This general hypothesis could be tested by measuring lactate-related dynamics at different scales, and through the technological advances of infusion[10] and isotopic analysis,[12] tests at multiple scales within a study are a possibility. From this basis an aerobic/anaerobic exercise test that is more reliable at the scale of an individual athlete may also be developed. Applied widely, a ST perspective may help pave the way to a general unified theory for sports medicine (aka "GUTS ME").

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This summary covers the British Journal of Sports Medicine issues from July to December 2014 inclusive.

JULY

The July issue was concerned with monitoring of physical activity. In the opening editorial, Weiler and colleagues asked the question 'Is the lack of physical activity strategy for children complicit mass child neglect?' This summarised the current data indicating that today's school children are much less active than their forebears. They report on limited funding that has been pledged by the UK government to improve the provision of physical education for primary school children, and comment that the investment seems pitiful in comparison to the overall education budget. They call on current and future governments to create a comprehensive national policy for child centred physical education.

Later in the same issue is an excellent review article on exercise training in children with asthma. Wanrooij and colleagues from the University of Maastricht summarised 29 studies and concluded that training had positive effects on several cardio- respiratory fitness parameters. They noted, however, that the effects of training on asthma control, airway inflammation and bronchial hyperresponsiveness were barely studied. They conclude that an effective training programme for children with asthma consists of at least two 60-minute training sessions per week, with training intensity individualised, and the programme should be continued for at least three months.

Excessive time sitting has been shown to be detrimentally related to several health outcomes. Samantha Stephens and colleagues from the University of Queensland instituted a pilot study in a single workplace with 21 intervention participants provided with standing workstations; their 22 colleagues on a separate floor acted as controls, sitting at standard desks and continuing their usual activities. Activity monitors were worn by all participants for 24 hours per day. All intervention participants reduced their total workplace sitting time, although there was wide individual variability. They recommended that intervention messages to reduce sitting time in the office be promulgated to encourage regular interruptions to sitting time across the workplace.

Personal recall of physical activity is notoriously unreliable. Brown and associates from the University of Utah added GPS data to accelerometry data to improve recall of physical activity. They then provided participants with maps of their bouts of moderate to vigorous physical activity in the past week and this prompted participants to provide more accurate recalls of their locations. This novel method should improve reliability of self-reported physical activity data.

Hip problems, particularly femoroacetabular impingement, are much in the research literature these days. FAI is a hip disorder presenting mainly in young adults, often without positive clinical findings. However, if left untreated it can lead to significant morbidity in the form of early arthritis. Many orthopaedic centres around the world have carried out studies on hip arthroscopy and labral resection or acetabular rim reduction. However, the data are less than consistent. Joanne Kemp and colleagues from Australia found the prevalence of hip chondral damage at hip arthroscopy to be 72% in their study of 100 consecutive patients who underwent hip arthroscopy over an 18 month period. These participants averaged 36 years of age. Not surprisingly, articular cartilage damage was more severe with increasing age, coexisting labral pathology or femoroacetabular impingement. Severe chondropathic changes were associated with worse pain and function at 18 months post-surgery. The authors note that chondropathic change appears to be a marker of early degenerative hip disease and treatment strategies should include education, maintenance of physical activity and fitness, pain coping skills and weight management.

As a non-operating clinician, I have found precious little in the literature regarding the use of orthotics to reduce subtalar joint pronation and thereby also reduce internal rotation of the hip. Biologically this would seem to be a plausible method of helping symptoms acutely, whether or not the person is going to have surgery at a later date.

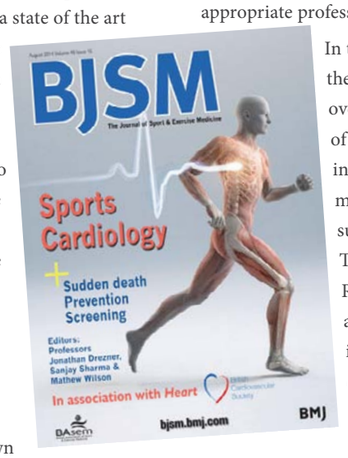
Also in the same issue was a position statement from the British Hernia Association on treatment of the sportsman's groin. The term inguinal disruption was agreed as the preferred nomenclature, rather than sportsman's hernia, as no true hernia exists. The authors, who included OJ Gilmore whose name has long been associated with hernia surgery in the UK sports medicine literature, recommend an initial non operative treatment programme incorporating a lot of the elements noted in the Danish intervention study. The authors noted that to date there has been no RCT comparing different surgical approaches to treat this condition, and arguments for both open and laparoscopic surgery were advanced. This article provides an excellent overview of the state of play in the UK, at least with regard to groin pain in athletes.

Low carbohydrate diets are much in the news. An article entitled 'Low carbohydrate diets for athletes: what evidence' by Tim Noakes and colleagues advances arguments in favour of a low carbohydrate diet. They point out that athletes adapted to a low carbohydrate diet live and train with chronically low blood insulin concentration

and have instantaneous access to fat reserves at all times. By contrast, they say athletes chronically adapted to high carbohydrate diets likely become entirely dependent on exogenous carbohydrate for their performance. Tim Noakes is an avid enthusiast of the low carbohydrate diet and, as they point out in the last paragraph of the article, there is a proven need for research regarding low carbohydrate diets in all sports, not just those involving endurance. At this stage I believe we should be cautious before advocating a significant change in our athletes' dietary habits.

AUGUST

The August issue was published in association with the British Cardiovascular Society and covered aspects of sports cardiology. It included a state of the art review on the incidence of sudden cardiac death in athletes. Rates of sudden cardiac deaths varied from 1:917,000 to 1:3,000. Certain athlete subgroups, particularly African-American male athletes and basketball players, appear to be at higher risk of sudden cardiac death.



Also in the same issue was an article by our own Dan Exeter and colleagues reporting on a randomised controlled trial of 62 doctors including GPs with an interest in sports medicine, sports physicians, sports medicine registrars and cardiologists. In all groups correct ECG interpretation was higher in the intervention group, who had been provided with a two-page standardised ECG criteria tool to use in assessing ECGs. This important study shows that doctors at all levels of experience can improve their accuracy in ECG interpretation.

Also in the same edition was an article by David Pryor and colleagues showing that use of the Seattle Criteria reduced the false positive rate of ECG screening from 17% down to 4%, whilst still identifying the 0.3% of athletes with a significant cardiac abnormality. All in all, we have made good progress in this area following the adoption of the Seattle Criteria.

What are the legal responsibilities of doctors when making participation decisions in athletes with cardiac disorders? Panhuyzen-Goedkoop comments that the screening physician has a legal responsibility to consider consensus recommendations in sports cardiology, to avoid wrongly grounding an athlete and prevent misinterpretation of test results. Likewise, the athlete can ask for a second opinion and further medical advice to help in decision making when a cardiovascular anomaly is identified. In addition, sports governing bodies have a legal responsibility to provide teams and coaches with appropriate professional backup.

In the later August issue there was an evidence-based overview of the effectiveness of physiotherapy interventions and manual therapy to treat subacromial impingement. The authors reviewed ten RCTs and two reviews and concluded that, in the medium term, exercise therapy gave the best results compared to placebo or controls. For other interventions, e.g. hyperthermia or ultrasound, conflicting, limited or no evidence was found.

Anterior dislocation of the shoulder is both common and serious. Recent advances in imaging and shoulder surgery have shown the potential dangers of traditional reduction methods such as Kocher's and the Hippocratic methods. These authors recommend the Stimson technique, i.e. placing the patient prone with the injured arm hanging off the edge of the bed and applying 5kg of traction to the patient's wrist. Other traction techniques including the scapular manipulation technique and Milch's technique have proven to be easy, safe and effective in reducing the shoulder and are recommended by these authors. The article includes excellent illustrations describing the various methods. They conclude that trainees should learn these better and safer relocation methods based on the current evidence that is available.

How good is soft tissue massage or exercise for the treatment of non-specific shoulder pain? Van den Dolder and colleagues reviewed 23 papers and concluded that there was low quality evidence that soft tissue massage is effective for improving pain, function and range of motion in the short term. Exercise therapy can produce small improvements in pain, but not in function or range of motion.

Rehabilitation following ankle sprains is a controversial area. Verhagen and colleagues carried out a three-arm randomised controlled trial of 384 athletes divided roughly equally into a bracing group, neuromuscular training group and combination group. They found that during the one year follow up, 20% of participants reported a recurrent ankle sprain. However, there was marked variation between the groups, with 15% recurrence in the brace group, 27% recurrence in the training group and 19% recurrence in the combination group. Based on this data, bracing is the most effective intervention and the authors recommend ongoing use of braces during sports for 12 months, rather than bracing being phased out earlier.

Minimalist footwear has grabbed the attention of runners in recent years. Jack Taunton and colleagues examined the injury risk and pain perception in runners using this footwear. They found that the runners in neutral shoes reported the fewest injuries and those in partial minimalist shoes the most. Runners in the full minimalist shoes (Vibram 5-finger Bikila) reported greater shin and calf pain. They comment that clinicians should use caution when prescribing the use of minimalist running shoes. From my clinical experience and the biological plausibility argument, it would appear that those athletes with significant biomechanical abnormalities are the ones who should particularly avoid minimalist shoes if they wish to run long distances in a pain free manner with minimal risk of injury.

SEPTEMBER

The September issue reported on research carried out in the four IOC centres of excellence that were identified in 2009:

- The Australian centre in Ballarat studied sports injury surveillance, coding and classification systems; prospective monitoring of sports injury incidents and injury causation; and also implementation research within community sport.
- The Canadian centre in Calgary studied concussion and injury in youth ice hockey, and injury prevention to prevent osteoarthritis.
- The South African centre in Cape Town studied the burden of injury and illness in specific populations of athletes, protection of the health of the athlete participating in mass community-based endurance sports events, plus development and implementation of a comprehensive lifestyle intervention programme for patients with lifestyle related chronic diseases.
- The Oslo Sports Trauma Research Centre in Norway examined the burden of injury and other health issues in specific athlete populations and is applying video analysis methods with novel model-based imaging matching technology to a range of sports, including handball, football, alpine skiing and snowboarding.

All of the centres have provided research opportunities for trainees under the guidance of world leading experts.

Of potentially most interest to New Zealanders was the study by Schwellnus and colleagues on the 2012 Super Rugby competition. They found more than 50% of players sustained a time loss injury during the four month season; 42% of injuries were severe enough for the players to miss a week or more of competition. These data are higher than the reported incidence in club rugby and serve to emphasise the high level nature of the Super Rugby competition.

The second issue in September looked at muscle injuries. Our own Bruce Hamilton wrote an editorial with the intriguing title 'Medical management of hamstring muscle injury: strained evidence for platelet rich plasma'. Platelet rich plasma has been vigorously advocated in the lay press and via testimonials from selected elite athletes. However, the paper by Reurink and colleagues published in the New England Journal of Medicine earlier in 2014, which was a double-blind randomised controlled trial, found no benefit from use of PRP compared with a placebo injection of saline. This challenges the proponents of PRP to substantiate their opinion with equally high quality trials.

Later in the same issue there was an excellent editorial by Nicola Maffulli that had previously been published in the BMJ. He comments that, despite the findings of well conducted studies, that autologous blood products probably do not work, it seems likely that they will continue to be widely used.

Predicting return to play after hamstring injuries is notoriously difficult. Moen and colleagues studied 28 clinical and MRI parameters in 80 non-professional athletes with MRI-positive hamstring injuries undergoing a standardised rehabilitation programme. The clinical parameters that were most useful were self-predicted time to return to play by the athlete, and a deficit in passive straight leg raise on the injured side versus the normal side. MRI parameters in Grade 1 and 2 hamstring injuries were not predictive.

John Orchard, well-known to New Zealanders, commented on the role for MRI in hamstring strains. He proposed that in professional athletes, having MRI information in addition to clinical information might improve clinical decision making. Certainly in the Australian professional sporting environment MRI scans are ordered routinely in those athletes with hamstring injury. By contrast, in recreational athletes there are not the same pressures on return to play. Orchard also comments on the 'risk appetite' of the player and coach; certainly player confidence is an issue that has been under emphasised to date.

OCTOBER

The October issue was sponsored by the Swedish Society of Exercise and Sports Medicine. An editorial by Mats Borjesson and Jon Karlsson examined the ethical dilemma faced by the team physician and commented that these are often overlooked in sports medicine education. In New Zealand, our own Lynley Anderson has published extensively in the field and New Zealand clinicians arguably have a heightened awareness of these issues following her work.

Later in the same issue, Dominic Malcolm and colleagues examined practical responses to confidentiality dilemmas in elite sports medicine. They commented that clinicians use a range of interpersonal strategies to manage the challenges with regard to patient confidentiality; as far as practicable, the athlete should be encouraged to be upfront with their condition with the coach. Over the years I have taken to including the athlete in the circulation list for their clinical letter. They can then share this information with whomever they wish.

Concussion has been much in the news recently. Later in the same issue is an article by Nordstrom and colleagues studying 46 elite male football teams in 10 European countries over 10 seasons. Over that time it was found that concussion increased the

risk of subsequent injury by about 50%. The authors suggest that a more in-depth medical evaluation is necessary after a concussion, to focus on assessment of neurological and cognitive deficits. They advocate comparing pre season and post concussion tests of cognitive function to help in determining readiness to return to play and subsequent injury risk. This would be standard practice in the professional sporting environment in this country but variably applied at the community sport level.

Can a specific exercise strategy reduce the need for patients with subacromial impingement to proceed to surgery? Certainly the Swedes think so. A study by Holmgren and colleagues from Linkoping University looked at 102 patients with six months or more of subacromial impingement. The patients were randomised to a specific exercise strategy targeting the rotator cuff and scapular stabilisers, or to a control group exercise for 12 weeks. Only 20% of the specific exercise group subsequently required surgery versus 63% of the control exercise group. One would hope that in this country, patients with subacromial impingement were being treated with the specific exercise strategy outlined above.

The second October issue was headed 'Food for Thought' and examined the complex and controversial interactions between diet and exercise.

There has been much controversy in the literature with regard to the female athlete triad following the publication of the IOC Consensus Statement on Relative Energy Deficiency in Sport. De Souza and an impressive list of colleagues, including some of the leading researchers, have published an article heavily critical of the RED-S. They systematically debunked a range of statements and conclusions made in the RED-S article. In particular, they comment that in the treatment section no critical analysis of randomised controlled trials versus prospective studies was presented and no source literature was referenced. In addition, they comment that treatment recommendations for bone health for men are not based on studies in male athletes. Clearly, this controversy will simmer for a while yet. If you wish to be fully informed on the controversy, you should read both articles and come to your own conclusions.

One thing that is clear is that obesity is a growing problem in most parts of the world. Myer and colleagues report that injury initiates unfavourable weight gain and obesity markers in youth. They reported on 862 young female athletes playing soccer or basketball. Of those athletes, 71 reported knee injuries, and the athletes with knee injuries increased their BMI percentile by up to five units more than someone of the same age without an injury. Clearly a worrying statistic.

What about weight training? Schranz and colleagues examined 56 overweight and obese males from 13 to 17 years of age. They were randomly allocated to an intervention group put onto a six month resistance training programme, and a control group who did not undertake the programme. After six months the intervention group was stronger, which is no surprise. There was no statistical difference in body composition outcomes, but the weight training group had an improvement in their self worth.

From Norway, Moholdt and colleagues reported on current physical activity guidelines and commented that these were insufficient to mitigate long term weight gain. They conclude that the amount of physical activity required to prevent long term weight gain is greater than the guideline amount for health benefits.

Low back pain is incredibly common and we need red flags to screen for malignancy and fracture. Downie and colleagues from Australia and the Netherlands included 14 studies evaluating 53 red flags and concluded that older age, prolonged corticosteroid use, severe trauma and the presence of a contusion or abrasion increased the likelihood of spinal fracture. Not surprisingly, a history of malignancy increased the likelihood of spinal malignancy. No other reliable predictors of spinal malignancy were found, but it would seem sensible to not ignore significant weight loss in the preceding year.

NOVEMBER

The November issue could well be called the rowing issue, as it concentrated on issues relevant to that sport. There was an overview of the role of the FISA Medical Commission, which overviews medical aspects of rowing. FISA, along with UCI, has been active in promulgating a no-needle policy. FISA has also been proactive in instituting a requirement for athletes competing in World Championships at the U23 level to have a cardiac questionnaire administered and a resting ECG recorded. This requirement is about to be extended to competitors in the Open Age World Championships.

Later in the same issue there was a collection of articles entitled 'Mythbusters'. These examined common injury and medical issues within rowing. Low back pain is the most common injury, and our own Craig Newlands provided an excellent insight into management of this challenging problem.

I was fortunate to get Rob Waddell, Olympic gold medallist and current Chef de Mission of New Zealand Olympic and Commonwealth Games teams, to contribute a personal account of his own experiences with atrial fibrillation. I provided a medical perspective on atrial fibrillation in rowers, and Larissa Trease examined the data collected from an ECG screening

programme carried out in Australian rowers who were scheduled to compete internationally. She commented that the crews were often selected a relatively short time before they were due to depart overseas, and this caused logistical problems in trying to arrange flow-on investigations, e.g. echocardiography, where these may be required.

DECEMBER

The December issue included several articles on muscle injuries including deep posterior compartment syndrome. Winkes and colleagues carried out a systematic review of surgery for deep posterior compartment syndrome of the leg. They found seven studies all with Level 3 evidence reporting on a total of 131 patients that met their inclusion criteria. However, only four of these studies strictly adhered to predefined internationally recognised criteria and cut-off levels for intracompartmental pressure varied widely among the seven studies. Surgical procedures ranged from a superficial crural fasciotomy to multiple fasciotomies of various deep posterior compartments. Not surprisingly success rates were not high, ranging from 30% to 65%.

In the accompanying editorial, Mark Hutchinson comments that release of at least 80% of the entire fascia is required in order to adequately decompress a fascial compartment. Also, there may be coexistent problems such as popliteal artery entrapment and medial tibial stress syndrome which require their own specific management, or the outcome will be suboptimal.

Later in the same issue, Arden and colleagues from Australia and Sweden studied the impact of psychological readiness to return to sport and recreational activities after ACL reconstruction. In their group of 164 participants, less than 50% returned to their pre-injury sport or recreational activity after ACL reconstruction. They found that psychological readiness to return to sport and recreation was the single factor most strongly associated with return to the pre-injury level of activity. This is an area which has been underdone in the literature over the years, as far as I can see, and it is good to see people paying attention to athlete confidence, as this is critical in return to sport.

Concussion is much in the news of late, and our own Ken Quarrie and Ian Murphy make some progress towards an operational definition of sports concussion. They identified limitations in the 2012 Zurich Consensus Statement and the accompanying SCAT-3. They comment that there is no guidance in the SCAT-3 as to when the test should be conducted and that standardising the time at which the SCAT-3 is performed following injury would help provide consistency for injury surveillance. Furthermore, if concussion diagnosis by clinicians is regarded as a test, they question the sensitivity and specificity of the test. Such information has not been published thus far. They propose potential strategies for improving the operational definition of concussion. This data could then be used more effectively in follow up studies, which could examine more closely the relationships between sport concussion and long term health outcomes. A thought-provoking article.

Finally, in the December issue there is an update on the Exercise is Medicine global health initiative. Lobelo and colleagues have found that EIM has a presence in 39 countries, although from the world map presented it appears that New Zealand is not one of them. The global centre is in the ACSM headquarters in Indianapolis, USA. They outline a five step model for Exercise is Medicine, starting with physical activity assessment, followed by prescription and behavioural counselling. Step 3 involves physical activity self-management or referral and Step 4 relates to development and training of a community-based physical activity referral network. The final stage involves integration between the clinicians and the community, utilisation of active health technology and objective assessment of physical activity; this can be via pedometers, accelerometers, smart phone applications, etc. Clearly, we have a fair way to go in moving along this journey.

So there you have it. My pick for most valuable article in the six month timespan under review would be that by De Souza and colleagues regarding the female athlete triad. This is essential reading for those who wish to be fully informed on the issue and should be read in conjunction with the original RED-S paper.

CHRIS WHATMAN

Double hundred not out! Laura Langman on staying injury free

Laura Langman first came into the Silver Ferns over ten years ago as an 18 year old. Since then she has played over 100 consecutive games in the ANZ championships and 100 consecutive games for the Silver Ferns. This obviously marks her as a great player and one that has managed to avoid injury and we thought it a great opportunity to hear from a player's perspective what kept her on the court. Thanks to Sharon Kearney for setting the interview up and to Laura for taking the time to answer a few questions. When talking to Laura it quickly became apparent that there was a little luck involved (she's had a couple of well-timed injuries!), but there are far more significant reasons for her achieving a double hundred not-out than just luck!

What is your experience of player and coach attitude toward injury in netball?

Laura discussed how every coach gets frustrated by injuries as it affects the team line-up and often ultimately the result. In some team environments it has been very clear who makes the call regarding an injured player and others not and she has seen players play injured. Laura's preference was for a team environment where it was clear the physiotherapist made the call on injury as this removed the onus from the player and also avoided issues where senior players might put pressure on a player to play without understanding the full nature of the injury. She emphasised this often required a strong physiotherapist to stand up to senior players and sometimes a coach, noting that if the season was on the line and you only had one player who can play in a position then the physiotherapist can come under significant pressure. Laura recalled occasions when a coach had overridden a physiotherapist's decision but then regretted it as it had negatively impacted on the player's performance and the team's performance.

When did you specialise in netball?

Laura recalled that when she was growing up specialisation in netball wasn't really an option as there was "no such thing as the under 8's". The first representative team she made was the under 15's and even then they only had one tournament so there was plenty of time for her to engage in other sports such as volleyball, cross country and horse riding. Netball didn't really become serious until her last two years at secondary school and more so when she made the New Zealand secondary schools team. She also mentioned that growing up on a dairy farm exposed her to natural weight training with feeding out, carrying milk buckets and challenging herself to chin-ups in the cow shed. Looking back she may have had a better conditioning background than she realised – she made specific note that she certainly didn't have an iPad!

What do you think you have done that has helped keep you on the court?

Laura highlighted how she was influenced at an early age by a coach who "scared the living daylights out of her" but was very focused on good landing technique and a physiotherapist who was pedantic with regard to muscle balance screening – it was obvious she had huge respect for both individuals. She also realised early (in secondary school) that it took a long time to recover from injuries (eg, calf problems) and that prevention was thus crucial given that she hated sitting on the bench and always wanted to be available to play. She made the point that if the physiotherapist mentioned she had a deficiency she hated it and was always asking "show me what I need to do to get better" and for example during one off-season "smashed her calves" until they were up to speed. She also never wanted to look like "Robocop" on court – held together by tape!

As well as believing the advent of physiotherapy muscle screening had assisted in preventing injuries, she spoke about taking up Pilates around 5 years ago (once a week). She believed this had improved her ability in the gym and improved her movement control – rather than just going for quantity in the gym she became more focused on quality. She also highlighted the introduction of Matt Kritz (Strength and Conditioning Coach) to the Ferns strength and conditioning programme and believed the increase in volume in his programme compared to previous programmes had the team better prepared to cope with the increased physical demands of an increasingly physical game.

You obviously value the input of the physiotherapist and the conditioner?

Laura admitted to being a bit of a weirdo and loving fitness testing (she loved getting a few numbers in front of her – eg, power profiles) – at one stage a power imbalance was picked up (left worse than right) so Laura took that on board to the point where her left side was better than her right. She loved gathering information on her weaknesses/imbalances and was clearly highly motivated by this to improve. She took on the message from strength and conditioning that she needed to be as strong as she was big to handle how she played the game – she is clearly motivated to be the best she can be. She mentioned how not all players were motivated by fitness tests in the same way and some needed to suffer a substantial injury before they sat up and took notice. Interestingly when doing the fitness testing Laura emphasised that she was only ever interested in beating her own previous best and had no interest in the outcomes of other players – internal motivation to the fore. Her summary "when taking the court I want to know that my conditioning/strength numbers are the best they can be so I know I have that behind me so I can just focus on playing"

What injuries have you had and how did you cope?

Laura has had a few ankles sprains - all caused by contact with other players. The only other injury she's had was a stress fracture of the foot and she acknowledged she wasn't the best "patient" - she initially wanted to try and play through the stress fracture (taping up her foot). She recognised this could be viewed negatively but also suggested this was a positive when she saw it in young players as it indicated high motivation to be on the court.

Laura saw a fine line between playing through an injury or pulling out too early – in her opinion netball has players doing both and it's very player dependent and team environment dependent. The ANZ championship is often a one shot opportunity for many players and fear of losing an opportunity and or conversely under performing on court is a huge influence.

Although she hasn't had any knee issues she noted her paranoia at the prospect of a knee injury was a motivating factor to do the injury prevention work. She had clearly spent hours doing preventive landing programmes, massive amounts of single leg training in the gym as well as neuromuscular training programmes.

What advice would you give to younger players to reduce their risk of injury?

Laura emphasised the onus was on the players to turn up in shape to be able to handle the demands of the game. It was fairly obvious that she has a great work ethic and would clearly buy into the old adage of you get out of it what you put in. She speaks at clinics with young players for Netball NZ and clearly knows how to instruct good landing technique. She also invites younger U23 players to train with her at the gym so they have an idea of what is required – "two laps around the field is not conditioning!" Laura also mentioned that some young girls were still concerned by the myth that if you lifted weights you were going to get massive and that put them off – she was keen to educate younger players that this wasn't the case.

Do you think players need access to academies and the like?

Laura mentioned that on the whole she wondered if the Australian players were fitter, stronger and faster with what she viewed as greater access to academy structures and possibly sports science. However she freely admitted that she came from a "hick town" and had still managed to succeed. She did comment that a possible downside of a high performance environment is players thinking they will have more done for them and in the process they end up doing less themselves.

Sharon Kearney has worked with Laura ever since she made the Silver Ferns. I asked Sharon if it was any surprise to her that Laura had played so many consecutive games and what she put her resilience down too.

"No I am not surprised. Laura is an attention to detail athlete. She moves well naturally and never had many biomechanical movement, strength or flexibility issues that impeded her movement competency or efficiency. However anything she did present with Laura would always aim to improve on – being competitive she strived to better herself at each movement competency and musculoskeletal assessment.

"We assessed her landing mechanics when she first entered the Silver Fern programme, educating Laura on safe and efficient landing strategies (both double and single foot landings). Any issues we identified Laura addressed, working hard on her corrective programmes, which has culminated in the fine athlete she is today. Irrespective of the delivery of the ball, Laura lands well whether that be double or single footed landings.

"Resilience is not due to luck. Laura has worked incredibly hard for many years to be the resilient athlete she is. I am sure coming from a rural background is a piece of the resilience model. As she said she was developing strength and condition in a farm setting form a young age. The timing of her very few injuries have been somewhat lucky. Yep she was not the "best patient" when she had a stress fracture in her foot but that was only because she wanted to be on the court. An athlete of Laura's capability and passion will question and challenge injury management plans – we are acutely aware of this and so we have the best medical team at our finger tips to ensure we are making very sound evidence based decisions and those decisions always involve the athlete. We managed to talk Laura round to a sound resolution re her foot and hence she did not miss a game.

"The great thing about athletes like Laura is they keep you on your toes. They are always raising the bar and pushing the envelope and you have to be doing the same thing in your own profession (whether it be Strength and Conditioning, Physiotherapy or Coaching) to keep up with them but also ensure you are one step ahead!"

John Herbert Heslop
1925 - 2014

The death of John Heslop, earlier this year, signalled the departure of another highly respected "statesman" who left an indelible mark on the development of sports medicine in New Zealand.

John Heslop, a General Surgeon, Dunedin born and bred, was passionate about three things. There was the Otago Medical School, his cherished alma mater, then there was cricket where he had gained provincial level status as a player and national level recognition for leadership and finally there was his culinary interest, best exemplified by membership of the "Dunedin Tripe and Onions Club". But it was through his unbridled love of cricket that John Heslop most publicly espoused the link between clinical medicine and sport, long before the advent of sports medicine as a specialty.

John Heslop's academic credentials at Otago as an Associate Professor in the Department of Surgery, his prolific list of publications and his tireless work for the Royal Australasian College of Surgeons are well documented and these were recognised through a number of prestigious professional awards. Generations of undergraduate students and advanced surgical trainees benefitted from his wit, wisdom and unique teaching style. Student attendance at Mr Heslop's general surgical outpatients clinic was a never-to-be-forgotten experience, peppered with countless fascinating anecdotes, stamping him as a remarkable teacher and empathetic doctor.

However what is less well known to many in the sports medicine fraternity is the leadership John Heslop provided as an outstanding sports administrator and a mentor to many accomplished sportspeople. From the New Zealand Cricket Board of Control to Presidency of New Zealand Cricket and as a highly successful Manager of two New Zealand touring teams to England (1975) and the West Indies (1985) John Heslop left his mark on cricket at every level.

It was no coincidence therefore that in 1963 at the foundation meeting of the New Zealand Federation of Sports Medicine, that John Heslop had willingly joined the late Dr Norrie Jefferson in setting the future for our organisation. At that meeting in February 1963 John Heslop articulated his strong beliefs that doctors in sports medicine needed to understand and apply fundamental clinical skills that were to become the forerunner of modern sports medicine practice. He was instrumental in helping to advise the future development of Sports Medicine New Zealand serving for many years on our Executive and becoming a Foundation Fellow and Life Member in 1995. In the same year John Heslop was recognised in the Queen's Honours, receiving the award of CBE (Commander of the British Empire) for his services to medicine, sport and the community.

His legacy to sport and medicine in New Zealand was truly remarkable and as a student, friend and colleague I am humbled in providing such a brief snapshot of an inspirational mentor.

David Gerrard
Professor, Dunedin School of Medicine
University of Otago

Jock Anderson

Sydney's preeminent musculoskeletal radiologist Jock Anderson died in May of this year. We were all very saddened to hear of his demise.

He was a great friend of ACSP and also of Sports Medicine New Zealand, and gave freely of his time to speak at our meetings. We all learned so much from him – mostly about radiology but also quite a bit about life in general. His quiet, understated style meant that he got his message across in a gentle but effective manner.

Outside of his involvement with the College, Jock was a hugely respected radiologist who bridged the gap between radiology and clinicians with consummate ease. He understood the mechanism of the injury as a critical factor in diagnosis as he had been a good athlete in his youth.

He was responsible for setting up the imaging services for the Sydney Olympic Games and went about this with his usual skill and enthusiasm. His diplomacy was key to getting an onsite MRI machine at the Sydney Games, the first time this service had been offered within an Olympic village. Not surprisingly, plenty of athletes (and also officials) were able to make use of this superb service. Jock was able to generate a fair amount of data which formed the basis for some useful publications in subsequent years. His skill in setting up the service in Sydney led to his recruitment as a consultant for imaging services at later multi-sports events.

As a Kiwi, I was always struck by Jock's appreciation of our country. He had a bunch of fishing mates who used to fish with him and he would stay in the huts by the braided rivers of South Canterbury. With his Rodd and Gunn attire and gentle laconic style, I imagine this was his spiritual home.

His real home was in East Crescent Street on Sydney's North Shore and enjoyed a magnificent view overlooking Sydney Harbour and the Opera House. Jock was generous in granting many of us Kiwis temporary residency and we greatly enjoyed his hospitality on many occasions. One such memorable event was just prior to the 1999 IOC Conference in Sydney, when we went round to his place to witness the Wallabies versus Springboks match at the 1999 World Cup. The hospitality and atmosphere was superb, and it helped that there was an entertaining game of rugby to watch as well.

Jock was a real renaissance man and had interests that spread far beyond medicine including vintage boats, old military memorabilia and the like. Such people enhance our profession well beyond their numbers.

Farewell, my friend, and rest in peace knowing that you have contributed hugely to sports medicine in this part of the world and well beyond.

Chris Milne
Sports Physician, Hamilton, New Zealand

Ode to Jock

To Jock, a 'walking textbook of sports and musculoskeletal radiology', thanks so much for all you gave to sports medicine not just in Australasia but worldwide.

Your textbooks will always be a wonderful reminder of the importance of plain film radiology alongside the more recent adjuncts to musculoskeletal imaging.

Thanks for welcoming me on so many visits to you in your lifetime, from those very 'early 90s' days at Crows Nest , Nth Sydney - when I'd arrive with an armload of x-ray packets that you'd patiently wade through, with an explanation that would invariably help my patient management. Some of those images would later turn up in your textbooks which was great, and which you would even kindly acknowledge.

It was fun working with you at the Sydney Olympic Games, and being able to image some of the most extraordinarily interesting stuff amongst our NZ athletes. Your support aided our elite athletes management consistently.

You were such a personality with diverse interests in music, the arts, multiple sports, gardening, and your 'strange and unusual collections' (some of which I didn't even know about till attending your send-off in Sydney…). Of course the great NZ fishing which was a major attraction that got you across to this side of the Tasman so frequently for Sports Medicine meetings.

Thanks Jock for all your contributions. I, like many other fellow Kiwi'shysicians, feel privileged to have worked and trained at a time when you were so involved in Sports Medicine and the Australasian College of Sports Physicians.

Your name will never be forgotten in international Sports Medicine circles.

Ruth Highet
Sports Physician, Wellington, New Zealand

Return to play after soft tissue injury: The role of nutrition in rehabilitation

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ABSTRACT

Injury can place a significant burden on an athlete, its timing can be cruel and jeopardise success. The inter-disciplinary rehabilitation process is crucial at the elite level, providing athletes with appropriate care and strategies that promote an optimal return to competition. The purpose of this review was to investigate the role of nutritional support during rehabilitation from soft tissue injury. Immobilisation following an injury places affected muscle groups at risk of atrophy due to anabolic resistance, where muscle protein synthesis is reduced via the absence of muscular stimuli. Maintaining optimal host nutrition is critical during rehabilitation from soft tissue injury. Furthermore, amino acid supplementation has been shown to alleviate muscle atrophy during significant periods of immobilisation. However, in the absence of resistance exercise, diet alone cannot attenuate the decline in strength observed during immobilisation. Wound healing and tissue regeneration is a vital component of rehabilitation, tendon tissue is responsive to exercise in a similar manner to that of myofibrillar and sarcoplasmic fractions within the muscle. Recent evidence suggests a leucine-rich protein supplement can augment the hypertrophic response of tendon to resistance exercise. There is a theoretical rationale for the supplementation of creatine monohydrate during rehabilitation although HMB and LCn–3PUFA supplementation requires further investigation. Dietary strategies that attenuate muscle atrophy, promote tissue healing, and maximize the response to exercise are a vital component of the rehabilitation process.

Keywords: immobilisation, muscle protein synthesis, muscle atrophy, rehabilitation

Injury is unpredictable by nature, its frequency and timing can be cruel. In professional European football the risk of injury can be 1000 times greater than that of typical industrial operations.[1] Modern day sport can involve millions of dollars being invested in athletes' salaries and in high performance programmes in the hope of a winning performance. Therefore ensuring athletes are able to compete and train is paramount for success. Hägglund et al 2013 showed a lower injury burden ($p<0.001$) and higher match availability ($p<0.002$) was associated with increased points per league match in domestic competitions of the teams involved in the UEFA Champions league injury study.[2] With this in mind player availability and an optimal return from injury is crucial. Unfortunately, injury is not always preventable and its incidence does not appear to be reducing in professional sport. Ekstrand et al 2013 showed that injury rate was constant over an 11 year period (2001-2012) for clubs involved in the UEFA Champions League injury study.[3] Similar findings have also been observed in the Australia Football League (AFL), where total injury incidence has remained constant across a 21 year period from 1992-2012.[4] Here the authors concluded that although significant gains have been made in the field of sports medicine, the tendency for the game to become faster, has in itself increased the risk of injuries.

The role of nutrition during the rehabilitation from soft tissue injuryhas received limited attention to date. This is surprising given the role of the diet in maintaining optimal health and performance may be considered unequivocal. This review aims to summarise specific research regarding nutrition during rehabilitation from injury. The reader will be provided with practical recommendations for the key areas where nutritional intervention may have a positive influence and will focus on soft tissue injury management.

Immobilisation

When soft tissue (eg. muscle) is injured the goal is to reduce bleeding and swelling at the site of injury by applying the RICE method (rest, ice, compression, elevation). In most cases athletes will be advised cease activity to decrease swelling and bleeding. Immobilisation or resting helps to avoid further damage; however it is recommended immobilisation should be limited to only a few days, after which gradual and supervised mobilisation is required.[5]

Absence of a stimulus to the immobilised muscle groups can place them at significant risk of atrophy. Muscle disuse has shown to reduce total muscle mass by 0.5% per day, resulting in 100-200g of muscle tissue lost per day in a healthy adult.[6-8] Accompanying this loss in lean muscle Paddon-Jones et al 2004 demonstrated a 22.8% (0.8% loss per day) loss in 1RM leg press strength resulting from 28 days of bed rest.[9] Recent evidence suggests that muscle protein breakdown (MPB) may be a factor in the early periods of immobilisation (within 10 days).[6] However it is generally accepted that the primary reason for atrophy observed during immobilisation is due to a reduction in the rate of muscle protein synthesis (MPS) rather than an increase in MPB. [8,10,11] Phillips et al 2009 have termed this impaired muscle protein response as "anabolic resistance".[12] This response was clearly demonstrated by Glover et al 2008 when they subjected healthy men and woman to 14 days of unilateral knee immobilisation.[13] A 27% reduction in post-absorptive MPS was observed through immobilisation when amino acids were infused at a high (261mg/kg-1h-1) and low (43 mg/kg-1h-1) doses. The non-immobilised limb displayed a greater MPS response by + 68±17% and + 54±12% respectively compared to the immobilised limb.

Protein Supplementation during Immobilisation

Nutritional interventions to counteract such atrophy and impairments in muscle function during the immobilisation period would be advantageous for the rehabilitating athlete. Paddon-Jones et al 2005 supplemented healthy males with 15g of essential amino acids (EAA) + 30g of carbohydrate three times daily between meals during 28 days of bed rest.[10] This was compared to a control group who consumed isocaloric meals, minus the supplement. No weight loss was observed in the supplement group but a significant weight loss occurred in the control group. Similar observations were reported in lean leg mass where -0.4 ± 0.1 kg was lost in the control group while the supplement group remained stable throughout the bed rest period. Although the experiment group consumed more calories in the form of protein and carbohydrate, the authors concluded that providing controls with an equivalent isocaloric supplement in the form of carbohydrate and fat would not have further altered the muscle protein response and subsequent losses in lean mass. They summarised the unique ability of the EAA supplement to repeatedly stimulate net muscle protein synthesis as the contributing factor in maintenance of lean muscle mass.

By contrast, a similar study, involving 60 days of bed rest in healthy women, Trappe et al 2007 observed that supplementation with 5g of branch chain amino acids across each meal, comprising of a total protein intake of 1.6g/kg could not avoid significant reductions in quadriceps muscle volume and calf volume.[14] However, a group consuming a lower daily protein intake (1.0g/kg) minus the BCAA supplement but also exercised 3 x week maintained thigh volume and attenuated the decrease in calf muscle volume. The authors concluded that the amount of time of immobilisation was too great for nutrition alone to offset lean muscle loss. It would have been of interest to observe potential further changes if the exercise group were also supplemented with protein.

It is of note that in both studies nutrition alone was unable to offset strength loss during immobilisation, highlighting the need for an exercise stimulus.[10,14] Fortunately, complete immobilisation of 30 or 60 days is unlikely to take place in the majority of soft tissue injuries observed in sport that do not require major surgery. Nevertheless the impairments observed highlighted the need to ensure dietary strategies are utilised to minimise lean muscle loss during the early stages of immobilisation. Dietary education should be an important element of the early stages of soft tissue injury management.

Maintaining Energy Balance during Immobilisation

If an athlete is immobilised or has substantially reduced energy expenditure it may not be surprising that they deliberately reduce their energy intake in the hope of avoiding gains in body fat. However, a negative energy balance is known to be catabolic and if a negative energy balance was to occur this may further intensify the anabolic resistance during immobilisation.[15] In healthy, young men and woman a 500kcal decrease in total energy intake (1.5g/kg protein intake) for 10 days decreased muscle protein synthesis by 19%.[16] This highlights the importance of dietary counselling and nutritional planning in the immediate post injury period to ensure an athlete remains in adequate energy balance. Furthermore, it is important that reasonable expectations are placed around body composition via the multi –disciplinary team to avoid athletes feeling the need to implement sudden drops in energy intake. Dietary education focusing on nutritional requirements to maintain lean muscle mass during early stages of rehabilitation is critical to optimal recovery.

Nutritional Supplements of Potential Benefit during Immobilisation

Long-chain n–3 polyunsaturated fatty acids (LCn–3PUFAs) are essential nutrients which have received much attention for their proposed health benefits including their potential role in promoting protein synthesis.[17] Smith et al 2011showed a greater anabolic response (FSR & mTOR/p70S6K signalling) to insulin and amino acid infusion after 8 weeks of a high dose LCn–3PUFA supplementation (4 g of Lovaza®/day) in healthy untrained adults.[18] While these results are promising in their potential to counteract the anabolic resistance observed during immobilisation it is important to note that subjects were infused with a less than optimal dose of amino acids. It remains to be seen if protein synthesis rates would be elevated above those observed with an optimal dosing strategy.[19]

LCn–3PUFA supplementation during immobilisation has recently been studied in rodents.[20] Here the authors demonstrated a slight but significant alleviation of loss in soleus mass when rodents' hind limbs were immobilised for 14 days while fed a high dose LCn–3PUFAs diet. Conversely in a study out of the same laboratory rodents supplemented with a high LCn–3PUFAs diet displayed an inhibited muscle response during the early stage of soleus muscle recovery after disuse atrophy.[21] After 10 days of immobilisation, the activation of Akt–p70s6k signalling and PGF2α synthesis was suppressed during the subsequent 13 days of mobilisation. With these contrasting findings, the limitations in comparison of animal models to humans and the potential negative effects that LCn–3PUFAs supplementation may have on wound healing strength, more research is required on LCn–3PUFA supplementation.[11,22]

ß-hydroxy-ß-methylbutyrate (HMB) is a metabolite of the amino acid leucine and has received attention for its potential muscle-sparing qualities. HMB has shown to attenuate muscle wasting in disease states such as cancer and AIDS.[23-24] To date its effect on lean muscle mass in healthy and trained individuals remains inconclusive.[25] In a meta-analysis by Rowlands and Thomson 2009 on the effects of HMB supplementation in trained and untrained athletes, they concluded the effects of changes in fat and fat free mass were trivial and inconsequential regardless of training experience.[26] Wilkinson et al 2013 recently compared the acute effects of consumption of Leuince (Leu) and HMB in young men.[27] When 3.42g of HMB was consumed compared to 3.42g LEU, MPS was stimulated +70% (HMB) versus 110% (LEU). HMB consumption also attenuated MPB by 57%. With recent evidence that MPB may be a factor in early onset muscle atrophy caused via immobilisation, HMB supplementation may have a potential benefit in the early stages of immobilisation.[6] Molfino et al 2013 concluded that the safety profile of HMB as

"unequivocal", and as a result, further studies are warranted to investigate any role for HMB in in the early stages of immobilisation after soft tissue injury.[28]

Tissue/Wound Healing

For the nutrition practitioner strategies promoting healing of the tissue as well as maintenance of lean muscle mass during immobilisation should be at the forefront following injury. Scar tissue formation to injuries involving tendon, ligament and wounds is imperative for healing and the main component of scar tissue is collagen. The relationship between successful wound healing and nutrition has long been recognised, with questions whether particular certain amino acids may enhance collagen synthesis.[29] The majority of studies have focused on the provision of substrates based on collagens' molecular structure of Glycine, Proline and Hydroxyproline.[30]

Although Glutamine has abundant roles in cells involved with wound healing, no research has supported a beneficial effect of supplemental glutamine on wound healing or collagen synthesis.[30] The amino acid Arginine (ARG) has received the most attention in recent decades regarding wound healing. Several mechanisms are proposed as to why arginine may be effective in promoting wound healing. ARG is both a precursor to proline and a unique substrate for the generation of nitric oxide (NO), which has shown to be critical for wound healing.[31] ARG supplementation has been shown to be effective in improving wound strength in rodents and similar observations have been found in humans where significant doses have resulted in greater hydroxyproline and protein deposition in a standardised wound.[32-35] Despite these observations Stechmiller et al 2005 concluded that host nutrition is the most important factor in wound healing, and highlights that studies to date have used different doses of supplemental ARG in subjects with varying ages and health status, and typically studies lack dietary controls.[36] One may also question whether these observations would be sustained when host nutrition is adequate, particularly when nutritional strategies such as optimising protein intake are employed by athletes during rehabilitation. Nonetheless this reiterates the importance of adequate host nutrition during stages of healing. Collagen synthesis is also an energy expending process and therefore every effort should be made to ensure an adequate energy intake and nutritional deficiencies are avoided.

Tendon and Collagen Synthesis

Studies on collagen synthesis in wound healing have focused on tissue concentrations of hydroxyproline and wound strength, limited investigations have assessed collagen synthesis in human muscle or tendon. Collagen is the major extracellular matrix protein of musculoskeletal tissue but despite its obvious importance in tissue function, our knowledge regarding its turnover remains poor, with most studies limited to animal models.[37-38]

Barbraj et al 2005 observed that tendon and ligament collagen synthesis rates are similar to those of mixed skeletal muscle protein in the post-absorptive state, whereas the rate for muscle collagen synthesis is much lower.[38] However they demonstrated muscle collagen and tendon turnover was unresponsive to feeding at rest (20g essential amino acids and a solution containing 15% protein, 64% carbohydrate, 21% fat respectively). This was in contrast muscle myofibrillar protein which showed a significant increase in the synthetic response to the nutrient provision of 20g of essential amino acids.

Miller et al 2005 compared muscle protein synthesis to that of patella tendon collagen synthesis after a repeated one hour, one leg kicking exercise in healthy young men.[39] They showed that tendon is highly responsive to exercise, showing a 1.7 fold increase in protein synthesis 6 and 24 hours post exercise. In addition, MPS in myofibrillar and sarcoplasmic fractions increased 2 fold by 6 hours and peaked at 24 hours. The authors concluded there may be a common mechanical or humoral pathway for a muscle and tendon anabolic response, most probably the MAP kinase and or mTOR pathways. Recently Farup et al 2013 illustrated patella tendon hypertrophy in response to exercise and nutritional supplementation.[40] Twenty-two healthy, young and active men were assessed for the effect of a 12 week resistance training programme combined with either a high-leucine whey protein hydrolysate (WHD) (19.5g) and carbohydrate (19.5g) supplement or an iso-energetic carbohydrate placebo (PLA). Both the quadriceps muscle and the patellar tendon cross sectional area (CSA) were assessed, using magnetic imaging (MRI). Quadriceps CSA significantly increased (in both WHD (7.3±1.0%) and in PLA 3.4± 0.8%. A significantly greater increase was observed in WHD compared to PLA. Proximal patellar tendon CSA increased significantly for WHD (14.9±3.1%) but not for PLA (8.1±3.2%) with a significantly greater increase in WHD compared to PLA. Similar observations have been reported by Holm et al 2005 where subjects consuming a 10g protein supplement of milk powder displayed greater CSA in the quadriceps when undergoing 12 weeks of a rehabilitation program from an anterior cruciate ligament injury.[41] Recently Barbosa et al 2012 demonstrated in a rodent model that a leucine-rich diet stimulates collagen synthesis in tendon, particularly when in combination with physical exercise.[42]

These observations demonstrate a key role for protein supplementation in rehabilitation from soft tissue injury. It again emphasises the need to have a well-planned dietary strategy in order to optimise responses from rehabilitation exercise. Athletes should therefore treat the rehabilitation phase as they would when looking to maintain optimal lean muscle mass during regular training by consuming quality protein sources distributed regularly throughout the day and within close proximity post exercise.

Creatine Monohydrate Supplementation

Creatine Monohydrate is considered the most effective nutritional supplement for increasing lean body mass in athletes.[43] Its use during rehabilitation should therefore be of interest. In the most extensive double blind study to date regarding creatine in young men undergoing rehabilitation, Hespel et al 2001 showed that with 5 - 20g of creatine supplementation daily, muscle hypertrophy was stimulated in 10 weeks of rehabilitative strength training which followed 2 weeks of leg immobilisation.[44] They found that MRF4 protein expression was significantly increased in the creatine group and this correlated with a change in mean muscle fibre diameter. However, confounding results have been seen in other studies. For example, Tyler et al 2004 observed no effect of creatine supplementation (20g/ day to 5g daily on body weight, body composition or strength in the first 12 weeks following ACL reconstruction.[45] Roy et al 2005 observed similar findings 30 days after knee replacement surgery in elderly patients who were supplemented with creatine (10g/d x 10d pre-surgery to 5g/d x 30d post-surgery).[46]

Both studies concluded that the exercise stimulus during the rehabilitation was insufficient to facilitate the presumed hypertrophic effects of creatine supplementation.[45-46] Of note, in all three studies creatine supplementation had no effect in minimising muscle atrophy during immobilisation or in the absence of a sufficient exercise stimulus.[44-46] Only in young men with seven days of arm immobilisation has creatine supplementation (20g/day) been shown to maintain lean muscle mass and strength.[47]

With its short and long term safety in use, creatine monohydrate supplementation may help promote gains in lean muscle during rehabilitation. However, its use in reducing muscle atrophy during immobilisation requires further investigation.

Long-chain n–3 Polyunsaturated Fatty Acids (LCn–3PUFAs)

Reduction in pain levels has been observed in recreational athletes with chronic tendon disorders when supplemented with high dose LCn–3PUFA and an anti-oxidant complex.[48] In one of the only investigations regarding LCn-3PUFA during rehabilitation, subjects consumed the supplement for 32 days whilst undertaking ultrasound therapy (LCn–3PUFA supplement: 2.49g/d eicosapentaenoic acid (EPA), 1.8g/d docosahexaenoic acid (DHA), 5.38g/d of gamma-linolenic acid (GLA)). After 32 days a mean reduction in pain score of 99% was observed in the supplemented compared to 31% in the placebo group. The authors' reasoned that LCn–3PUFA supplementation had the potential to dampen inflammation and pain without inhibiting the healing process, as seen with traditional Non-Steroidal Anti Inflammatory Drugs (NSAID's). Caution is needed in interpreting these results to the elite athlete due to the small number of recreational based subjects (31), a lack of dietary control, activity levels and the limited effectiveness of questionnaires to rate pain scales without functional tests. Currently no studies have repeated these observations but despite this LCn–3PUFA supplementation has been proposed to be used without restriction as part of a "polypill" approach in athletes with tendinopathy.[49]

Summary

Literature pertaining to nutritional interventions for the promotion of rehabilitation following injury is in its infancy. Nevertheless, there are several important aspects for athletes and practitioners to consider during rehabilitation from soft tissue injury.

Adequate nutrition and the avoidance of nutritional deficiencies is critical in this period. An appropriate protein intake, spread evenly across the day will promote the maintenance of lean mass, while optimising protein synthesis throughout the day.

Although an athlete's energy expenditure maybe restricted during this period, consideration of the energy demands of optimal healing warrants careful nutritional planning. In most cases this will vary across the different stages of rehabilitation and require detailed guidance by a nutrition professional.

The addition of micro-nutrient and anti-oxidant supplementation is not recommended when an optimal diet is consumed. The supplementation of creatine monohydrate maybe warranted during rehabilitation but the use of HMB and LCn–3PUFAs requires

Table 1: Nutritional recommendations during rehabilitation from soft tissue injury

• Dietary intervention and counselling should take place as soon as possible after injury to ensure appropriate dietary strategies are promptly instigated to avoid muscle loss and to promote optimal healing.
• An adequate energy intake is critical for the maintenance of lean muscle mass during immobilisation and rehabilitation, and to promote the healing of soft tissue. • A diet promoting an appropriate intake of micronutrients to ensure the avoidance of nutrient deficiencies will promote optimal healing; micronutrient supplementation is not warranted in situations where a balanced diet can be achieved.
• A sufficient protein intake is recommended, with high quality protein sources containing 20-25g protein spread across the day (5-6 times) to aid the maintenance of lean muscle mass. • The inclusion of a rapidly digested and leucine rich protein source such as whey milk protein immediately after exercise may promote a greater anabolic response in exercise recovery. • Excessive protein intakes (>2.0g/kg/day) are not required for further maintenance of lean muscle mass.
• Dietary interventions that compromise energy and nutrient intake, or promote rapid weight loss during rehabilitation should be avoided. Realistic expectations should be established with regard to body composition. • Regular contact with a nutrition professional will ensure the dietary strategy is aligned with the overall rehabilitation goals. • The nutrition professional should be part of the inter-disciplinary rehabilitation team, to facilitate optimal healing, maintenance of lean muscle and body composition during rehabilitation.
• The supplementation of creatine monohydrate during rehabilitation may promote hypertrophy and improved strength, however currently its effectiveness during initial immobilisation to preserve lean muscle is not supported.
• HMB supplementation during initial immobilisation exhibits potential due to its role in decreasing muscle protein breakdown. Omega 3 fatty acid supplementation has also shown to potentially dampen pain during rehabilitation from chronic tendon disorders. Both supplements warrant further investigation before their inclusion during rehabilitation can be warranted.

further investigation.

At a time when athletes may become despondent due to the necessarily slow rehabilitation process, dietary experimentation or lack of dietary adherence, that compromises total energy intake, protein intake or micronutrient supply may be detrimental to optimal rehabilitation and the expedient return to play. It is recommended that during this rehabilitation period athletes work closely with a nutrition professional and their inter-disciplinary team, to ensure appropriate nutrition strategies are implemented.

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Juvenile Osteochondritis Dissecans of the femoral trochlea in a cricket fast bowler

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INTRODUCTION

The term Juvenile Osteochondritis Dissecans (JOCD) refers to the separation of a fragment of articular cartilage and subchondral bone from the joint articular surface in a skeletally immature child. JOCD has been reported most commonly in children who are athletes and more commonly in boys. In fact the maximum reported incidence is between the ages of 10-20 years.[12] More than 70% of JOCD lesions are found in the posterolateral aspect of the medial femoral condyle, with inferior central lateral condylar lesions accounting for only 20% of cases and femoral trochlear lesions, less than 1%[9]. Even though Axhausen[2] in 1912 was the first to report osteochondritis of the femur trochlea, a review of literature reveals only a few reported JOCD cases involving the femoral trochlea.[13,15]

We report a rare case of JOCD involving the femoral trochlea in a skeletally immature fast bowler and its management.

CASE REPORT

A young 16 year old fast bowler presented with complaints of pain in his left knee for three months. There was no history of any direct trauma; the pain would occur on deep knee bending and squatting, and significantly interfered with his bowling run-up and play.

On examination, the patient was moderately built, muscular and tall. Knee examination showed normal patellar tracking and Q-angle. The patellar grind test was negative in full extension.

M.R.I. of the knee revealed an ovoid area of altered signal intensity suggestive of OCD involving the articular cartilage and subcortical bone of the anterior surface of the lateral femoral condyle in the trochlear groove (Figure 1). The M.R.I. lesion was classified as Anderson1 stage IIB (Table 1).

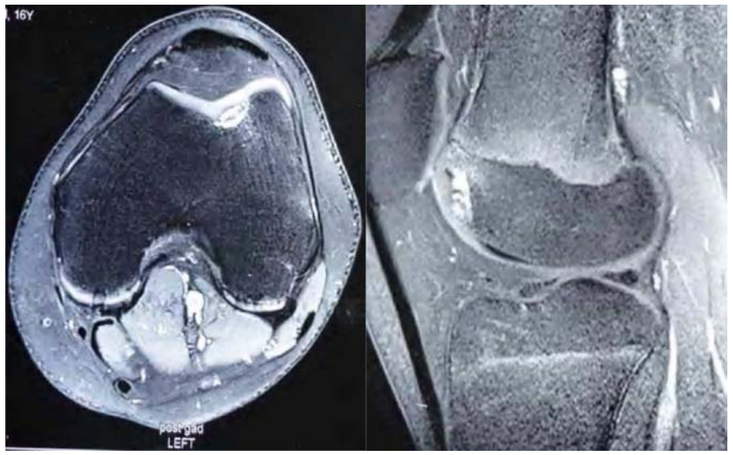

Figure 1: Showing Osteochondritis Dissecans of the trochlea notch of the femur

Table 1: MRI staging of osteochondritis dissecans (Anderson et al)[1]

Stage	Evaluation	Findings
I	Early	Subchondral bone flattening in the epiphysealplate before growth plate closure
IIA	Stable	Subchondral cyst present
IIB	Unstable	Incomplete separation of the osteochondral fragment
III	Unstable	Fluid around an undetached, undisplaced osteochondral fragment
IV	Terminal	Complete separation of the ostechondral fragment, loose bodies

Table 2: Arthroscopic staging of osteochondritis dissecans (Cheng et al)[4]

Grade	Findings
A	Articular cartilage is intact and smooth but may be soft or ballotable
B	Articular cartilage has a rough surface
C	Articular cartilage has fibrillations or fissures
D	Articular cartilage with a flap or exposed bone
E	Loose, undisplaced osteochondral fragment
F	Displaced osteochondral fragment

The bowler was taken up for arthroscopy of his left knee. Intraoperatively an area of cartilage softening was identified in the trochlear groove, with no separation of the osteochondral fragment. This finding correlated with Chen's[4] stage A of arthroscopic staging (Table 2). As the lesion was stable with intact overlying cartilage, it was not drilled. A comprehensive rehabilitation protocol was initiated. It involved passive patellar mobilisation exercises with retinacular stretching, knee range of motion and quadriceps muscle strengthening exercises. Open kinetic chain exercises were initially allowed as knee extension from 90 – 45 degrees of flexion. Closed kinetic chain exercises were performed from 0 – 30 degrees after the first 3 weeks and then gradually increased to 60 degrees flexion. The player was prohibited from squatting for 2 months. Once he regained full painless range of motion with no muscle wasting, the player gradually resumed cricket over the next 4 months, and after 6 months of continuing aggressive rehabilitation he had resumed fast bowling.

DISCUSSION

Munro was the first to describe the disease that we now know as "osteochondritis dissecans", but it was in 1905 that Konig gave this condition its name believing that inflammation was a causative factor.[10] Barrie et al further defined possible etiologies of JOCD formation through an aberrant development of only a portion of the epiphyseal growth plate.[3] Repetitive trauma is currently the most commonly accepted etiology, especially traumatic contact between the lateral aspect of the medial femoral condyle and the tibial spine as the cause of JOCD.[7]

Cricketers can suffer from a range of overuse injuries associated with all aspects of the game including running, throwing, batting and bowling. Stretch[14] reported that the back and trunk (24.7%) and lower limbs (49.9%) were most commonly injured. Abnormal biomechanics can result from hereditary factors, incorrect bowling technique, poor preparation or overuse. Injuries to the fast bowler frequently result from a combination of repetitive movements such as twisting, bending and rotating.[5] Ground reaction forces as high as eight times the bodyweight have been reported at front foot impact during the delivery stride in pace bowlers by Ferdinands et al[6] and these forces may contribute to repetitive microtrauma to the knee.

JOCD of the knee is being seen with increased frequency in pediatric and young adult athletes where early recognition is essential.[7] Whereas adult osteochondritis dissecans lesions have a greater propensity to instability, juvenile osteochondritis dissecans lesions are typically stable, and those with an intact articular surface have a potential to heal with nonoperative treatment through cessation of repetitive impact loading.[8]

The results of nonoperative treatment for JOCD are successful in properly selected children with stable lesions.[11] Yoshida et al have reported a 1-year healing rate of 81% in skeletally immature children by simply having them abstain from sporting activity.[17] Skeletally mature patients as well as those approaching skeletal maturity need to be treated more aggressively.[11] Conservative management can however still be attempted with stable lesions keeping in mind that healing may take >4 months and if a fibrous union develops, the fragment may displace at a later date.[16] The JOCD lesions in this case were Anderson1 stage IIB (according to MRI) and Chen[4] stage I (according to arthroscopy). This young bowler had a good functional outcome with conservative management and appropriate physiotherapy.

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MANDEEP DHILLON, JOHN ORCHARD,CHANDER BHUSHAN,
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Post-traumatic AV malformation within the quadriceps muscle: An unusual cricket injury

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ABSTRACT

Background

Musculoskeletal injuries are fairly commonly in cricketers, despite this being a non-contact sport. Direct blows in the game from the ball are common, but most resolve with simple measures.

Case Presentation

We report the first case of Arteriovenous malformation (AVM) presenting with severe pain at the proximal patellar pole. Examination revealed a mobile, tender, firm nodule; MRI showed a cyst at the lateral aspect of the quadriceps tendon, which was evaluated arthroscopically and then excised by an incision centered over a marking needle. Histopathology showed large dilated venous channels with interspersed arterial channels and some thrombosis, leading to a diagnosis of an intramuscular AVM. Symptoms resolved completely after excision, with the player going back to the same level of competitive cricket.

Conclusion

This case is presented as it is the first of its kind. AV malformations in sports are rare, and have never been reported in cricket; a high index of suspicion should be kept in sports-persons who present with persistent pain and swelling in large muscles after contact injuries. Minimally invasive treatment is an option for larger lesions. Surgical excision of a small lesion also gives good results and allows full return to competitive sports.

Keywords: Arterio-venous malformation – sportsperson - cricket

INTRODUCTION

Hemangiomas and vascular malformations are benign lesions of blood vessels. Mulliken and Glowacki in 1982, divided vascular anomalies into hemangiomas (which are neoplastic lesion with endothelial hyperplasia) and vascular malformations (which are congenital lesions with normal endothelial turnover).[1]

Extra-cranial arteriovenous malformations (AVMs) are far less common than intra-cranial AVMs.[2] AVMs frequently involve the skin, subcutaneous tissue and sometimes the musculoskeletal system. AVMs are high-flow lesions providing a direct connection between an artery and a vein.[3] Congenital AVMs are usually latent during infancy and childhood but may enter an active expanding phase in adolescence.[4] These lesions often occur on the extremities or trunk where they may present as an enlarging soft tissue mass in the subcutaneous tissue, or may be located below the deep fascia and involve the musculoskeletal system. Intramuscular AVMs have been reported in the pyriformis muscle, flexor digitorum superficialis and in the temporal and lingual musculature.[7,8,9,10,11] Sports related lesions of this kind are rare, and do not come to mind, leading to diagnostic confusion and management delays. Only one previous case has been reported in the muscle of a football player,[12] and that too after repeated interventions, but no case has ever been reported after direct impact injury to a muscle by the impact of a hard ball.

CASE REPORT

A 20 year male cricketer presented with severe localised pain 2 inches proximal to the proximal pole of patella; he had been hit by a cricket ball while fielding at "Silly mid on," and the pain had not subsided in the previous 7 months.

Clinical examination revealed an exquisitely tender firm nodule that could be rolled under the fingers. There were no inflammatory features, and knee range of motion was full, except for pain in the nodule at terminal flexion. On detailed history taking, both the player and his mother were very clear that no swelling or pain at this site had been present prior to the impact injury with the cricket ball. X-rays were normal; MRI showed a cyst like lesion at the lateral aspect of the quadriceps tendon (Figure 1).

Arthroscopy showed a discoloured area in the upper part of suprapatellar pouch, which was extra-articular and was marked with an externally inserted needle. The swelling was then excised by a small incision centered over the marking needle (Figure 2). Histopathology of the excised specimen showed large dilated venous channels with interspersed arterial channels and some thrombosis; a diagnosis of arteriovenous malformation was made, and no further treatment was planned. Rehabilitation was started within 3 weeks, and the patient regained full motion and strength within 3 months The patient went back to competitive cricket and is asymptomatic at 3 years follow up with no swelling or pain at the surgical area.

Figure 1: MRI showing loculated contained cyst like lesion proximal to patella at musculo-tendinous junction of quadriceps tendon

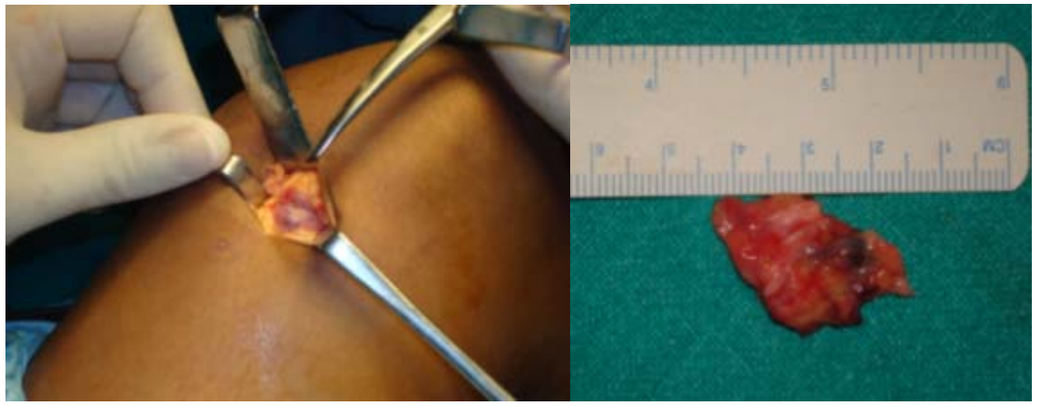

Figure 2: Intra-operative photos showing excision of lesion. Note the bluish-black discolouration of the lesion due to dilated venous channels.

DISCUSSION

AV malformations are infrequent, with a reported prevalence estimated to be around 1.5% of the general population. AVMs are abnormal communications between the arterial and venous system. They may be congenital or acquired. Acquired AVMS form secondary to trauma, surgery, or tumor. Most AVMs involve the head and neck, followed by the lower extremities and trunk.[5]

Post-traumatic AVMs develop most commonly after penetrating trauma. They have also been reported to occur after blunt trauma, but this is much less common and usually occurs in the setting of a fracture, compartment syndrome, or crush injury.[11] An extensive literature review showed only one published report of this condition related to traumatic contact injury in sports.[12]

Although cricket is strictly a non-contact sport, injuries in the game can result in a number of ways. Cricketers can suffer from direct impact type injuries which include hits by the bat or ball while fielding and collisions with the structures around the field (eg, fence) or with other players.[6,7]

The only previous case of post-traumatic AVM in sports has been a professional American football player who received both corticosteroid and platelet-rich plasma (PRP) injections for a noncontact gastrocnemius

injury. He subsequently developed an AVM requiring embolisation.[12] To our knowledge no case of post-traumatic AVM has been reported in a sports of any kind, let alone cricket.

The gold standard for diagnosis of an AVM is arteriography.[12] Ultrasonography with Doppler helps identify the flow patterns through vessels and identify abnormalities indicative of an AVM.[13] Magnetic Resonance Angiography can not only identify flow patterns but can also clearly define the extent and location of the pathology.[14] In our case the diagnosis of AVM was missed on the initial MRI as it was a plain MRI without contrast, as we had not suspected this lesion. Histopathology subsequently confirmed the diagnosis after excision.

Treatment options for AVMs in the extremities include surgical ligation or excision, or endovascular embolisation. Endovascular techniques have the advantage of being well tolerated, can be performed under local anesthesia, can be done on an outpatient basis and avoid dissection through a traumatised zone of tissue.[12] The choice for endovascular embolisation depends on the size of the AVM, its accessibility, and the rapidity of flow across the fistula.[15] The method is safe and effective for vascular lesions of the extremities,[16] but was not considered in our case, since the lesion was not suspected prior to excision, and the diagnosis was retrospective.

The possibility that the AVM was congenital in nature and the trauma merely drew attention to its presence cannot be ruled out, even though the player and his mother both insist that the swelling was not present prior to trauma. Davidovic et al in their study on post-traumatic AVMs and pseudoaneurysms found that 17.6% of their patients had surgery for AVMs within 1 month of their injury.[17] This would indicate that 1 month is a sufficient time to develop an AVM after trauma.[12] In our case the patient presented 7 months after the injury. This strengthens the possibility of the AVM being post-traumatic in nature.

CONCLUSION

We present a rare manifestation of a contact injury to the muscle by a hard ball. AV malformations in sports are rare, and have never been reported in cricket; a high index of suspicion should be kept in sports-persons who present with persistent pain and swelling in large muscles after contact injuries, and sometimes even plain MRIs are not diagnostic. Specialised tests would lead to the diagnosis earlier, and then minimally invasive treatment options become viable, especially for larger lesions. Surgical excision of a small lesion gives good results and allows full return to competitive sports.

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Athletes with spinal cord injuries

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This article is the third in the NZJSM series on athletes with disabilities, focussing on medical issues in athletes with spinal cord injuries.

True / False:

1 An athlete experiencing autonomic dysreflexia will typically be tachycardic.

2 There is minimal benefit in attempting heat acclimatisation for an athlete with a spinal cord injury.

3 A tibia fracture in a wheelchair athlete should unite in a similar timeframe to an able-bodied athlete.

The effects of a spinal cord injury (SCI) depend on the level and severity of the lesion. The most common site of SCI in athletes is the lower cervical spine, with resultant spastic paralysis of the lower limbs (usually requiring the use of a wheelchair), and partial paralysis of their upper limbs. The nerve roots corresponding to the level of the injury are typically only partially affected. The purpose of this article is not to review the neurology, which can be reviewed in textbooks, but rather cover the potential clinical implications including an increased risk of injury, autonomic dysreflexia, impaired thermoregulation, neurogenic bladder, osteoporosis, and peripheral nerve entrapments.

Autonomic dysreflexia can potentially affect those with a spinal cord lesion at T6 or above, the level of the major sympathetic outflow tract. A noxious stimulus (eg, a blocked catheter) originating below the level of the SCI triggers an unregulated sympathetic response with a number of flow-on effects. The most concerning effect is severe hypertension, which can potentially be life threatening from an intra-cranial haemorrhage or cardiac arrhythmia. It is important to note that a high SCI athlete's normal blood pressure may be low (eg, 90/60) and hence even a mildly elevated blood pressure may be relevant depending on the clinical circumstances.

Symptoms may include headache, anxiety or simply the sense that 'something is wrong', or symptoms related to the reactive parasympathetic response above the level of the SCI such as nasal stuffiness, skin flushing, sweating, or chills. For the same reason, the patient will typically be paradoxically bradycardic. Management involves quickly identifying and addressing the precipitating cause, such as a blocked catheter and overdistended bladder, faecal impaction, a skin lesion or even an occult fracture. The patient should be placed as upright as possible and either oral nifedipine or a GTN spray can be given to temporarily reduce the blood pressure (a caution is that males with SCI may use medication for erectile dysfunction, in which case GTN is contraindicated). If things are not able to be quickly and adequately controlled, urgent transfer to more advanced medical facilities is appropriate.

Tim Williams at Bike NZ National Champs - Bike NZ
(NB Photo reproduced with Tim Williams' permission.)

There are cases of athletes intentionally invoking this response immediately before competition to try to gain a physiological advantage (eg, a 10% improvement in a simulated 7.5 km wheelchair race[5]), a technique known as 'boosting'. As a result, pre-competition clinical and blood pressure checks are randomly performed, with repeat offenders subject to sanctions similar to those imposed for other doping violations.

A SCI athlete's ability to control their body temperature is affected by their inability to vasodilate/constrict, sweat or shiver below the level of the spinal cord lesion, which is of more concern in high level and/or complete SCIs. Monitoring of athletes during training or competition is important, but with an increased level of suspicion, since the symptoms of heat illness in a SCI athlete may be non-specific. Extra attention should be directed towards preventative measures including maintaining hydration, wearing appropriate clothing, controlling the training environment, and applying external cooling before, during or after exertion as appropriate. Despite a SCI athlete's more limited physiological adaptation response there is still significant value in implementing measures that improve heat tolerance in able-bodied athletes such as pre-acclimatisation and optimising fitness/conditioning.

Most athletes with a SCI will have a degree of bladder dysfunction, with the attendant increased risk of urinary tract infection.

Symptoms may be atypical and non-specific, such as a general feeling of unease, and left untreated, can cause an individual to become rapidly unwell. Appropriate antibiotic treatment is thus critical, noting that bacturia in an otherwise well SCI athlete should not usually be treated with antibiotics. Thus the decision to treat or not often comes down to the gut feeling of the practitioner in close consultation with the athlete, and will also depend on the ability to closely monitor the athlete and also possibly the proximity to competition. Reminding the athlete about the importance of aseptic technique during catheterisation, may assist with prevention of infections.

Rebecca Dubber Photos (at Pan Pacific Para-Swimming Championships) - PNZ
(NB Photo reproduced with Rebecca Dubber's permission.)

One hundred percent of individuals with SCI have premature osteoporosis in the paretic extremeties, and loss of total bone mineral content of 25-50% depending on the level and completeness of their spinal cord lesion.[1] This effect appears related to both the loss of the mechanical stimulation of weightbearing (particularly in wheelchair bound individuals) and other neural factors. Treatment options remain limited, but an awareness of an increased risk of fracture in this group of athletes is crucial particularly as the lack of sensation may render such injuries relatively occult. Clinicians should therefore maintain a low threshold for requesting appropriate radiology, and be aware that healing of fractures may be delayed compared to "normal" timeframes.

Pressure sores on the buttocks are a potentially significant issue in wheelchair athletes, with sport-specific wheelchairs often placing the knees higher than the hips, resulting in increased load on the ischial tuberosities. A study on a wheelchair basketball team identified evidence of deep tissue injury at the ischial tuberosity or sacrum via ultrasonography in 65% of team members. This process will only become evident on the skin surface at a later stage, hence the need for vigilance.[2] The principles of prevention and treatment follow similar lines to those outlined for the stumps of lower limb deficiency covered in a previous article in this series.[4]

Finally, repetitive contact of the hands with wheelchair rims places the athlete at risk for median or ulnar nerve entrapments as well as other problems related to direct pressure on the upper limb. Padding of the wheel rims and/or gloves as well as wheelchair design, and good technique can reduce but not completely eliminate this risk. Specific musculoskeletal issues affecting the upper limbs, including shoulder and thoracic spine dysfunction, will be covered in the next article focusing on physiotherapy-specific issues.

For a comprehensive review, particularly of musculoskeletal injuries and autonomic dysreflexia, the interested reader is referred to a previous article in this journal.[3]

While slightly daunting at first, care of the athlete with SCI is helped greatly by an understanding of the physiological effects of spinal cord compromise, and the common medical issues that occur.

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ACC National Concussion Guidelines

Safeguarding against concussion harm - launch of the ACC Sport Concussion Guidelines

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The consequences of head injuries and concussion in sport has brought widespread public focus on the importance of having well defined policies and practices to reduce the harm from concussion. Over 7,000 head injuries are recorded by ACC each year as a direct result of sport related activity. In the last four years sports related concussion claims cost ACC $76 million.

ACC has been working with four National Sports Organisations (NSO's) to develop and implement injury prevention initiatives. The Sports Collaboration Group (SCG) - New Zealand Rugby, New Zealand Rugby League, Netball New Zealand and New Zealand Football working closely with Auckland University of Technology's Sports Performance Research Institute New Zealand (SPRINZ) – was formed to work together to provide a leadership platform to address issues related to sport. The first issue identified was concussion in sport.

The ACC Sport Concussion Guidelines were officially launched by Dr Peter Robinson (Chief Clinical Advisor for the Accident Compensation Corporation), at a media briefing on Friday 5th December at AUT Millennium. "The knowledge, experience and expertise this group brought in dealing with issues around concussion has been invaluable," said Dr Robinson. "We all agreed something had to be done and that a national guideline would be a starting point for all NSO's, the recreation, health and education sectors to have a policy around concussion." "It is no longer acceptable to allow sports participants who sustain a knock to the head to continue to play until a proper medical assessment has been made." "The important thing is to get everyone involved to ensure a high standard of care across New Zealand," said Dr Robinson. The aim of the ACC Sport Concussion Guidelines is to translate to the New Zealand context the key information from the 2012 Zurich Consensus, and to build on the work in concussion of the four sports leading the SCG. It is acknowledged that a number of groups such as Sports Medicine New Zealand (SMNZ) have also had useful guidelines for concussion in sport.

The ACC Sport Concussion Guidelines set out what to do, how to recognise the signs and symptoms, what action to take and how sports organisations can develop a concussion policy and implementation plan for their particular activity. ACC has an expert panel available to assist sports organisations to develop and review their policies, plans and education material. Members of SMNZ are encouraged to volunteer to be part of the ACC expert panel. The ACC website (www.concussion.acc.nz) and the SMNZ website have downloadable pdfs of the Concussion Recognition Tool (CRT), the SCAT3 and the ACC Sport Concussion Guidelines.

ACC with the SCG and AUT's SPRINZ are now working on the concussion implementation plan. Consultation with members of SMNZ, Sport New Zealand, and Ministry of Health amongst other key groups will be undertaken to ensure its appropriate implementation, including education, in those groups involved with the identification and treatment of concussion. For example, education for medical doctors could include:

- SCAT3 use
- Clinical assessment and diagnosis as per the Zurich Consensus
- Knowledge of medical clearance for return to school/work/sport

Education for allied health care professionals and public (non-doctor, non-allied health) involved in physical activity rehabilitation during return to play (e.g. coaches, teachers) could include:

- CRT
- SCAT3 symptom only use
- Return to physical activity as per the Zurich Consensus

The media launch of the ACC Sport Concussion Guidelines followed a public seminar by Professor Winne Meeuwissee on the Zurich Concussion Consensus Statement and research updates since the statement was published in 2012. Dr Meeuwisse as a founding member of the Concussion in Sport Group and Co-Chair of the 2012 International Consensus Conference on Concussion in Sport, was able to provide advice to ensure the ACC Sport Concussion Guidelines were up to date with international best practice and current research on concussion.

Members of the SCG who helped develop the guidelines were Isaac Carlson (ACC), Natalie Hardaker (ACC and SMNZ member), Patria Hume (AUT SPRINZ sports injury biomechanist and SMNZ member), Alice Theadom (AUT NISAN neuropsychologist), Rosamund Hill (Auckland Hospital Neurologist), Mark Fulcher (Sports Physician, and Medical Director for both NZ Football and Netball New Zealand and SMNZ member), Dean Watkins (National Talent Development Manager for NZ Rugby League), Richard Skelly (Game Development Manager at NZ Rugby), Ian Murphy (NZ Rugby Medical Director and SMNZ member), Cam Mitchell (NZ Football), Jamie Milne (NZ Football), Adrienne Morrin (NZ Netball), Laura Menzies (NZ Netball), Jacob Cameron (NZRL), and Sharon Kearney (NZ Netball Physiotherapist and SMNZ member). Dr Bruce Hamilton (HPSNZ and SMNZ member) and Dr Bryn Jones (Ministry of Health) also contributed to the media interviews during the launch.

Media panel during the launch of the ACC Sport Concussion Guidelines Professor Patria Hume, Dean Watkins, Dr Peter Robinson, Dr Mark Fulcher, Richard Skelly.

Sport Concussion in New Zealand National Guidelines

This guideline document has been produced to inform National Sports Organisations (NSOs), and recreation, education and health sectors in their development of specific policy for concussion in sport. This guideline produced by ACC in consultation with a panel of medical, sport and research experts, is based on the 2012 Zurich Consensus Statement[1] on Sport Concussion.

These guidelines are intended to help provide advice via the NSOs and recreation, education and health sectors to help people (e.g. medical doctors, health providers, first aiders, coaches/trainers, players, parents, sports administrators, school teachers etc.) be able to understand:

1. **Why there is a need for concussion guidelines.**
2. **What concussion is.**
3. **How to recognise the signs and symptoms of concussion.**
4. **What action to take when a concussion occurs, and how to get help.**
5. **Who can assess and diagnose concussion (only a medical doctor).**
6. **Why a management protocol for graduated return to school/work/sport is needed.**
7. **How NSO's can develop a concussion policy and implementation plan.**

Key Messages

We need **concussion guidelines** because concussion can be a serious injury to the brain and it occurs frequently in New Zealand. Concussion is a mild traumatic brain injury (mTBI). Concussion is a brain injury defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces. Several common features that incorporate clinical, pathologic, and biomechanical injury constructs can be utilized in defining the nature of a concussive head injury.[1]

- **Recognise and Remove.** If concussion is suspected, remove from play/activity immediately and seek urgent assessment by a medical doctor.
- Concussions often occur **without** loss of consciousness (only 10-20% lose consciousness).
- Extra caution is required for child and adolescent athletes.
- It may take several hours (or even days) post injury for some or all of the symptoms of concussion to emerge.
- Non-medical personnel have an important role to play in recognising the signs and symptoms of concussion. Concussion can present in a similar manner to other catastrophic conditions with delayed onset of symptoms.
- A medical doctor must provide assessment and diagnosis of concussion because the diagnosis may be difficult and relies on clinical judgement.
- It is unanimously agreed that **no return** to sport/activity on the day of concussive injury should occur.[1]
- The effects of concussion can interfere with the athlete's ability to learn in the classroom or to function well at work. Return to school/work may need to be graduated and demands altered to reflect level of function, guided by a medical practitioner experienced in this area. Return to school/work and social activities should be achieved before return to sport/activity.

1 Why we need concussion guidelines

Concussion is a serious injury and occurs frequently:

- Estimated 35,000 head injuries in New Zealand per year.[2]
- 21% (7,350 injuries per year) of all head injuries in New Zealand are sustained through sport related activity.[3] ACC only receive claims for 6,250 of those sports related concussion injuries suggesting that 1,100 currently go untreated.
- 2009-2013 sports related concussion claims cost ACC $76 million.
- 46% (3,381 injuries per year) of sports head injuries are classified as 'mild with a high risk of complications'. Injuries are most frequently sustained during rugby, cycling and equestrian activities.
- 11% of sports related concussion claimants had multiple concussions within a 2 year period (2009-2013).
- Evidence shows that with repeat concussion people may experience a decline in general health and quality of life up to 10 years following injury.[4]

2 Definition of concussion

Concussion is a mild traumatic brain injury (mTBI). Concussion is a brain injury defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces. Several common features that incorporate clinical, pathologic, and biomechanical injury constructs can be utilized in defining the nature of a concussive head injury.

A laymen's definition of concussion is:

Concussion is a brain injury that can occur in any sport, particularly where there is full body contact. Concussion is caused by the impact of force (a blow) to a part of the body not necessarily the head directly.[1]

3 Signs and symptoms of concussion

Concussion presents with a range of signs and/or symptoms that may or may not include loss of consciousness.[1] It is important to remember that not every sign and symptom will be present every case and signs and symptoms may have delayed onset.

Physical signs (you see)

- Loss of consciousness or non-responsive
- Lying on the ground not moving or slow to get up
- Loss of balance/co-ordination
- Disorientation/confusion
- Visible injury to face or head (especially in combination with any other signs)
- Seizure or convulsion
- Vomiting

Clinical symptoms (they feel)

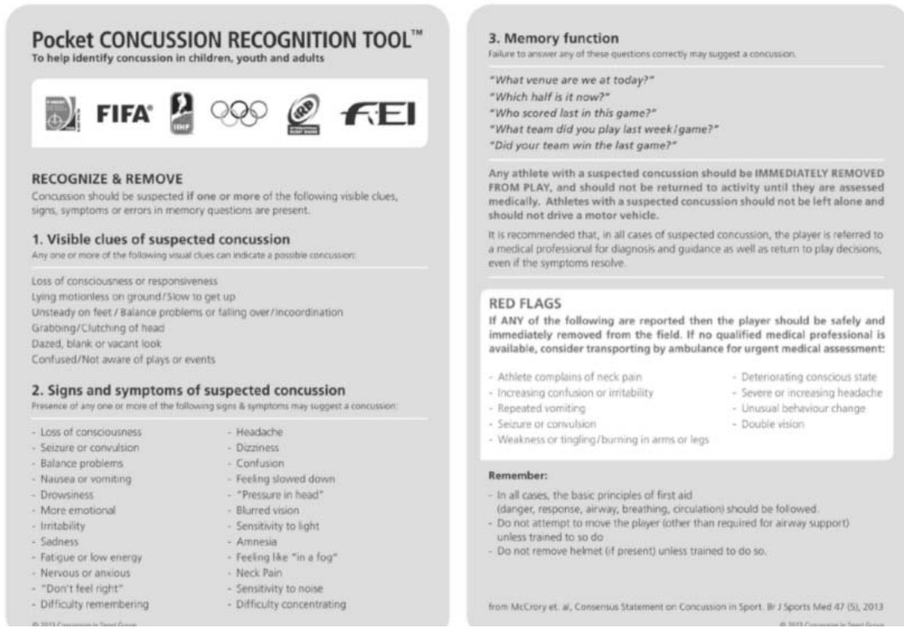
- Blurred vision
- Neck pain
- Nausea
- Dizziness
- Confusion
- Difficulty sleeping
- Headache/pressure in the head
- Sensitivity to light &/or noise
- Generally feeling "not quite right"
- Fatigue
- Drowsiness/trouble sleeping
- More emotional
- Irritability
- Problems with memory
- Reduced ability to think/concentrate

4 Action to take when a concussion occurs, and how to get help

When a concussion or possible concussion occurs it is important to take action and to get help. **The most important steps in the early identification of concussion are to recognise a possible injury and remove the athlete from the sport/activity.**

Recognise and Remove

Use the Concussion Recognition Tool (CRT) (a printable PDF of the pocket CRT can be downloaded at: http://links.lww.com/JSM/A32).



Pocket CONCUSSION RECOGNITION TOOL™

To help identify concussion in children, youth and adults

RECOGNIZE & REMOVE

Concussion should be suspected **if one or more** of the following visible clues, signs, symptoms or errors in memory questions are present.

1. Visible clues of suspected concussion

Any one or more of the following visual clues can indicate a possible concussion:

Loss of consciousness or responsiveness
Lying motionless on ground/Slow to get up
Unsteady on feet / Balance problems or falling over/incoordination
Grabbing/Clutching of head
Dazed, blank or vacant look
Confused/Not aware of plays or events

2. Signs and symptoms of suspected concussion

Presence of any one or more of the following signs & symptoms may suggest a concussion:

- Loss of consciousness
- Seizure or convulsion
- Balance problems
- Nausea or vomiting
- Drowsiness
- More emotional
- Irritability
- Sadness
- Fatigue or low energy
- Nervous or anxious
- "Don't feel right"
- Difficulty remembering
- Headache
- Dizziness
- Confusion
- Feeling slowed down
- "Pressure in head"
- Blurred vision
- Sensitivity to light
- Amnesia
- Feeling like "in a fog"
- Neck Pain
- Sensitivity to noise
- Difficulty concentrating

3. Memory function

Failure to answer any of these questions correctly may suggest a concussion.

"What venue are we at today?"
"Which half is it now?"
"Who scored last in this game?"
"What team did you play last week/game?"
"Did your team win the last game?"

Any athlete with a suspected concussion should be IMMEDIATELY REMOVED FROM PLAY, and should not be returned to activity until they are assessed medically. Athletes with a suspected concussion should not be left alone and should not drive a motor vehicle.

It is recommended that, in all cases of suspected concussion, the player is referred to a medical professional for diagnosis and guidance as well as return to play decisions, even if the symptoms resolve.

RED FLAGS

If ANY of the following are reported then the player should be safely and immediately removed from the field. If no qualified medical professional is available, consider transporting by ambulance for urgent medical assessment:

- Athlete complains of neck pain
- Increasing confusion or irritability
- Repeated vomiting
- Seizure or convulsion
- Weakness or tingling/burning in arms or legs
- Deteriorating conscious state
- Severe or increasing headache
- Unusual behaviour change
- Double vision

Remember:

- In all cases, the basic principles of first aid (danger, response, airway, breathing, circulation) should be followed.
- Do not attempt to move the player (other than required for airway support) unless trained to so do
- Do not remove helmet (if present) unless trained to do so.

from McCrory et. al, Consensus Statement on Concussion in Sport. Br J Sports Med 47 (5), 2013

- Non-medical personnel have an important role in observing possible concussion and its effects (e.g. behaviour/symptoms), and should take responsibility for removing the injured athlete from the sport/activity.
- If a suspected concussion has occurred it is important to see a medical doctor for assessment immediately.
- Medical doctors are available at general practitioner practices, concussion clinics or hospital emergency departments.
- It is unanimously agreed that no return to sport/activity on the day of concussive injury should occur.[1]
- In cases of uncertainty always adopt a conservative approach – "If in doubt sit them out".

It is useful to have a list of local medical doctors, concussion clinics and emergency departments close to where the sport/activity is being played. A pre-activity checklist of the appropriate services could include:

- Local doctors or medical centre.
- Local hospital emergency department.
- Ambulance services (111).

To help an unconscious athlete:

- Apply first aid principles – DRABC (Danger, Response, Airway, Breathing, Circulation).
- It is extremely important to treat all unconscious athletes as though they have a neck injury.
- An unconscious athlete must ONLY be moved by a medical professional trained in spinal immobilisation techniques.
- Urgent hospital care is necessary if there is concern regarding the risk of structural head or neck injury – call 111.
- An athlete with any of the following should be referred to hospital URGENTLY:
  - Loss of consciousness or seizures.
  - Persistent confusion.
  - Deterioration after being injured – increased drowsiness, headache or vomiting.
  - Report of neck pain or spinal cord symptoms – numbness, tingling, muscle weakness.
- If at any time there is any doubt the athlete should be referred to hospital.

5 Assessment and diagnosis of concussion by medical doctors

Only a qualified medical doctor can assess and diagnose a concussion.

Anyone with a suspected head injury needs to see and be assessed by a medical doctor. This is essential to confirm the diagnoses of concussion and to assess the risk for more serious injury.

We endorse the Sport Concussion Assessment Tool version 3 (SCAT3) and the Child-SCAT3 as a validated means of assessing concussion by a medical doctor. A printable PDF of SCAT3 can be downloaded at: http://links.lww.com/JSM/A30. A printable PDF of Child-SCAT3 can be downloaded at: http://links.lww.com/JSM/A31. We recommend you become familiar with symptoms evaluated in SCAT3.

The SCAT3 is NOT to be used for diagnosis of concussion alone. It provides a standardized assessment to aid diagnosis by a medical doctor.

NOTE: In some areas of the world, sports physiotherapists and other trained medical personnel can do the assessment (e.g., SCAT3), **but only a doctor can diagnose concussion.**

How do you feel?

"You should score yourself on the following symptoms, based on how you feel now".

	none	mild		moderate		severe	
Headache	0	1	2	3	4	5	6
"Pressure in head"	0	1	2	3	4	5	6
Neck Pain	0	1	2	3	4	5	6
Nausea or vomiting	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Blurred vision	0	1	2	3	4	5	6
Balance problems	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Feeling slowed down	0	1	2	3	4	5	6
Feeling like "in a fog"	0	1	2	3	4	5	6
"Don't feel right"	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Fatigue or low energy	0	1	2	3	4	5	6
Confusion	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
Trouble falling asleep	0	1	2	3	4	5	6
More emotional	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervous or Anxious	0	1	2	3	4	5	6

Total number of symptoms (Maximum possible 22)

Symptom severity score (Maximum possible 132)

Do the symptoms get worse with physical activity? Y N

Do the symptoms get worse with mental activity? Y N

self rated | self rated and clinician monitored

clinician interview | self rated with parent input

Overall rating: If you know the athlete well prior to the injury, how different is the athlete acting compared to his/her usual self?

Please circle one response:

no different | very different | unsure | N/A

6 Concussion management and a graduated return to school/work/sport protocol

Initial concussion management involves physical and cognitive rest until the acute symptoms resolve and then a graded programme of exertion (physical and mental activity) prior to medical clearance and return to sport.

All athletes diagnosed with concussion must go through a graduated return to activity protocol led by a person trained in concussion management (e.g. coach, physical trainer, teacher, parent etc.). Athletes should have fully returned to school or work and social activities before returning to activity. Clearance by a medical doctor is required before return to sport/activity.

There is a lack of research to support the optimal period of time an athlete should be out of training and competition. Below is an example of a graduated return to sport protocol based on the best available evidence and expert experience.

Return to activity stage	Functional exercise at each stage of rehabilitation	Objective of each stage
No activity	Avoid all physical and mental exertion including the use of technology (e.g. use of phones, computers, reading, watching TV).	Recovery.
Light aerobic exercise	Walking, swimming or stationary bike keep intensity of exercise very low/easy. No resistance training.	Increase heart rate.
Sport specific exercise	Running drills. No head impact activities.	Add movement.
Non-contact training drills	Progression to more complex training drills e.g. passing, drills.	Exercise, co-ordination and cognitive load.
Full contact practice	Following clearance from medical doctor, participate in normal training activities.	Restore confidence and assess functional skills by coaching staff.
Return to play	Normal sport.	Full return to sport.

- It is unanimously agreed that no return to sport/activity on the day of concussive injury should occur.[1]
- Return to activity should be particularly cautious where children and adolescents are concerned.
- Each individual international sports federation may have specific rules which must be considered (e.g. International Rugby Board rules for New Zealand Rugby).
- The safety of the athlete is the priority and must NOT be compromised.
- The decision regarding return to school/work and clearance to return to restricted activity should always be made by a medical doctor.
- The decision regarding the timing of return to sport/activity should always be made by a medical doctor.
- In some cases, symptoms may be prolonged or graded activity may not be tolerated. If recovery is prolonged, evaluation by a concussion specialist or clinic may be warranted to determine if there are other aspects of the concussion that could respond to rehabilitation.

In summary, the figure shows the roles and responsibilities for concussion management (i.e. stages of identification, assessment and diagnosis, rehabilitation and return to sport).

	Recognition of Injury	Assessment and diagnosis	Rehabilitation and management	Return to school/work/sport	Sport Training and competition
Responsibility	Everybody	Medical doctors	Physio's, OT's, coaches, parents, athletes, teachers, physical therapists, sports medics	Medical doctors	
Tools/How	Concussion Recognition Tools (CRT)	SCAT 3 Medical assessment and diagnosis	SCAT 3 – Symptom checklist only Return to play graduated protocol	SCAT 3 Medical assessment and diagnosis	
Education required	General Public Ambulance staff First aiders	GP, ED docs, Sports physicians – use of SCAT 3	All responsible	GP's	

7 Develop a policy and implementation plan

It is suggested that National Sport Organizations (NSOs) and other relevant organisations develop a concussion policy and educate their members/community in how to implement the guidelines specific to their sport.
ACC has an 'expert panel' available that can be consulted to review organisations' concussion policies, implementation plans and education material with the goal of ensuring a consistently high standard of care across New Zealand.

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It is intended to formally review this document prior to February 2017.

Care of the adolescent athlete

#youtholympicsmedicalreport

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In August 2014 the 2nd Youth Olympic Games were held in Nanjing, China. Nanjing is a city of merely 9 million or so people situated a 5 hour bus ride inland from Shanghai. The NZ team consisted of 51 athletes (14-18 year olds) and about 30 support staff. A range of sports were represented, including hockey and basketball teams (modified to 5- and 3-person teams respectively), swimming, wrestling, rowing, beach volleyball, golf, weightlifting, gymnastics, and a smattering of others. The Chinese built an amazing athlete's village and competition venues on a grand scale reminiscent of the Beijing Olympics in 2008.

Our medical team consisted of one doctor and two physiotherapists. Pre-event medical information was collected via a questionnaire on the NZ Olympic Committee online platform. A mini-conference was held a few weeks before departure for the key support staff as well as most of the coaches. This was a fantastic way of all being on the same page when we met again at the airport at departure. At the village out of necessity our medical room was the common area in our two bedroom apartment, with anything requiring privacy conducted in a makeshift consultation area in the larger of the two bedrooms, with a chaperone present as appropriate.

The NZ team did not have any major medical issues or injuries during the Games. Common medical complaints included relatively low grade gastrointestinal symptoms, upper respiratory tract infections, insect bites and minor wounds. From an environmental perspective it was hot but not dramatically so, and the air quality seemed to cause issues for some of those with pre-existing asthma. Injuries were all relatively low grade. We thus had minimal requirement for the medical Polyclinic in the village, with a few precautionary x-rays and ultrasound, and one set of blood tests (where the value of persevering against bureaucracy was required to be demonstrated). Drug testing included blood as well as urine tests for most athletes. A strong emphasis was placed on the cultural and education programme rather than results, but of course all athletes are very competitive. In this sense the campaign was successful, with gold medals in equestrian and trampolining, a silver medal in triathlon, and bronze medals in swimming (x2) and triathlon team event.

We were fortunate to have a relatively mature and easygoing group of teenage athletes; however adolescent athletes can pose some unique challenges to a medical team on tour. Adolescents fall into an awkward, perhaps slightly spotty gap between the paediatric and adult populations. Most literature has focused on the special considerations of the incompletely developed musculoskeletal system; covering acute and overuse injuries to growth plates and specific areas such as the pars interarticularis. The more conservative management of concussion[1] recognises the increased vulnerability of the developing brain. Medical conditions requiring particular consideration include asthma, certain infectious diseases not least of all the area of sexual health. Provision of optimal treatment to adolescent athletes however also requires an appreciation of specific psychosocial factors, and the rest of this article will briefly touch on some of these.

Taking time early on to develop a relationship with athletes will ultimately be worthwhile from a therapeutic perspective and as a bonus almost certainly also make the ongoing provision of treatment more enjoyable and satisfying. Parents (hopefully!) still play a very prominent role in a teenager's life - athletes are no exception - and healthcare providers need to bear this in mind when managing certain situations. The athlete's coach will often be a very strong influence or even something of a mentor, and when travelling may assume the primary caregiver role as well. Another strong source of influence is the athlete's peer group, something that they may not always decide to share this, or in fact be completely aware of it themselves!

For many young athletes it can be a new experience to have readily accessible medical support; many may have never before engaged with a health professional without a parent present, and hence may be lacking in health literacy. They will probably need education about the importance and benefits of early reporting of symptoms, and at times even reminders about supposedly commonly accepted hygiene practices! Being mindful that time management and general organisational skills are often still a work in progress may help in dealing with lateness or missed appointments, or their decision to stop by with a non-urgent issue at 10:30 pm at night. A balance between tolerance and attempting to educate on what will eventually be expected of them would seem a reasonable approach.

Adolescents tend to be more self-conscious about their bodies and medical staff should be sensitive to this. The use of a chaperone is strongly encouraged in any situation that has the potential to be misinterpreted, and when gaining formal consent is required - remember that some are still legally minors. Being aware of potential social pressures and motivators that may influence their behaviour and decision-making with respect to injury or illness may help identify and address any barriers early on. Providing explicit reminders about the sanctity of medical confidentiality is recommended.

Athletes have coping strategies for the stress associated with elite competition, but these strategies may not yet be fully developed. Possible maladaptive coping behaviours may involve alcohol or recreational drug use, or even manifest as disordered eating.[3] From both a health and anti-doping perspective, clinicians should be aware that young athletes may be more susceptible to the persuasive marketing of supplements.

All of the above arguably also apply to dealing with adult athletes, but seem particularly relevant in adolescents. It is a great privilege to work with the superstars of tomorrow, and the opportunity to contribute to their development is not taken lightly.

The next Youth Olympic Games is scheduled for 4 years time in Argentina; if you get the chance, jump at it.

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1st World Conference on Groin Pain in Athletes

Qatar, November 2014

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With the support of a Prime Ministers Scholarship, I was fortunate to be able to attend this conference in Qatar from 1-3rd November. The conference was rich in experts such as leading physiotherapists Tim Tyler and Kristian Thorborg, through to world renowned surgeons including professor Per Holmich and Ulrike Muschaweck.

Despite groin injuries having such a high prevalence in football, arguably the most popular worldwide sport, there remains a dramatic lack of consensus regarding its nomenclature, diagnostics and causes.

Sports involving rapid changes of direction and/or kicking such as football, ice hockey and AFL all have a high incidence of groin injuries.[1,2] The risk rate of a groin injury is 2.5 times greater in male athletes compared with female athletes[3] and subsequently was frequently referred to during the conference as the male equivalent of ACL injury in women. It has also been shown to primarily involve the adductors, and most frequently the adductor longus.[1]

A frequently articulated point was that studies which assess hip and groin pain can be misleading depending on the definition of injury utilised. For example, many footballers experience groin pain but are able to keep playing (indeed some experts state that up to 70% of the squad in a professional football team will experience groin pain in any given season[4,5,6]). Hence, if an injury is defined purely on time absent from training or playing, then there is a whole sub-population who are not being captured in these studies.

Moving forward, it was suggested that future studies needed a terminology consensus to allow cross study comparison. Furthermore, instead of prospective trials, a number of speakers suggested that the next high quality randomised controlled trials should specifically target the at risk athletes.[7,8] At risk athletes are those involved in sports which combine kicking and change of direction, play at higher competition levels, have had a previous groin injury, and have both reduced adductor strength and volume of sports specific training.

These athletes can be identified through both subjective and objective assessment. Key objective tests highlighted in the diagnosis and/or prediction of those who would develop groin pain include hand held dynamometry (HHD) to assess the adductor:abductor ratios on eccentric testing (if adduction is less than 80% of abduction, the athlete has a 17x greater risk of developing groin pain),[9] squeeze test at both hip neutral and 45 degrees of hip flexion[10] , the HAGOS scale[11] and perhaps also useful (based solely on clinical observation) was Askling's adductor H test- which some presenters had found beneficial in assessing groin pain related return to play decisions

Discussion arose surrounding the presence or not of a fibro-cartilage plate anterior to the pubic symphysis. While many acknowledge the presence of this anatomical structure, its role in groin pain remains unclear. Some experts believed that this plate negated the attachment of adductor longus to the pubic symphysis, while others countered that it was the means by which it originated. The importance of bone marrow oedema also provoked discussion as while it was noted in many cases of groin pain, it was also observed in up to 65% of asymptomatic athletes.

It was clear that further research (as always) is required. However, there are some exciting studies being performed in Qatar looking at objective testing of footballers and the relationship to the development of groin pain over subsequent years.[10] The need for accurate diagnostics was reinforced, along with the need to standardise nomenclature to both facilitate consistent communication between professions internationally and to allow direct comparison between research projects.

I would like to acknowledge the support of the Prime Ministers Scholarship in attending this outstanding international conference.

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6th Edition Muscletech Network - Research on Hamstring Injuries

Barcelona, October 2014

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With the funding of a Prime Minister's Scholarship I was fortunate enough to attend the 6th Edition Muscletech Network workshop in Barcelona, 13th and 14th of October. With the sole focus of hamstring injury research, the work shop showcased the most current work of leading muscle injury researchers including but not exclusive to Jan Ekstrand, John Orchard, Erik Witvrouw and Bryan Heidersheit.

Hamstring muscle injury continues to plague our running sports athletes, with consensus across football, track and field and AFL statistics that the hamstrings are the mostly commonly injured muscle group in this athletic population.[1,2,3] Compounding the impact hamstring injury has on these sports is the hamstrings tendency to reinjure, with biceps femoris, the most commonly injured of the hamstring group, particularly implicated in this re-injury risk.[1]

Recent research and meta-analysis has helped identify and confirm that athletes with previous hamstring injury histories, eccentric hamstring strength asymmetries, reduced hamstring endurance and reduced muscle length are at greater risk of hamstring muscle injury; overall risk that increases as the athlete ages.[3,4] However, despite this knowledge and our clinical efforts to minimise hamstring injury and re-injury risks the incidence of hamstring injury increases in our elite and professional running sport athletes.[1]

So where are we going wrong? As a sports medicine and therapy profession we can largely agree targeted injury prevention and sports specific rehabilitation return to play programs hold a leading role in our management of the problem . In controlled populations, we can even show evidence for their positive impact on hamstring injury and re-injury prevention.[5,6,7,8,9,10] The challenge underlying the success of this concept as a global solution, however, is an inability to date to reach an evidence based consensus on the actual mechanism of hamstring injury. Is the bicep femoris failing in the stance phase, as it is exposed to high external joint moments.[11] Or is its failure the result of a deceleration load at the end of range as experienced in late swing phase.[12,13] If indeed it is the late swing phase that creates the morbid load is it in fact a relative failure of an under-prepared semitendinosis at these joint angles that results in a compensatory overload of its stable mate, the biceps femoris .[13] Selection of prehabilitation exercises to specifically protect the hamstring muscle group based on its most injurious loads would require confirmation of what the true nature of those loads are.

There is conflicting evidence as to the most appropriate means by which to prognosticate true muscle injury recovery times, as well as determine clinically and diagnostically when true, sport worthy recovery has occurred.[1,3,5,14,15,16] To date we have been working on the academic premise that our diagnostic and clinical findings allow us to make assumptions about the histological process in a repairing myofascial tissue.[17] Yet we currently have little evidence linking the histological phase of injury repair with our clinical or diagnostic findings. Furthermore, there are challenges in safely returning hamstring injured athletes to play in a timely manner, while preventing re-injury.

Despite a wealth of exciting new research findings in the hamstring muscle injury arena, an evidence based consensus on their practical application to hamstring injury prevention, rehabilitation and return to play determination is, as yet, unavailable to the sports medicine clinician. For those of us immersed in the daily work of rehabilitating hamstring injured athletes and protecting their yet to be hamstring injured team mates this could be viewed as a professional frustration. Alternatively, it could be considered affirmation of what many practicing the art of hamstring injury rehabilitation hold to be true; that it is a multi-muscle, multi-joint, sports specific, individualised process that cannot be easily corralled into the confines of a randomised control trial. Future consensus amongst authors of high level evidence will no doubt help form the clinical reasoning behind our prehabilitation and rehabilitation choices moving forward, and provide impetus for us to think critically about the science behind our daily practice. It is unlikely, however, to offer us a panacea for hamstring injury in athletes, constantly challenging the limits of our knowledge.

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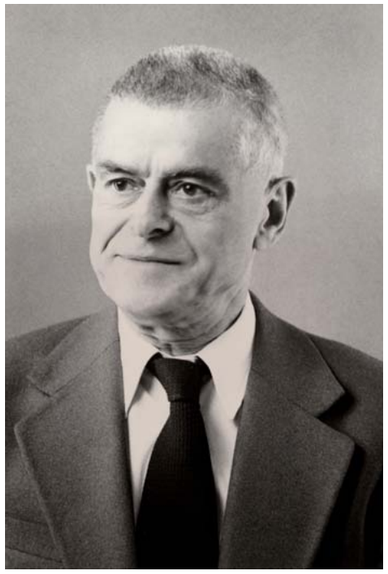
Jerry Morris



Jerry Morris, one of the fathers of exercise medicine, died in London in 2009 at the age of 99½ (curiously very close to the batting average of the great Don Bradman). His study on the activity patterns and mortality of London bus drivers versus conductors produced the first real evidence that regular physical activity was an important protector against premature death.

He was notoriously reluctant to travel by air, so I was first exposed to his teaching during lectures at the Diploma Course in Sports Medicine held at London Hospital Medical College in the mid 1980s. By that stage he was officially 'retired' and in his mid 70s, but had the spring in his step of a much younger man.

His ingenious study of London busmen recruited drivers and bus conductors from the famous London double-decker buses in 1949. The study rolled on to 1953 and it became obvious that the drivers were suffering many more heart attacks and other cardiac events than the conductors. This was at a time when 'stress' was thought to be the genesis of many medical ailments (think peptic ulcer disease before H. pylori was discovered). It was hypothesised that the drivers were experiencing the effects of stress from driving in the busy London traffic - but 'no' said the redoubtable Dr Morris. He had asked the drivers and conductors their views on stress and it became obvious that the stress of navigating the streets for the drivers was far less than the stress for the conductors on getting money out of Londoners to pay for their bus fares.

Subsequent commentators wondered if a degree of self-selection had occurred, as the height to weight ratio of the drivers was less than that for the conductors. This may well have been true. Drivers got to sit for 90% of their duties, whereas the conductors had to climb an average of 600 stairs per day. However, later studies of Londoners in other occupations showed that leisure time activity, e.g. mowing the lawns, gardening and walking the dog, was also protective against cardiac events. So the field of exercise medicine was born.

Morris' work was not happening in isolation. Over in the USA, Ralph Paffenbarger was studying the lifestyle and health events of longshoremen (waterside workers) in Los Angeles. He found similar results to Jerry Morris, i.e. that those in more active jobs had a lower risk of cardiac events; further proof of the hypothesis that exercise prevents against cardiac events.

Then in 1999 I witnessed a meeting of these two great men, Morris and Paffenbarger. They were both invited speakers at the IOC Conference of Medicine and Science in Sport held at the Sydney Convention Centre. What made the biggest impression on me was seeing them at the Sydney Olympic Stadium on an organised tour. Morris, by then 89 years of age, and Paffenbarger were still active men. They each got into a crouch start position on the athletic track that was to witness so much drama the following year (think Cathy Freeman in the bodysuit winning the 400m and the legendary sprint between Haile Gebrsellasie and Paul Tergat in the men's 10,000m).

Later, others took up the challenge of applying the new knowledge to cardiac rehabilitation. Traditional teaching was that heart attack victims needed to rest up for six weeks following a cardiac event. However, based on Morris' work, Professor Terry Kavanagh of the University of Toronto began offering exercise rehabilitation programmes to heart attack victims. They worked. In 1973, seven heart attack and cardiac bypass patients who had been rehabilitated by Dr Kavanagh's team ran in the Boston Marathon.

Their work did not go unnoticed in New Zealand. Morrie Rendall of the YMCA in Auckland got together with Colin Kay, a local businessman, and with the advice of Auckland cardiologists including Trevor Agnew they started a cardiac rehabilitation programme in Auckland. It was taken up in other New Zealand centres, too. In Hamilton, where I have worked since graduation, Dr Denis Friedlander started a similar programme and was himself an active member of the Hamilton Marathon Clinic. Now cardiac rehabilitation programmes are the norm and exercise is recognised as the most cost-effective method of reducing the burden of non-communicable diseases.

And it all started with one man's hunch about bus drivers and conductors.

Sports Nutrition for Paralympic Athletes

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The 2012 London Olympics saw worldwide coverage and spectator support for this rapidly growing area in sport by well-trained athletes, at the elite level, with various impairments. Many previous records were broken and today Paralympic athletes are well trained, managed and experienced in competition. There is growing interest in all areas of sports science and medicine to gain a competitive edge and to maximise the benefits of training and competition, with sports nutrition one of these key areas. There is a growing body of knowledge in this area and more research is being published in peer review journals.

Involvement in physical activity and sport is recognised for the many benefits for the person with impairments and undergoing rehabilitation (medical, psychological, social and physical improvements) from injury.

Sports nutrition is changing and evolving constantly and adapting sports nutrition principles in some impairments (amputee, visually impaired) may require minimal change while for other disciplines with impairment additional issues including medical conditions or constraints provide more challenge and care, with a highly individual focus. Sports nutrition practices are no longer just an adjunct to rehabilitation following injury or therapy.

This 230 page referenced text pulls together the information from experts in sports nutrition specific for athletes with the range of impairment performed at the Paralympic Games into one volume. Details of the unique challenges these athletes face and also for the sports nutritionist working individually with these athletes with a range of impairments (amputees, hearing and visually impaired, spinal cord injuries, intellectual impairment and injuries) and the various classifications within each category are all highlighted.

Broad is an experienced and skilled practioner in Paralympics and in addition to contributing specific knowledge areas in the text has joined with internationally recognised experts in sports nutrition (Louise Burke, Greg Cox and Nanna Meyer) and specialists in the Paralympic field (researcher Vicki Goosey-Tolfery and UK Dietitian Jeanette Crosland) to produce a comprehensive volume. The key benefit of this text is the knowledge provided in sports nutrition when working with athletes with a range of impairments, and the holistic view and complexities in incorporating sports nutrition support into practice. Chapters on unique aspects of gastric emptying, chronic and complex medical issues, thermoregulation, as applied to the Paralympic athlete grow the understanding of the athletes impairment on performance, health and individual requirements. Key is the applied knowledge of sports nutrition to the specific population group and the commentary boxes containing quotes from Paralympic athletes and experts adds personal perspectives to the content.

Use of various supplements is a growing area of interest in this sporting population and is well covered in Chapter 11 including the expense, adverse health consequence, contamination and doping concerns. Case studies provide valuable insight and examples for young practioners working in the field particularly in the area of supplements. The information is not limited to the Paralympic athlete wishing to compete on the international stage but for those who wish to become active and those desiring to enhance their health and performance at any level.

A special chapter on Les Autres (the others) which includes the impairments not classified by the main categories – dwarfism, muscular dystrophy, poliomyelitis, severe arthritis, congenital limb deformities (club foot) and several other impairment types is insightful. The technical support provided in the chapter on body composition in challenging environments and with the range of impairments illustrates the advances in technology and practice. Table 12.2 on interpretation of skinfold and body mass results will assist many practioner both able and impaired athletes.

This text is a valuable resource for experienced sports nutrition practioners and key reading for new practioners in the area and anyone with a general interest in the application of sports nutrition to challenging and rewarding environments and athletes. It is inspiring to read and to know the immense advances in knowledge and also to appreciate the work still to be done. Application of the information in this text will aid sports nutrition practioners to raise the level of care and impact on performance for Paralympic athletes.

Topics covered include:

- Classification and body composition assessment
- Spinal cord injuries – including cooling strategies and hydration status
- Cerebral Palsy and Acquired brain injuries – physiology, terminology, energy expenditure and sweat rates
- Amputees – chronic medical conditions, injuries, body composition and nutrition priorities
- Vision and hearing impairment – various classification and practical aspects working with these athletes
- Intellectual Impairment – Down syndrome, Autism and Phenylketonuria and challenges to the ability to eat, chew and swallow
- Medical Issues, Drug and Nutrient Interactions – medical concerns such as pressure ulcers, urology, Hygiene, nutritional deficiencies, use and impact of medications such as antibiotics, anticoagulants, herbal and NSAIDs (nonsteroidal anti-inflammatory drugs)

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THE DR MATT MARSHALL LECTURE
HAMSTRING INJURIES: AN OVERVIEW OF A COMMON AND CHALLENGING PROBLEM

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Hamstring injuries are frequently identified as a common soft tissue injury occurring in athletes who participate in sports involving rapid acceleration/deceleration and frequent stopping and starting as well as kicking. These injuries account for up to 20% of all sport injuries and the financial impact of these injuries has recently been estimated to be quite considerable. The frequency of injury, recurrent rate, and optimal treatment methods continue to challenge clinicians, athletes, and team personnel alike.

The high incidence of hamstring muscle strain-type injuries and potential associated costs has resulted in a substantial amount of research into the factors related to such injuries. Two recent systematic reviews have attempted to collate the evidence around risk factors for hamstring injuries. Both reviews identified hamstring muscle weakness and thigh muscle imbalance, muscle flexibility, previous hamstring injury, other previous injury and age as potential risk factors; however, these reviews concluded that single variables were inconsistently identified as associated factors. During the recent decades, the approach of assessment and treatment of soft tissue injuries has changed from exercises targeted at developing strength alone, toward modifying the motor system. Balance within the motor system is derived from coordinated activity of synergist and antagonist muscles. According to this point of view, change in muscle length and strength characteristics can lead to altered movement patterns, pain, and movement disorders. Increased or decreased muscle activity and delayed muscular activation can also change the normal movement pattern. Recently, several authors have suggested that the main focus of rehabilitation should be on modification of the altered movement patterns found in patients with hamstring strains.

This talk will cover several aspects of hamstring injuries. First, we will review what is known about risk factors for hamstring injuries. A review of recent studies examining hamstring kinematics during running will serve as a foundation for our current understanding of treatments aimed at the management of altered movement patterns. Findings from these studies will be put into the context of both return to sport as well as mitigating risk for recurrent injury. Secondly, basic science data aimed at understanding the role of inflammation in muscle injury and repair will be reviewed with an effort to provide clinicians with evidence to guide the use of medications such as non-steroidals as well as modalities such as massage to mitigate tissue injury and permit more rapid return to sport while reducing risk for subsequent injury. Finally, the use of ultrasound and its potential for management of hamstring injuries will be explored. Recent studies using ultrasound show altered muscle structure following hamstring injury that will be used to potentially show why the recurrence rate of hamstring injuries continues to be high despite our best efforts at implementing evidence-based rehabilitation programmes.

HAMSTRING ANATOMY REVISITED

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Hamstring strains represent one of the most common injuries in sport, particularly in disciplines that involve high-speed running, kicking and change of direction. Hamstring pathology can involve a variety of structures within the muscle-tendon-bone complex. However, the proximal muscle-tendon unit is often implicated in acute strains,[1] and the long head of biceps femoris is injured more frequently than its medial counterparts.[2] Recent evidence suggests a relationship between the anatomical site of acute strain and the type of activity being undertaken at the time of injury. For example, high-speed running injuries mainly result in damage to the long head of biceps femoris, typically involving the proximal musculotendinous junction. In contrast, stretching-type injuries are usually located more proximally, with the free tendon of semimembranosus being the most vulnerable.[3]

An understanding of hamstring muscle architecture is a fundamental consideration in the diagnosis and management of hamstring injuries.[4] As expected, a number of studies have examined the morphology of the hamstring muscles; however, few have focused on proximal anatomy. The anatomy of the hamstrings (biceps femoris, semitendinous and semimembranosus) is complex, and each muscle is unique in terms of its attachment sites,[5] muscle and tendon architecture and pattern of innervation.[6,7] Of note, an appreciation of the long proximal and distal tendons and elongated musculotendinous junctions is relevant to aid in determining site(s) of injury.7 This talk will revisit hamstring anatomy with a focus on clinically relevant areas of interest.

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THE MERITS OF BASELINE HISTORY TAKING, PHYSICAL EXAMINATION AND MRI ON RETURN TO PLAY

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In the past the prognostication of acute hamstring injuries was mainly based on patient history (PH) and physical examinations (PE). Nowadays, sports physicians are increasingly requested to perform magnetic resonance imaging (MRI) of acute hamstring muscle injuries and to provide a prognosis of the time to return to play (RTP) on the basis of their findings. The value of these findings has never been systematically studied.

The objective was to systematically review the literature on the prognostic value of PH, CE and MRI findings for time to RTP in acute hamstring muscle injuries. The databases of PubMed and SportDiscus were searched in July 2014.Prospective studies evaluating PH and CE as a prognostic tool for determining time to RTP in athletes with acute hamstring injuries were eligible for inclusion.

One author screened the search results and assessed risk of bias using criteria for quality appraisal of prognosis studies. A best-evidence synthesis was used to identify the level of evidence.
The results showed that of the 11 studies included, one had a low risk of bias and 10 a high risk of bias. There is moderate evidence that self-predicted time to RTP is associated with the actual time to RTP. There is limited evidence that clinician-predicted time to RTP is associated with the actual time to RTP and there is limited evidence that a combined clinical assessments battery is associated with RTP. Limited evidence was also found for an association between higher VAS score, stretching type of injuries vs. sprinting type of injuries, dancers (vs sprinters) and longer time to RTP. The other PH and CE variables studied showed either no association or there was conflicting evidence.
For the MRI examination, there is moderate evidence that injuries without hyperintensity on fluid-sensitive sequences are associated with a shorter time to RTP and that injuries involving the proximal free tendon are associated with a longer time to RTP. Limited evidence was found for an association of central tendon disruption, injury not affecting the musculotendinous junction and a total rupture with a longer time to RTP. The other MRI findings studied showed either no association or there was conflicting evidence.
There is currently no strong evidence for any PH, CE and MRI finding that gives a prognosis on the time to RTP after an acute hamstring injury, owing to considerable risks of bias in the studies on this topic.

LOWER LIMB INJURIES IN THE NZ ARMY

Jacques Rousseau

Introduction: Results of 9 months of NZ defence force injuries reports most injuries as musculoskeletal[2] of which nearly half are lower limb injuries. This has implications on overall costs of injuries to the army: loss of manpower, training time, and duty time, non-deployability, and an increase in medical costs and at times can lead to service discharge.[3]
Analysis of nearly a decade of injury data shows 43% of all NZ Army soldiers are injured annually. Lower limb injuries account for a significant proportion (42%) and this rate has remained static. Of all the lower limb injury sites, the ankle has the highest injury rate at 37%, with most of these occurring during military training (ie, PT, battle drill and pack march) and sport (ie, indoor court sport, contact sports, running). Overall, lower limb injuries remain the highest proportion of all injuries sustained in the NZ Army, while running was the most common activity causing ankle injuries.
Regardless of many interventions over the years (ie, change of boots, introducing orthotics, change in training practices) the statistics for lower limb and ankle injuries remains a consistently high proportion of all injuries sustained. The causes are unknown. It has been suggested that recruit training regimes are not suitable and there is speculation that wearing boots with high shafts to provide support and stability to the ankle joint1 may actually be weakening the ankle. The precise aetiology has yet to be elucidated during a series of studies to determine multiple effects. The results of these are expected to help determine future policy of footwear in the army with a view to decrease lower limb and ankle injuries.

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MECHANICS AND CONTROL IN PELVIC GIRDLE PAIN

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Background: Pelvic girdle mechanics and control is a rapidly evolving area of research. The pelvic girdle may be seen from a mechanical perspective as a three link closed kinetic chain which is attached superiorly and inferiorly to the lumbar and hip joints thus compiling the lumbar-pelvic-hip complex. This lumbar-pelvic-hip complex provides a two-way dynamic link for load transmission between the axial and the lower appendicular skeleton through the bones and joints of the pelvic girdle. Pelvic girdle pain is associated with pregnancy, trauma, arthritis and spondyloarthropathies. The joints of the pelvic girdle have been identified as the source of low back and buttock pain for approximately 15-30% of the population.3 Appropriate load transfer through the pelvic girdle is dependent up on active compression of the pelvic articulations through the muscles and fascia of the lumbopelvic region.2 Chronic pelvic girdle pain has been shown to alter motor strategy reflected in delayed activation of key stabilizing muscles likely contributing to poor stabilisation of the pelvic girdle during functional load transfer leading to failure of the load transfer mechanism and reinforce pain cycles.[1]
Objectives: This paper will explore the hypothesis that loss of early local muscle activation leads to compensatory motor patterns in global muscles which overcompensate for poor stabilisation of the pelvic girdle. Such motor patterns cause excessive stiffness of the lumbar-pelvic complex leading to reduced coordination variability.
Methods: A total of 120 participants took part in this project 80 healthy controls and 40 with low back (n = 20) and pelvic girdle pain (n = 20). Participants performed two functional load transfer tasks to an auditory signal (the modified Trendlenburg and the ASLR). EMG activity of the internal oblique/transvers abdominis, external oblique, lumbar multifidus, gluteus maximus and biceps femoris was recorded using an 8 channel telemetry system collecting at 1000Hz. Ten Vicon MX T20 cameras were used to collect the kinematics of the trunk, pelvis and lower limbs (model defined using 52 retroreflective markers) at 100Hz. Ground contact forces and moments were measured with a force platform collecting at 1000 Hz with an amplifier gain of 1000. From this data we examined the muscle onset timing and the EMG integrals, angular displacements of the trunk, pelvis and hip, as well as hip-spine and pelvis-spine coordination patterns and postural stability from centre of pressure data.
Findings: The pain group had significant muscle onset delay yet, they displayed higher muscle activity at movement onset in the biceps femoris ($p<0.05$) as well as the external oblique ($p<0.05$). Furthermore, the pain group experienced asymmetrical spinal range of motion with increased motion on the contralateral side ($p<0.001$), reduced flexion velocity on the symptomatic side ($p<0.001$), and lower hip-spine coordination variability ($p<0.001$).
Conclusions: The findings of this study provide support for the hypothesis. Such loss of early muscle activation leads to aberrant activation pathways that are inherently less variable. Putatively such patterns may lead to repetitive/cumulative overload of certain soft tissues involved in the load transfer and thus enhanced nociceptive efficacy and chronic/recurrent pain.

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THE DR TOM ANDERSON MEMORIAL TRUST VISITING LECTURER MITOCHONDRIAL FUNCTION IN HEALTH AND DISEASE

Kevin McCully
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This presentation will present current methodologies for assessing muscle mitochondrial function and how these measurements can be used in both sport and patient populations. Non-invasive assessments of mitochondrial function use either 31P magnetic resonance spectroscopy or near infrared spectroscopy, and are based on the rate of recovery of oxidative metabolism after a short bout of exercise.
These methods can quantify endurance trained athletes as well as endurance training programmes. Because mitochondrial dysfunction is associated with chronic illnesses and injuries, these methods have also been applied to patients to quantify the magnitude of mitochondrial impairment and the impact of medication use on muscle function.
The goal of the symposium is to discuss the utility of making assessments of muscle mitochondrial capacity; so that the audience can better understand how they might use these measurements in their training, research, or practice.

PERFORMANCE EFFECTS OF A RUGBY SIMULATED UPPER BODY ACTIVITY ON SUBSEQUENT LOWER BODY ACTIVITY

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Introduction: Examining collision sports, such as rugby, can be difficult due to the unique contact situations combined with running. Activity in match play consists of running at various intensities as well as contact situations and static exertions such as tackling and wrestling for possession of the ball. The static exertions require involvement from the legs and trunk for stabilisation, while the upper body muscles are needed for pushing and pulling opposition. Match analysis methods, including the use of GPS, has provided a better understanding of game demands in terms of locomotion, but fails to quantify the static activity in player to player contact situations. The volume and frequency players engage in static exertions would indicate the success of a team is highly dependent on performance and ability in this area. While it is understood the static exertions are demanding, a better understanding of the demands and performance impact is required for a complete representation of player demands. The aim of the present research is to examine the performance impact of an upper body activity that simulates the upper body movements in rugby on subsequent lower body activity.
Methods: Male rugby and hockey players are presently participating in a balanced crossover study to examine the relationship between an upper body rugby simulated activity, referred to as grappling, and anaerobic cycling performance. Participants completed 4 different protocols which were performed in randomised order with a minimum of 24 hours and maximum of 3 days recovery between protocols. The study included two single protocols and two combined protocols. The two single protocols consisted of grappling and a cycling task. The two combined protocols varied in order of exercise, with one protocol being grappling immediately followed by cycling, and the other being cycling followed by grappling. We are currently collecting data and hypothesise that the rugby trained participants will have a greater performance in the grapple activity as well as the cycling task preceded by grappling.

INFLUENCE OF COLD WATER IMMERSION ON CARDIAC AUTONOMIC MEASURES DURING A SIMULATED RUGBY SEVENS TOURNAMENT

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Introduction: Cardiac parasympathetic reactivation (PR) following exercise mirrors a restoration of cardiovascular homeostasis and possibly readiness to perform. It has been postulated that a facilitated post-exercise PR may improve the peak sympathetic response during subsequent exercise. This has particular relevance within Rugby Sevens (R7s) where players compete at maximal intensities repeatedly within a two-day tournament with a short recovery period between matches. Cold water immersion (CWI) has been consistently demonstrated to facilitate PR following high-intensity exercise. This study aimed to determine whether a facilitation of PR via CWI following each simulated R7s match would influence sympathetic drive and repeated sprint (RS) performance.
Methods: Ten, trained, team sport athletes (24.7±2.9 yr; 180.6±3.8 cm; 88.2±9.4 kg) completed six R7s match simulations over two days (three each day separated by two hours) with a post-match intervention of either CWI (5min, water 14°C) or passive recovery (PAS; air 20°C) in a randomised, cross-over design. PR was inferred from heart rate variability (lnrMSSD; natural logarithm of square root of mean of sum of squares of differences between adjacent R-R intervals) measured prior to each match (lnrMSSDpre-match) and following the recovery intervention (lnrMSSDpost-intervention). Sympathetic drive was inferred from the mean (HRRSmean) and peak (HRRSpeak) heart rate response during the RS performance task and post-match blood lactate (BLApost-match). RStime was calculated as time taken (s) to complete 6 x 30 m sprints on a 20-s cycle within the first half of match simulations.
Results: There were no significant effects of time or condition on lnrMSSDpre-match, while CWI elicited 13±1.7% ($P < .01$) greater lnrMSSDpost-intervention. There was a significant impairment in HRRSmean from match one on the first day (M1D1) to match one on the second day (M1D2) (-3.6±0.5%, $P < .01$), M1D1 to M3D2 (-3.2±0.6%, $P < .01$) and a trend towards the same from M1D1 to M2D2 (-2.8±0.7%, $P = .06$). HRRSpeak was similarly impaired from M1D1 to M1D2 (-2.9±0.4%, $P < .01$) and trended towards the same from M1D1 to M3D2 (-2.3±0.6%, $P = .07$). The average impairment in HRRSpeak was lower with CWI than PAS (-0.6±0.6 vs. -2.5±0.7, $P < .05$) and a trend towards the same was seen in HRRSmean (-1.4±0.5 vs. -3.5±1.0, $P = .09$). There was no condition effect on BLApost-match but a progressive reduction was observed with a -2.2±0.5% ($P < .05$) decrease from M1D1 to M3D2. There were no significant effects of time or condition on RStime.
Conclusion: Cold water immersion facilitated cardiac parasympathetic reactivation acutely following a simulated R7s match. However, recovery of vagal activity occurred within two hours irrespective of recovery condition. Sympathetic drive, as indicated by heart rate, declined across a simulated R7s tournament, this was partially attenuated by CWI. However, there was no effect on repeated sprint performance. Whilst acknowledging the limitations of simulated versus actual R7s comparisons; these data indicate that CWI may be beneficial in increasing the parasympathetic recovery phase and reducing the decline in subsequent sympathetic reactivation.

THE LONG-TERM CONSEQUENCES OF RUGBY PARTICIPATION ON THE NECK

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Introduction: The study of retired professional athletes offers a unique opportunity to evaluate the long-term impact of sport participation. Currently there has been no examination of the impact neck injuries sustained during collision sports have on players once they retire. The purpose of this study was to examine the long-term effects that rugby participation has on the cervical spine and subsequent health impacts.
Methods: Members of the Players' Associations in New Zealand, Australia, Ireland, Canada and England were surveyed using an online questionnaire. The survey included questions on: personal descriptors, playing history, all injuries sustained during their careers, current levels of all pain and stiffness, current physical activity levels and current neck pain (NP) and neck stiffness (NS). The survey was completed by 255 retired players; however, only those that retired in 1995 or later were included in the analysis (n=195). The response rate ranged from 10.8 – 43.0%.
Results: The neck was the 4th most frequently injured body region with most neck injuries attributed to 'playing games' (n=64). For injuries that resulted in surgical interventions the neck ranked 9th in frequency. Overall 78.7% of participants reported that they had sustained a neck injury during their careers. Examination of current symptoms of pain and stiffness revealed that the neck was the top ranked area of current pain, with the majority of respondents attributing this pain to 'playing and training for rugby' (34.6%), followed by 'aging' (25.8%). For stiffness the low back was the most frequently cited region of stiffness followed by the neck. Of the 174 that responded to the question on current NP and/or NS, 79.9% (n=139) indicated that they were experiencing one or both of these symptoms. For those that were currently experiencing NP, 90.65% indicated that they had previously sustained a neck injury. Of these 88.6% (n=124) related this NP and/or NS to 'training for or playing rugby'. The most common response for the intensity and frequency of NP and/or NS symptoms was 'occasionally mild' (33.1%) or 'occasionally moderate' (25.2%). A more concerning factor was that 27.4% of repondents were continually experiencing some form of NP and/or NS of varying severity. For the Neck Disability Index (NDI) forwards did not differ significantly from backs in their total score (p=0.38). Examination of the total NDI scores revealed that 3.0% (n=5) reported severe disability related to their NP, 16.8% (n=28) moderate disability, 28.1% (n=47) mild disability, and 51.1% (n= 86) reported no disability. When each of the components in the questionnaire were examined for the two positional groups, the highest level of disability was recorded for 'pain intensity' for the forwards and 'recreation' for the backs.
Conclusion: These findings highlight the frequency of neck injuries and the potential for development of long-term NP and NS once players have retired. These findings provide sufficient evidence to indicate that neck injuries sustained during the careers of rugby players will have long-term consequences that for some may impact on their quality of life and, thus, warrant further investigation.

PREDICTORS OF VITAMIN D STATUS IN NEW ZEALAND ELITE ATHLETES

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Background/Aim: Vitamin D deficiency is prevalent amongst athletes and can impact negatively upon their health and performance. Athletes' knowledge and attitudes towards vitamin D has not previously been researched nor whether this correlates with 25(OH) D status. Sun safety messages often dominate over vitamin D education in New Zealand and the impact of this upon athletes' sun behaviour and consequent vitamin D status is unknown. Despite high rates of deficiency in elite athletes, few studies have documented the prevalence of vitamin D supplement use in this population. This study investigated: knowledge of and attitudes towards vitamin D and sun exposure, prevalence of vitamin D-containing supplement use, and predictors of vitamin D status in elite athletes.
Methods: 110 elite, outdoor-sport athletes completed a vitamin D and sun exposure questionnaire during summer months at three New Zealand training bases located at approximately 37° latitude. Summer and winter finger prick serum 25(OH)D samples were collected. Regression analyses determined predictors of vitamin D status from the questionnaire.
Results: Ninety-three percent of athletes had sufficient (≥32ng/mL) 25(OH)D in summer and 69% were sufficient in winter. Only one athlete was found to be deficient (<20ng/mL) in winter. Two-thirds of athletes were able to name the sun as a source of vitamin D, although there was no relationship between athletes' overall vitamin D knowledge and 25(OH)D status. Athletes were more concerned about the risk of skin cancer (33%) than their vitamin D status (5%), yet 12% reported intentionally spending time in the sun to improve their vitamin D. Those athletes most concerned about their 25(OH)D status tended to have better knowledge of vitamin D, however this did not impact upon 25(OH)D sufficiency. Vitamin D, calcium and cod liver oil supplements were taken by 6-7% of athletes, 28% used fish oils and one-third used multivitamins. Dark-skinned athletes, those who used fish oils and those with higher skinfolds were less likely to have sufficient vitamin D status. There were no significant associations ($p<0.05$) between knowledge and attitudes towards vitamin D, and behaviours that might affect 25(OH)D, such as spending time in the sun to tan and dietary vitamin D intake. Concern for skin cancer with sun exposure was not associated with athletes' 25(OH)D.
Conclusions: As serum 25(OH)D is expensive to test, athletes should first be screened for risk factors. Dark-skinned athletes, those with higher skinfolds and who use fish oils are more at risk of vitamin D insufficiency. Therefore if fish oils are used by elite athletes they should be vitamin D fortified. Knowledge of and attitudes towards vitamin D does not impact upon athletes' 25(OH)D sufficiency therefore education interventions to this group may not be effective in reducing risk of deficiency. Sun safety and vitamin D messages need to be promoted concurrently to ensure athletes are not further increasing their risk of skin cancer in attempt to improve vitamin D status and sun safety campaigns are unlikely to increase elite athletes' risk of vitamin D deficiency.

PHYSIOTHERAPY KEYNOTE ADDRESS
PHYSIOTHERAPY APPROACH IN HAMSTRING INJURIES

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Before we can start a well-structured rehab programme it is important to have a good understanding of the function of the hamstrings, the anatomy and the injury mechanism. The hamstrings is mainly functioning in a lengthened position at high speeds in an eccentric way during the events when injuries most commonly happen (sprinting). This consequence of this is that we need to mimic this as much as possible during the rehabilitation.
Almost all of the hamstring injuries are located at the muscle tendon junction (MTJ) while the greatest stretch is placed in that area. It has been shown that the amount of elasticity is decreased near the MTJ in patients with previous hamstring injuries. Therefore, one of the aims of a physiotherapy approach should be to restore the normal elasticity of this area of injury. Research has shown that a dynamic stretching program or possibly an eccentric training program is able to influence this elasticity. So, an important amount of time during the rehab programme should be focused on this aim.
However, a hamstring injury is happening while the muscle is at its most lengthened position, but this doesn't mean it is happening while the muscle is overstretched. Research shows that a muscle injury happens when the (external) force on the muscle is higher than the amount of energy that can be absorbed by the muscle. In other words, the amount of energy that can be absorbed by the muscle is very important and is determined by the eccentric muscle force. Consequently, increasing the eccentric muscle force seems to be an important goal in rehab, especially since it has been shown that this is significantly decreased after injury. However the reason for a decreased eccentric muscle strength can differ from patient to patient and needs to be investigated before this can be solved. A proper assessment should be able to identify the cause of this muscle weakness.
Is the cause of a decreased muscle strength a decrease in quantitative muscle output, a qualitative decreased muscle output, a decreased intramuscular coordination, or a decreased intermuscular coordination?
Based upon an assessment of these different aspects, a tailor made treatment plan can be designed with emphasis on strengthening the hamstrings muscles by training the intra-or intermuscular coordination, by increasing the quality of the muscle activation or by increasing the quantity. Different exercises need to be used to reach these different goals. This training programme also needs to be addressed at the correct hamstring muscle. Is it always the injured muscle, or could it be that the real cause of the injury is situated in another hamstring muscle, and maybe the injured muscle is only the victim, but not the cause?

PRP FOR ACUTE HAMSTRING INJURIES

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Despite numerous prevention programmes, the hamstring is still the most frequently reported muscle injury in sports. It has been estimated that in a professional football squad of 25 players, five of them will sustain a hamstring injury with an average time to return to play of approximately 4 weeks.
There is increasing interest in the sports medicine and athletic community about providing endogenous growth factors directly to the injury site to potentially facilitate healing and earlier return to sport after musculoskeletal injury.
Probably the most popular and innovative therapy is the injection of platelet rich plasma (PRP). PRP is derived from centrifuging whole blood with separation of the platelets. The platelet concentration in PRP is dependent on the separation technique 2 till 6 times higher than that of the whole blood. PRP is the cellular component of plasma that settles after centrifugation, and contains numerous growth factors. The growth factors release from the α-granules of platelets is assumed to provide the regenerative benefits of PRP.
Anecdotal and low-level evidence suggests that PRP got the potentiality to facilitate healing and 50% earlier return to sport after muscles injuries. Although it is questionable if the time to return to sports can be halved, even a quarter decrease will have an enormous effect for the professional players and huge financial effects for the clubs. It might implies for an individual player to return to play two or three games earlier, might potentially be the difference between winning and losing the game and might lead to be second or live long recognised champion.
Two recently published RCTs – one double blinded and one non-blinded - show conflicting results. The third RCT was conducted in Aspetar (Qatar) and has not been published yet, but will be presented at the 2014 NZ Sports Medicine and Science Conference.

RETURN TO PLAY DECISIONS

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Hamstring strain injuries are amongst the most common and problematic injuries in a wide range of sports that involve high speed running. The comparatively high rate of hamstring injury recurrence is arguably the most concerning aspect of these injuries. A number of modifiable and nonmodifiable risk factors are proposed to predispose athletes to hamstring strains. Potentially, the persistence of risk factors and the development of maladaptations following injury may explain injury recurrence.
In this lecture we will explore the role of neuromuscular inhibition following injury as a potential mechanism for several maladaptations associated with hamstring re-injury. These maladaptations include eccentric hamstring weakness, selective hamstring atrophy and shifts in the knee flexor torque-joint angle relationship. Current evidence indicates that athletes return to competition after hamstring injury having developed maladaptations that predispose them to further injury. In addition, studies employing MRI to guide return to play and risk for recurrence will be examined as well as the potential use of ultrasound to guide treatment and safe return to play.

EFFICACY OF PREVENTATIVE NEUROMUSCULAR TRAINING ON ANTERIOR CRUCIATE LIGAMENT INJURY RATES IN FEMALE ATHLETES: A SYSTEMATIC REVIEW

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Background: Female athletes have been shown to have a three- to eight-times higher incidence of anterior cruciate ligament (ACL) injury as compared with male athletes, with approximately 80% of female ACL injuries occurring in non-contact situations.1,2 Several prospective studies have employed a variety of training interventions with female athletes in an attempt to decrease ACL injury rates. These studies employed what is commonly described in the literature as 'preventative neuromuscular training', which include one or more elements of: movement training; strength training; plyometrics; stretching; balance and/or proprioceptive training. A subgroup of

studies employed a 'neuromuscular warm-up' (NM warm-up) where the neuromuscular training intervention replaced the traditional sport warm-up. The objective of this research was to perform a critical systematic review of studies that investigated the effect of neuromuscular training interventions aimed at preventing ACL injuries in female athletes. The purpose was to evaluate the quality of the evidence and then to draw conclusions, based on the strength of the evidence, as to the effectiveness of such programmes.

Methods: A search to identify relevant research articles was undertaken in a number of electronic databases. Studies were included if they were: 1) prospective controlled trials; 2) a neuromuscular training intervention was conducted; 3) female athletes were participants; and 4) the number of ACL injuries were recorded. Two reviewers independently extracted relevant data, including ACL injury incidence, and assessed the methodological quality of each included study using the modified Downs and Black checklist. Quality Index scores were calculated to categorise methodological score. Overall levels of evidence were then synthesised.

Results: Thirteen studies were identified that met the inclusion criteria and exclusion criteria. The mean modified Downs and Black score of all reviewed studies was 18.5/28 (range 13 to 26). The mean modified Downs and Black score for studies that employed a NM warm-up intervention was 21.4/28. Quality Index score calculation showed that four studies had strong methodological quality; eight had moderate methodological quality; and one had limited methodological quality. Across all studies, control group athletes sustained 170 ACL injuries, as compared to 83 ACL injuries sustained by intervention group athletes. For control group athletes, mean injury incidence was 0.15 (range 0.03 to 0.24) ACL injuries and 0.11 (range 0.03 to 0.23) non-contact ACL injuries per 1000 sporting hours. For intervention group athletes, mean injury incidence was 0.08 (range 0.00 to 0.19) ACL injuries and 0.04 (range 0.00 to 0.09) non-contact ACL injuries per 1000 sporting hours. This indicates that, as compared to females who participated in a neuromuscular training intervention, control group athletes were almost twice as likely to sustain an ACL injury and almost three times as likely to sustain a non-contact ACL injury.

Conclusions: Studies varied widely by sport studied, intervention-type, participant characteristics and study design characteristics. Studies that employed an NM warm-up were of higher methodological quality and were relatively more effective than other types of interventions. Overall, there is a 'moderate' level of evidence for the efficacy of neuromuscular interventions in preventing ACL injuries in female athletes.

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THE EFFICACY OF INJURY PREVENTION PROGRAMMES IN REDUCING INJURIES IN SPORT

Jessica Meyer, Duncan Reid

Sport and recreation injuries constitute a major public health burden in many developed countries. Treating sports injuries is often difficult, expensive and time consuming, therefore preventive strategies and programmes are justified on medical as well as economic grounds. When developing an injury prevention programme, risk factors are identified through injury surveillance. Risk factors associated with sports injuries can be extrinsic or intrinsic. As intrinsic risk factors such as physical fitness, joint mobility, muscle flexibility and strength, motor abilities and sport-specific skills are modifiable they are often incorporated in injury prevention programmes. In 2001 a systematic review was conducted investigating the effectiveness of injury prevention measures and programmes in sport which indicated positive results for the prevention of sports injuries. Since this review, a number of new studies regarding injury prevention have been conducted, with varied results. Overall, there is conflicting evidence for the effectiveness of injury prevention strategies to reduce sporting injuries.

The purpose of this project is to systematically review the literature to evaluate the efficacy and identify the level of evidence of injury prevention programmes in reducing injuries in sport.

Electronic databases were searched in September 2013 to identify relevant studies. The inclusion criteria for studies were; randomised controlled trials and clinical controlled trials investigating the efficacy of injury prevention programme of reducing injuries in sport. Articles not written in the English language, those not available in full text or those published before 2000 were excluded. Data was extracted and methodological quality of studies was assessed by one independent reviewer using the Down's and Black Appraisal Tool.

The primary electronic database search produced 395 articles. Cross-referencing identified an additional two articles. 24 articles were assessed for eligibility, however 11 were excluded as they did not meet the inclusion criteria, leaving 13 studies to be included in the review. The overall methodological quality of the studies was moderate. Eleven of the 13 studies found positive results of their injury prevention programme.

Based on the results of this review there is level one evidence for the effectiveness of injury prevention programmes in reducing injuries in sport. Programmes involving running, active stretching, strengthening exercises, balance exercises, plyometrics and sport-specific drills appear to be effective in reducing ACL injuries and overall injuries in soccer players. Programmes including eccentric strength training for the hamstrings also appear to be effective at reducing the risk of hamstring muscle strains. Further research in this area is required to establish the effectiveness of different programme parameters such as programme duration and frequency for practical application.

ASSESSMENT STRATEGIES FOR INDIVIDUALISED INJURY PREVENTION IN SPORT

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Rationale: Injury prevention programmes are effective at decreasing injuries in sport by modifying variables such as knee flexion and knee valgus angles during landing tasks.[1] The majority of injury prevention programmes include components of running, active stretching, strength (concentric & eccentric), balance, plyometric and sport-specific drills; however the key components to make a successful programme are unknown. Failure to understand the key variables is attributed to 1) a reductionist view supporting a linear and unidirectional cause-effect model with single-component assessments to predict injury; and 2) a generalised "catch-all" approach to injury prevention throughout the sport season.

Discussion: While single-component assessment strategies (i.e. isokinetic peak torque values during knee extension/flexion) may financially match the needs of a sporting team, they isolate individual joints and/or movements and can potentially miss "the big picture" (Figure 1). Multi-component assessment strategies, on the other hand, (i.e. isokinetic peak torque and angles of peak torque values of the knee and hip during extension/flexion and/or non-motorised treadmill sprint kinetics) increase equipment, time and cost but allow for a holistic view of the strengths and weaknesses of the athlete.[2] Information gained from the assessments can then be used to further guide programming recommendations.

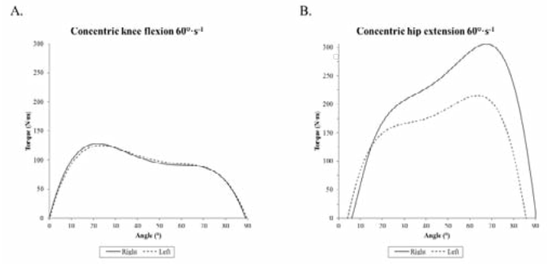

Figure 1. An example of a typical graph examining side-to-side asymmetries during concentric isokinetic A.) knee flexion with no apparent difference in peak torque (2%); and B.) hip extension with an obvious difference in peak torque (42%).

Generalised programming, designed for large team sports such as American football, may appear to be the best option, requiring minimal personnel and sectioning athletes into similar sub-groups while training. Generalised programming may overlook individual deficiencies, however, when compared to the progress of the majority. Individualised programming is custom-made to target an athlete's weakness; aimed at decreasing injury risk that may result from a deficiency and improving performance to the level of the position/team. Similar to the multi-component assessment strategy, individualised programming requires additional personnel, time and knowledge.

Injury prevention cannot be individualised without first identifying clinical and functional deficits for each athlete. Thus multiple and independent assessments are required that involve reliable, objective and quantitative results during various movements. Assessment data (profiling) will then begin to illustrate guidelines during the interpretation process.[3] Several researchers[2,4,5] have shown positive results from individual programming in sports such as Australian football league, football and rugby league. Knowledge in this area however, is limited; requiring further research into multi-component assessments and individualised programming on a large scale. Communication and collaboration between sports scientist, medical staff and strength and conditioners are required to ensure the most effective steps are taken in the injury prevention process (Figure 2).

Figure 2. An example of a collaboration to create an individualised training programme for an athlete.

Conclusions: Our jobs as sport scientists, physiotherapists or medical staff are not easy as we must continue to collect as much information as possible whilst considering important factors like time and cost. We must keep in mind that an athlete's career (short- and long-term) is often in our hands and should be our most important concern, regardless of the process. We therefore propose that all injury prevention "screening" include multi-component assessments to enhance our understanding of the athlete. This information should then be used to guide individualised injury prevention programming.

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ADRENAL INSUFFICIENCY IN FEMALE ATHLETES: THE PLACE OF DEHYDROEPIANDROSTERONE (DHEA) SUPPLEMENTATION

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Introduction: The relatively recent upsurge in DHEA supplementation to treat adrenal insufficiency in female athletes raises issues of clinical utility as well as compliance with the International Standard for Therapeutic Use Exemption in sport.

Purpose: This paper will discuss mechanisms for primary and secondary adrenal failure and highlight current literature relating to DHEA supplementation. It will raise the obligations of an attending physician to ensure that the diagnosis, particularly in an elite female athlete is clearly established. In addition this discussion will highlight the potential in female athletes for performance enhancement linked to DHEA as an androgenic precursor.

Methods: A review of literature relating to DHEA supplementation in females with documented adrenal insufficiency was undertaken.

Discussion: In partial or secondary adrenal failure, DHEA secretion and blood concentrations may be reduced but not abolished. However, reductions in serum DHEA(S) are often difficult to interpret given that prolonged exogenous glucocorticoid treatment will suppresses DHEA secretion and blood DHEA(S) concentrations. This is a common scenario in sport where the use of glucocorticoids is frequently employed to manage musculoskeletal trauma and even topical glucocorticoids may be absorbed sufficiently to suppresses serum DHEA(S). Clinical studies confirm that DHEA administration to women, increases blood testosterone1,[2] but not in men, reflecting a much higher (>20-fold) endogenous blood testosterone concentration between sexes. Therefore in the context of anti-doping, DHEA administration is of primary concern in women athletes where the potential for ergogenesis clearly exists.[3,4]

Conclusions: The role of DHEA replacement for women with primary or secondary adrenal failure remains controversial and is not well substantiated. In women with complete adrenal failure, daily supplemental DHEA treatment achieves restoration of blood DHEA concentrations to levels comparable with age-matched controls with normal adrenal function.[2] However instances of androgenic side effects3,4 are reported. Over-the-counter DHEA products, categorised as foods or "nutritional supplements" rather than "true" pharmaceutical products, frequently differ in their

bioavailability. Consequently, the uncontrolled use of unregulated products is concerning given the potential for ergogenesis from indeterminate DHEA supplementation. While a rationale exists for DHEA replacement therapy in primary adrenal failure, there is no physiological justification in partial or secondary adrenal failure.[5,6,7]

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SECONDARY SCHOOL NETBALLERS; ARE THEY MOVING TO THE RIGHT BEAT?

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Introduction: Netball is currently the most popular female sport in New Zealand. Unfortunately lower extremity injuries are common, especially during landing. Anecdotal reports suggest youth players often exhibit poor fundamental movement patterns and landing technique which may contribute to these injuries. Greater understanding of movement/landing competency in this group will aid development of injury prevention protocols.

Purpose: To undertake an observational study of secondary school netballers to quantify (i) landing technique and movement competency during a functional movement screen; (ii) the prevalence of overuse knee and ankle problems; (iii) differences in movement and landing competency between players with and without a history of overuse knee or ankle problems.

Methods: Video of 196 players was collected performing a modified movement competency screen (MCS). Tasks included the bodyweight squat, countermovement jump (CMJ), broad jump (BJ) with single leg land, single leg squat (SLS), lunge and twist and push up. Scores were recorded (bilaterally where appropriate) for each task based on previously reported criteria and a total given out of 32. The countermovement jump was performed on a force plate to allow calculation of maximum jump height and all players were measured for weight bearing dorsiflexion range of motion (ROM). Additionally all players performed a drop jump (DJ). Maximum frontal plane knee angle was also measured during the DJ, CMJ, BJ and SLS. Players completed an overuse injury questionnaire designed to give an indication of overuse problems experienced over the previous 12 months. Based on the questionnaire each player was given a total knee and a total ankle injury score. Descriptive statistics were used to report the range of movement competency scores, knee angles on landing and dorsiflexion ROM. Additionally independent t-tests were used to compare total MCS scores between players from higher and lower grades of the competition and to compare players who reported overuse problems to those who didn't.

Results: The total MCS score was (mean ±SD; 20 ±3). Less than 15% of players were rated as having good movement competency in the CMJ, BJ and SLS and only 50% were rated as having good movement competency in the lunge and twist. Total MCS score was better in the A grade players than those in the C grade (mean difference 2.3; effect size moderate, p=0.01). Players from A grade teams also recorded greater jump height (mean difference 3cm; effect size moderate; p=0.001).

The percentage of players who had frontal plane knee angles on landing greater than 15 degrees were; single leg squat (R=70%, L=50%), broad jump (R=51%, L=28%), drop jump (R=21%, L=21%), countermovement jump (R=6%, L=3%).

The prevalence of all knee problems was 31% and the prevalence of substantial knee problems was 10%. The prevalence of all ankle problems was 51% and the prevalence of substantial ankle problems was 24%. There were no significant differences in total MCS score, frontal plane knee angle or dorsiflexion ROM between players with a history of knee or ankle problems and those without.

Conclusions: Overuse knee and ankle problems remain an issue in secondary school netballers and strategies to improve fundamental movement and landing competency should remain a focus. Lower extremity injury risk is likely multifactorial and further prospective studies are needed.

HEALTH AS A PREDICTOR FOR MATCH INJURIES IN AMATEUR RUGBY UNION: A PROSPECTIVE COHORT STUDY

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Background: Rugby union (RU) is a popular collision sport worldwide. Injuries are a consequence of sport participation and the greatest burden of sports injury occurs at the community level. There are few studies which objectively assess pre-season health status as a predictor of in-season sports injury; in turn the role that health plays in the aetiology of sports injury is unclear. The objectives of the current study are to: (1) describe the health and physical characteristics of a cohort of amateur RU players; (2) describe the incidence, severity and nature of match injuries in amateur RU, and; (3) investigate whether health status pre-season predicts in-season RU match injury.

Methods: In 2012 data were collected from a cohort of 125 participants from one Australian amateur men's RU club as part of a one-season prospective cohort design study. The Injury Report Form for Rugby Union as outlined in the RU data collection consensus document was used by trained primary data collectors aligned with the club's chiropractor. Only match injury data were collected and an individual participant match exposure log was maintained. Baseline variables collected include: participant's age, playing experience, position of play, the SF-36v2 health survey, height and weight.

Injury incidence rates (IIRs) per 1000 match-hours exposure were calculated using standard methods. Injury sub-groups were compared by calculating rate ratios (RR) of two IIRs and ninety-five percent confidence intervals (95%CIs). Poisson mixed-effects generalised linear modelling was used to examine the multivariate relationships between IIRs and baseline variables (potential risk factors) using the statistical software R version 3.0.2.

Results: A total of 129 injuries were incurred during a combined period of 2465 match-hours of exposure. The overall IIR was 52.3 (43.7-62.2) /1000 match-hours exposure. Moderate-severe injuries (>1 week time-loss from play) comprised 36% of all injuries. Tackling was the most frequent mechanism of injury, the head/face was the most frequent body region of injury and sprain/ligament injuries were the most frequent injury type with IIRs 17.8 (13.0-24.0), 9.3 (5.9-14) and 10.1 (6.6-15.0) /1000 match-hours exposure respectively. Participant characteristics as measured at baseline were: age 24.3±4.9 years, playing experience 11.1±5.7 years, SF-36v2 physical component score 51.9±7, SF-36v2 mental component score 52.5±8.1 and BMI 26.7±3.5. Multivariate modelling found older age (RR: 1.04 [1.01-1.07], P=0.017), fewer years of rugby participation (RR: 0.91 [0.85-0.97], P= 0.003), lower BMI (RR: 0.96 [0.94-0.98], P=0.001) and lower SF-36v2 physical component summary score (RR: 0.98 [0.97-0.99], P=0.003) was associated with higher IIR in amateur RU. Whereas player position i.e. backs versus forwards (RR: 0.66 [0.22-1.94], P=0.443) and SF-36v2 mental component summary score (RR: 0.99 [0.97-1.00], P=0.071) were not associated with injury.

Conclusion: This is the first study that has included a validated health outcome measure to predict in-season injury in RU. The modifiable risk factors associated with injury were low physical health (as measured by SF-35v2) and lower BMI. Our findings draw attention to physical conditioning and functional training as modifiable aspects of health which can potentially be targeted through the development of preventative strategies.

THE TEMPORAL EFFECT OF PRIOR AND ACUTE TRAINING LOAD ON IN-SEASON INJURY RISK IN RUGBY UNION

Stephen Kara

Objective: Research in collision sport supports weekly training-related load as an independent risk factor for injury. We analysed injury risk based on acute team training load and prior cumulative team training- and match-related loading.

Methods: Effects of cumulative team match and training load on count and total duration of training- and match-related injuries in an observational study from 73 Super Rugby players over five rugby seasons were estimated via a novel application of over-dispersed Poisson regression. The cumulative team load was an exponentially weighted moving average, allowing for gradual decay of the effect of each match and training session. The time constant of the decay was varied over 2–20 days to establish the period during which prior cumulative load had most effect on injury.

Results: Cumulative team load with a 10-day averaging period had the greatest effects on measures of injury. Following periods of typically high vs typically low cumulative team load, a reduction in number of training-related non-contact soft-tissue injuries by a factor of 0.4 (90% confidence limits 0.2 – 0.7; possibly large) and in total duration by a factor of 0.3 (0.1 – 0.8; likely large) was seen, whilst match-related contact injury counts increased by a factor of 1.6 (1.1 – 2.4; possibly moderate). All training-related injuries increased with higher acute team training load by a factor of 2.9 (2.0–4.4; most likely very large).

Conclusions: This study supports the protective effects of higher cumulative team training load on training-related injury risk over a 10-day prior period, whilst adding evidence of increased risk with higher acute team load.

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CO-ORDINATIVE COUPLINGS BETWEEN ROWERS IN OLYMPIC SCULLING

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Applied sport science at the highest level requires cooperation between two sets of experts, sport scientists and performance practitioners. This has been something of a challenge for specialists in skill;5 not least due to competing discourses around performance.4 In seeking to understand "What makes a boat go faster" the current project endeavoured to use a multi-methods approach1 and methodical triangulation2 to incorporate the knowledge of scientists and expert practitioners in formulating a research programme. Results from a qualitative study of coach and athlete knowledge about Olympic sculling were used along with theoretical understanding and methodological rigour, to frame a series of questions to be addressed quantitatively. These questions interrogated how rowers row together in paired boats, the ability of coaches and athletes to detect successful performance and how to propel the boat for maximum effect. Key findings suggested that expert rowers are
more effective than coaches at detecting good performances and that interpersonal coordination between rowers is achieved by "rowing with the boat" as well as rowing with each other. Finally results indicated that rowers
use optic flow3 to detect small changes in boat deceleration in order to time impulse forces with the pitching and slowing of the boat between strokes. In conclusion, the approach adopted (though onerous) revealed useful applicable knowledge along with a limited contribution to the broader body of theoretical knowledge. Implications for future research are discussed.

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THE RELATIONSHIP BETWEEN INSULIN-STIMULATED MICROVASCULAR BLOOD FLOW AND GLUCOSE DISPOSAL IN TYPE 2 DIABETICS

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Background: Poor postprandial glucose disposal in type-2 diabetic (T2DM) muscle may be attributable, at least in part, to impaired insulin-stimulated microvasculature blood flow1. Until recently, technological limitations have prevented the in vivo investigation of skeletal muscle microvascular blood flow in human models. Recent advances in near infrared spectroscopy (NIRS), coupled with the principles applied to venous occlusion plethysmography, have facilitated the measurement of blood flow kinetics in skeletal muscle tissue across a range of testing paradigms.
Purpose: To determine the relationship between insulin-stimulated microvascular blood flow (vastus lateralis) and glucose disposal capacity in T2DM.
Methods: Middle-aged, male type-2 diabetics were recruited. Average glucose infusion rate was determined during the last 30 minutes of a hyperinsulinemic euglycemic clamp. Microvascular blood flow at the vastus lateralis was measured using NIRS (i) before insulin infusion, and (ii) 30 minutes prior to the termination of the clamp. Microvascular blood flow was calculated as the rate of increase in venous occlusion-induced total haemoglobin concentration.
Results: 11 non-insulin dependent males withT2DM (54.8±6.2y, BMI 27.7±3.6) were assessed. There was a strong association between the change in insulin-mediated blood flow rate and glucose infusion rate ($r = .73$, $P < 0.001$).
Conclusion: To the authors knowledge this is the first study to non-invasively demonstrate an in vivo relationship between insulin-stimulated microvascular blood flow in T2DM muscle and glucose disposal capacity. Further investigation with a larger cohort is needed to confirm these findings.

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OUTLIER DETECTION AND RELIABILITY OF HEART RATE MEASURES IN SEDENTARY MIDDLE-AGED PARTICIPANTS

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Background: While recommendations exist regarding the appropriate usage, filtering and analysis of heart rate variability (HRV) data, there are no recommendations regarding the selection of appropriate data segments or outlier detection.
Aim: Determine whether subjectively selected ('most stable'), predefined ('last 5 minutes'), or 'controlled breathing' 5-minute data segments produce the highest HRV reliability in a sedentary population.
Method: Eight males (age: 56.3 ± 4.6; BMI: 26.4 ± 4; on medication: n=6) and 11 females (age: 55.5 ± 6.7; BMI: 26.8 ± 5.6; on medication: n=6; mean ± standard deviation) attended 2 measurements 1 - 2 weeks apart. Supine resting HRV (Polar RS800CX) was assessed during spontaneous breathing (10 minutes) and controlled breathing (6 minutes). Visual inspection, the Median Absolute Deviation, and 2X Standard Deviation were considered for outlier detection.
Results: The 'last 5 minutes' demonstrated the best relative reliability in heart rate (HR: 0.82 (0.58 – 0.92 intraclass correlation coefficient and 95% confidence limits)), root mean square successive difference (rMSSD: 0.82 (0.56 – 0.93)), high frequency (HF: 0.76 (0.43 – 0.91)) and low frequency (LF: 0.42 (-0.08 – 0.75). The standard deviation of NN intervals (SDNN: 0.57 (0.13 – 0.82)) was most relatively reliable in the 'most stable' segment. The 'controlled breathing' and 'most stable' data segments produced best absolute reliability for HR (5.0% (3.8 – 7.5%) coefficient of variation (95% Confidence Limits)) and LF (56.4% (37.8 – 109.3%)); and SDNN (28.4% (20.4 – 46.3%)) and HF (61% (41.7 – 111.9%)) respectively. The 'last 5 minutes' produced the best absolute reliability for rMSSD (24.4% (17.5 – 40.2%)).
Discussion: We found it surprising that the 'last 5 minutes' rather than the 'most stable' or 'controlled breathing' intervals provided the most reliable measurement for measurements reflecting parasympathetic activity (i.e. HR, rMSSD and HF). The results based on the classification categories used in this study indicate that the high frequency measurement in the frequency domain and the rMSSD measurement in the time domain were sufficiently reliable in this population. However, the typical error is still large, and results, (especially SDNN, LF and HF) should be interpreted with caution. Regarding outlier detection, the median absolute deviation method was the most sensitive methods while using the standard method of removing data points greater than 2X SD failed to detect clearly outlying data points.
Conclusion: The rMSSD from the last five minutes of a 10 minute resting period during spontaneous breathing is more reliable than subjectively selecting the 'most stable' 5 minute portion, or using controlled breathing. Research in a larger cohort and with 2 or 3 measurements taken at closer intervals such as successive days is needed to confirm these findings.
Key words; Polar heart rate monitor, median absolute deviation, rMSSD, inactive

EPIGENETICS AND THE ROLE EXERCISE PLAYS

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The concept of epigenetics refers to gene expression states that are established in the absence of a change in the DNA sequence itself. This helps us to understand how our environment in the broad sense, including exercise, nutrition, toxins and even behaviour, contribute to the regulation of gene expression and hence to our resulting health phenotype. Variation in health is determined by our inherited non-changeable genome as well as our modifiable environmental and lifestyle factors. Exercise induced increased gene expression in those genes involved in oxidative phosphorylation, metabolic activity in adipose tissue, and anti-inflammatory pathways illustrate some of the potential mechanisms by which the benefits of exercise are conveyed. It is not known yet how long these changes last but epigenetic analysis provides further evidence emphasising the importance of exercise to achieve and maintain health and also possibly rethinking our attitude to exercise recommendations. The impact of physical activity on our health through epigenetic control mechanisms will be discussed.

'KEEPING THE DISTANCE': GLOBAL AND SEGMENTAL MOTION INFORMATION GUIDING INTERPERSONAL COORDINATION

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Interpersonal coordination in sports can be studied by examining interactions between agents. However, individuals differ in their ability to interact with others, which critically depends on perceiving information for action.[2] The current study addressed sources of information that are pertinent for guiding interpersonal coordination. We contrasted how local (ie, movement of body segments) and global visual motion information (ie, optical expansion) influence coordination.[3] In a 2-dimensional virtual reality setting participants performed a follow-the-leader task.[1] The 'leader' was a back- and forward moving fully animated avatar (both local and global information) or a sphere (only global information). The spatio-temporal synchronisation between the follower and leader was found to be equally accurate in both conditions. The temporal synchronisation however was slightly tighter when both local and global information were present.
In a follow-up study, we included more conditions in which the degree to which local and global information were available was varied: we isolated local information using a point-light display, and we included different shapes of 'leaders' that more closely resemble a human form (a mannequin – without limb movements, and a cylinder). These shapes without segmental motion information were presented with and without the subtle, but potentially pertinent, horizontal and vertical displacements that occur during gait. Preliminary analysis suggests that neither global, nor local information by itself could be equally valuable as the combination of the two. Overall, these findings suggest that the interaction between these types of information is most important. An individual's inter- actability might thus involve being able to tune into the most pertinent source of information at the right time.

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THE ROLE OF APPARENTLY AVERSIVE ENVIRONMENTAL CONSTRAINTS AFFECTING THE DEVELOPMENT OF SKILLS OF BRAZILIAN FOOTBALL PLAYERS

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To date, studies in the field of motor learning have been limited in scope and fail to consider in depth how informal and even aversive socio-cultural learning environment constraints affect skills development.1 However, considering that expertise in sports emerges from the complex interaction of multiple constraints, socio-cultural factors have to be further explored in a contextualised manner so that knowledge in the field of motor learning can be furthered. Alluding to the notion of Contextualised Skill Acquisition Research2 that advocates that not only physical but also socio-cultural environmental constraints play an important role in the development of elite athletes, I used Brazilian football as my research vehicle. Data were generated via historic contextual analysis, participant observation and unstructured interview. Differing from the traditional theories on sports expertise (eg, deliberate practice and deliberate play), our finding shows that highly unstructured activities such as pelada, poverty, samba, capoeira, and malandragem play an important role on the development of football expertise of Brazilian players. The specific purpose of this position statement is to provide a foundation for future empirical papers on this topic and to stimulate other researchers to consider the framework.

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THE RELATIONSHIP BETWEEN THE SPECIAL JUDO FITNESS TEST AND AEROBIC FITNESS IN SAUDI JUDO ATHLETES

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Conflicting evidence exists regarding the influence of the aerobic fitness variables on the judo-related performance.1-4 Therefore, the aim of this study was to assess the relationship between the Special Judo Fitness Test and aerobic fitness in Saudi Judo athletes. 14 judo athletes (mean ± SD, age, 17 ± 4 years; body mass, 66.7 ± 21 kg; height, 160.2 ± 13.6 cm) performed the Special Judo Fitness Test and a maximal multistage 20-m shuttle run test to estimate maximal oxygen consumption (VO2max). The mean (±SD) of the index of the Special Judo Fitness Test and VO2max were 16.2 ± 1.6 and 42.5 ± 8.5 (ml/kg/min), respectively. The index of the Special Judo Fitness Test was in inverse direct relationship with VO2max ($r = -.62$, $p < .05$). It is concluded that the aerobic fitness is associated to the judo-related performance.

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PROTEIN-LEUCINE INGESTION FOLLOWING INTENSE ENDURANCE EXERCISE STIMULATES A REGENERATIVE INFLAMMATORY TRANSCRIPTOME IN SKELETAL MUSCLE

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Introduction: Dietary protein and leucine intake following exercise modulates skeletal muscle gene expression, increases protein synthesis, and in some circumstances can lead to enhanced subsequent endurance performance, relative to low protein ingestion. The effect of protein-leucine dose on the transcriptome-directed molecular programme guiding acute-phase skeletal muscle regeneration and recovery after endurance exercise, however, is unknown.
Methods: In a randomised crossover study design, twelve trained men completed 100 min of high-intensity cycling prior to ingesting a total of 70/15/180/30 g protein/leucine/carbohydrate/fat (15LEU), 23/5/180/30 g (5LEU) or 0/0/274/30 g (CON) beverages across 4 servings during the first 90 min of a 240-min monitored recovery period. Biopsies from the vastus lateralis were taken 30 and 240 min into recovery and messenger RNA was analysed by Illumina microarray. Gene selection contrasts were interrogated using Ingenuity Pathway Analysis software.
Results: The top functional modular network in the 15LEU-5LEU dose contrast at 30 min was pro-inflammatory, centred on interleukin (IL)1β programming increased leukocyte migration and differentiation, and extracellular matrix protein gene expression. Furthermore, the 5LEU and 15LEU vs CON feedings promoted cytostasis and increased cell viability with a myogenic signature at 30 min. By 240 min, however, in both 5LEU and 15LEU vs CON, and with dose response, an IL6 centred anti-inflammatory and promyogenic transcriptome dominated, with inhibition of NF-Kappa-β and SMAD pathway activity guiding expression indicative of decreased leukocyte migration, increased immune and muscle cell apoptosis, and cell metabolism. The transcriptome suggests protein-leucine feeding up-regulated an early-phase regenerative programme, thus reflecting wound-healing biology.
Conclusions: Ingesting a supplement containing 23 g of protein and 5 g of leucine following exercise simulated an early inflammatory transcriptome common to skeletal muscle regeneration biology that was more evident with the 3-fold higher protein-leucine dose. These findings suggest the higher quantity of protein-leucine ingested over the 90-min period post-exercise may better stimulate an inflammatory promyogenic molecular response leading to faster skeletal muscle recovery following strenuous training.
Funding from Nestec Ltd, Switzerland

THE EFFECT OF ALTITUDE ON ELITE TRACK-AND-FIELD ATHLETES' PERFORMANCE

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The International Association of Athletics Federation (IAAF) considers marks set at altitudes at or above 1000 m as acceptable for record consideration but are distinguished by having an "A" listed adjacent to the performance. The setting of 1000 m as the critical altitude seems arbitrary and to our knowledge has not been based on empirical evidence. Here we quantify the effects of altitude on track-and-field athletes to determine whether such designation is appropriate. Lifetime track-and-field performances of athletes placed in the top 16 in at least one major international competition between 2000 and 2009 were downloaded from the database at tilastopaja.org. There were 132,104 performances of 1889 athletes at 794 venues. Performances were log-transformed and analysed using a mixed linear model with fixed effects for 6 levels of altitude and random quadratic effects to adjust for athlete's age. Men's and women's sprint events (100-400 m) showed marginal improvements of ~0.2% at altitudes of 500-999 m, and above 1500 m all but the 100-and 110-m hurdles showed substantial improvements of 0.3-0.7%. Some middle- and long-distance events (800-10,000 m) showed marginal impairments at altitudes above 150 m, but above 1000 m the impairments increased dramatically to ~2-4% for events >800 m. There was no consistent trend in the effects of altitude on field events up to 1000 m; above 1000 m hammer throw showed a marginal improvement of ~1%, discus was impaired by 1-2%, and women's high jump was impaired by ~1.5%. Above 1500 m, pole vault, triple jump and long jump showed marginal improvements of ~1%. The findings in sprinting and some field events generally support the 1000-m threshold for altitude designation, but there is no need for such designation for middle- and long-distance running, high jump, shot-put, discus and javelin.

LOOKING FOR ROBUST WAYS TO MONITOR AND DEVELOP PHYSICAL LITERACY

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Physical literacy is a multifaceted conceptualisation of the skills required to fully realise potentials through embodied experience.[2] Substantial financial investments in PL education by Governments are underpinned by
a wide range of anticipated benefits including expectations of significant future savings to health care, improved physical and psychological well-being of the population, increased work-force productivity and raised levels of expertise in sport and exercise participation. Disappointingly, however, scientific evidence showing the efficacy of PL interventions to successfully meet such high expectation is limited.
In a recent paper,[1] Button and colleagues discuss Whitehead's original concept of physical literacy (PL) and how researchers have attempted to measure components of PL. In this talk Chris offers the explanation that contradictions in research findings are due largely to limitations in movement assessment batteries and consequent discrepancies between measurements used to assess the immediate outcomes of PL programmes. There is currently no robust empirical tool for evidencing skill learning in the physical movement component of PL education and this presents a serious limitation to the design and monitoring of PL interventions. The current popular emphasis upon fundamental skills measurement and development may not be appropriate for the realisation of the benefits claimed for PL. Instead physical exercise programmes, guided ideally by evidence, should be ensuring the development of more sophisticated elements of motor coordination (see Table 1). One potential solution to this dilemma in the future may exist in the application of exer-gaming technologies (such as Microsoft® Kinect) to educate and evaluate physical literacy skills.

Table 1. Summary of movement capacities underlying physical literacy. Movement Assessment Batteries are insensitive to several of these capacities.

Simple Movement Capacities	Combined Movement Capacities	Complex Movement Capacities
Core stability	Poise (balance and core stability)	Bilateral coordination
Balance	Fluency (coordination balance and proprioception)	Inter-limb coordination
Coordination	Precision (accurate placement of the body and core stability)	Hand-eye coordination
Flexibility, speed, variation	Dexterity (coordination, accurate placement and flexibility)	Control of acceleration/ deceleration
Control, proprioception, power	Equilibrium (balance, core stability and movement control)	Turning and twisting, rhythmic movement

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EXPLORING PELVIC GIRDLE CLINICAL TESTS FOR EARLY IDENTIFICATION OF AXIAL SPONDYLOARTHITIS – A HYPOTHESIS STUDY

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The Assessments in Spondyloarthritis International Society (ASAS) have developed classification criteria for axial spondyloarthritis (SpA) which are now widely used and accepted. These criteria include assessment for inflammation at the sacroiliac joints using magnetic resonance imaging (MRI), as this may precede structural damage.[1] Although these criteria present excellent validity and identify patients with early stage of disease, they are dependent on the availability of MRI which is frequentlty resource limited and expensive. Physical examination findings strongly associated with inflammation in the sacroiliac joint may help identify a subgroup of patients who are most likely to have active inflammation detectable on MRI. To conceptualise the current knowledge relating to the biomechanics and motor control of the pelvic girdle and to develop a feasible set of clinical tests to determine sacroiliac joint dysfunction would be a valuable objective. This would potentially help to identify patients with early axial SpA using physical examination together with other clinical and laboratory features previously identified as having good positive predictive value. Based on the European Guidelines for Diagnosis and Treatments of Pelvic Girdle Pain,[2] we propose a set of six clinical tests, four pain provocation tests (Gaenslen´s test, posterior pelvic pain provocation test, Patrick's Faber test, and palpation of the long dorsal sacroiliac joint ligament) and two functional tests (active straight leg raise, and Stork test on the support side) to identify the likely presence of inflammation in the sacroiliac joints associated with early axial SpA. The reference standard used to determine the sensitivity and specificity of the set of clinical tests would be oedema identified at the sacroiliac joints on MRI as this is the current gold standard used to identify inflammation in the sacroiliac joints.
We hypothesise that specific clinical tests, which combine pain provocation and functional tests, for assessing the pelvic girdle help to identify early active inflammation at the sacroiliac joints in axial SpA. If such tests prove reliable, sensitive and feasible they could add further value to the diagnostic classification criteria for axial SpA. The clinical relevance of such set of clinical tests is as follows: (i) providing an alternative approach for assessing active inflammation in the sacroiliac joint when MRI is not available (ii) providing justification for performing MRIs; (iii) discriminating sacro-iliitis from low back pain of mechanical origin; (iv) helping primary care clinicians identify chronic back pain patients with potential axial SpA at an early stage and refer appropriately; (v) increasing the sensitivity and specificity of the current classification criteria for axial SpA; (vi) improving the comprehension of sacroiliac joint behaviour in early axial SpA.

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EFFECT OF LOW FREQUENCY WHOLE BODY VIBRATION FOR ELDERLY, BODY COMPOSITION AND PHYSICAL FITNESS

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Elderly population in nursing rehabilitation center is prone to diseases and disability. They are taken cared-off by health professionals to help function in day to day activities. Physiologically, elderly as they aged there bone mineral density (BMD), muscle strength and physical fitness will normally decline. In this study, the objective is to determine the effect of 3-month Low frequency Whole Body Vibration (WBV) after the intervention was withdrawn for 3 months. Eight nursing home residents were non-randomly assigned to WBV group (5 subjects; 82.80±5.07 years) and Control (CON) group (3 subjects; 85.33±10.97 years). The WBV group underwent 3 months of semi-flexed standing exercise in reciprocal vibratory machine at 12.6 Hz, 3mm amplitude, 6 sets per session with 1 minute interval rest period for 3 times a week while the CON group continues to their daily routine with no vibration. Outcome measures were right hip and whole body BMD ($g.cm^{-2}$) using Dual-energy X-ray Absorptiometry (DEXA), maximal strength and average power concentric isokinetic knee extension and flexion at 60°/s and 180°/s by isokinetic dynamometer and physical fitness measures such as 6 minute walk test, arm curl test, chair sit and reach, back scratch and 8 foot up and go.

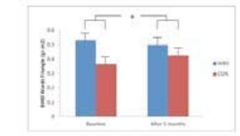

Figure 13. Bone mineral density in Wards triangle (gr.m²). *P<0.05 ANOVA to analyze the treatment effect

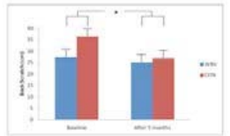

Figure 25. The length reached (centimeter) for upper flexibility by back scratch. *P < 0.05 ANOVA to analyze the treatment effects between groups

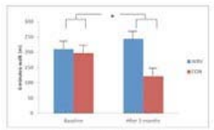

Figure 23. The distance spent (meters) by 6 minutes walk test. *P < 0.05 ANOVA to analyze the treatment effects between groups.

At baseline, WBV and CON group were statistically significant difference on their weight status (P=0.043). After vibration was withdrawn for 3 months, WBV group significantly decreased (6%) in BMD wards triangle compared to CON group increased by 4% (P<0.05). No significant changes in maximal strength and average power on both groups. There are training-induced changes in 6 minute walk test and Back scratch were better compared to CON group (P=0.024 for 6 minute walk test and P= 0.043 for back scratch). No other significant changes were observed in both groups.
In nursing rehabilitation center residents, 3 months low frequency WBV exercise has effect on physical fitness.

Keywords: Whole body vibration, bone mineral density, muscle strength, fitness

SLUMPED VERSUS NON SLUMPED ATHLETES: PSYCHOPHYSIOLOGICAL DIFFERENCES

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This investigation sought to compare brain activity of slumped and non-slumped athletes to determine psychophysiological characteristics or phenomenon of a slump using a Stroop task. Sport Adaptation of the Maslach Burnout Inventory (SAMBI) was administered to 460 Korean high school student athletes. Among them, twenty six participants with the highest (slumped group) and lowest (non-slumped group) scores on SAMBI participated in this experiment. Eelectroencephalographic data were recorded from frontal (Fp1, Fp2, Fz, F3, F4, F7, F8), central (Cz, C3, C4), parietal (Pz, P3, P4) and occipital (O1, O2) brain regions using the 10-20 electrode placement system. A computerized version of the Stroop Color Word Test was used. Analysis was carried out for group (2) × task (3) using a 2-way ANOVA. Dependent variables were theta, alpha, beta, and gamma power. Burn out data revealed that slumped athletes had significantly high level of burnout scores than those of non slumped athletes. Non-slumped athletes exhibited higher accuracy than slumped athletes on the Stroop task.
The results of this study indicated that slumped athletes are more under burnout state than non slumped athletes. The findings of this study showed lower magnitude of theta, alpha, beta, and gamma power in the frontal area in slumped athletes as compared to non-slumped athletes. This psychophysiological assessment offers the possibility to timely identify a state of slump in an athletic population.

Keywords: Slumped athletes, psychophysiological differences, brain, electroencephalograph

RELIABILITY OF ANTICIPATORY POSTURAL ADJUSTMENT PARAMETERS IN PREGNANT WOMEN AND CONTROLS

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Currently, it is unknown whether pregnant women present different anticipatory postural adjustment (APA) behaviour compared with matched controls. Examples of APA temporal parameters such as the initiation of the weight shift (T0), initiation of leg movement (T1) and muscle onset can be identified by a variety of techniques. Automated methods usually detect APA temporal parameters as a change of the signal magnitude in relation to the baseline. Visual inspection identification relies on the tester's subjective ability to identify changes in the signal. While the automated method has the advantage of being faster than the visual inspection identification, it can be unreliable in situations where the signal to noise baseline ratio is high. Visual inspection is more time consuming technique, but it allows the identification of APA temporal parameters under noisy baseline conditions. The reliability of visual inspection of the transversus and gastrocnemius muscles onset has been shown high in previous studies.[1,2] However, no previous studies looked at the reliability of other trunk and lower limb muscles.

Aim: To assess the intra-session, inter- and intra-tester reliability of APA parameters identification combining the automated and visual techniques.

Methods: Forty pregnant women and 30 controls were asked to perform a single leg stance in a self-selected speed. This was performed five times under four conditions: right and left leg lifting (with eyes open or closed). Superficial EMG of four bilateral muscles (external oblique, multifidus, rectus femoris and biceps femoris) was recorded during the leg stances. The EMG signals were bandpass filtered (16 to 500Hz) and amplified with an overall gain of 1000. A force plate was used to assess centre of pressure (CoP). For the intra-session reliability study, a total of 880 trials for pregnant women and 600 trials for matched controls were used. For inter-tester reliability, two researchers assessed 168 trials and for the intra-tester reliability, one researcher assessed the 168 trials in two different days, one week apart. All the APA parameters were initially automatically identified and then visually examined. If the automated method did not select the right time the tester manually corrected the value. Time T0 was determined when the CoP value raised 2 SD above or below the baseline; time T1 was identified after T0 when the CoP magnitude again reached the equivalent value to T0; finally, time of muscle onset was identified when the EMG value exceeded 2 SD above baseline for 50ms. Intra-class correlation coefficient (ICC) was used to determine the intra-session reliability, between two independent testers and within same tester.

Results: Intra-session ICC results showed moderate to high reliability for both groups. The lowest ICC value was found for RF muscle, in the control group (ICC= 0.63, 95%CI 0.33 to 0.81) and the highest ICC value was found in the BF muscle in the pregnant women group (ICC = 0.89, 95% CI 0.82 to 0.94). Inter-tester and intra-tester reliability results showed excellent agreement between testers and within tester with ICC ranging from 0.98 to 1 and 0.92 to 1 respectively.

Conclusion: A combination of computer-based and visual APA parameters identification showed reliable estimates of T0, T1 and muscle onset.

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RELIABILITY OF OSCILLOMETRIC CENTRAL HEMODYNAMIC RESPONSE TO AN ORTHOSTATIC CHALLENGE

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Background: Limited studies have used pulse wave analysis (PWA) to assess the reliability of central hemodynamic responses to an orthostatic challenge, reporting intra-class coefficient (ICC) values of 0.74 and 0.70 for central systolic blood pressure (cSBP) and augmentation (AIx), respectively. These previous studies have conducted PWA using radial artery tonometry; this technique may be impractical for use in the clinical setting or for epidemiological studies. Recently, oscillometric PWA devices have emerged, presenting user-friendly, operator independent and practical alternatives to tonometry.
Objective: The purpose of the current study was to determine whether an oscillometric PWA device can be used to reliably assess cSBP and AIx responses to an orthostatic challenge (modified tilt-table).
Methods: Twenty healthy adults (50% female, 26+5 y, 24.7 kg/m2) were recruited. Participants were tested on 3 different days between 7 am and 10 am in the fasted state, separated by a maximum of 7 days. Following a 10-minute supine rest period, baseline PWA assessments were collected. The participant was then passively and rapidly (~1 sec) tilted to a 60-degree upright position using a modified tilt-table for 5 minutes. During the tilt period, PWA assessments were collected at 2- and 5-minutes. Following the tilt, the participant was returned to a supine position for a 5-minute recovery period with further measurements collected at 2- and 5-minutes. Central hemodynamic variables were assessed on the left arm using an oscillometric PWA device (AtCor Medical SphygmoCor-XCEL, Sydney, Australia). The AIx was normalised to a heart rate of 75 bpm (AIx@75).
Results: Repeated measures ANOVA indicated a significant main effect of TILT on cSBP (P=<0.001, $\eta 2p = 0.71$) and AIX@75 (P=<0.001, $\eta 2p = 0.67$), increasing cSBP by 2.3 (CI: 4.4, 0.16) mmHg and decreasing AIX@75 by 3.4 (CI: 0.5, 6.2) %, respectively. The ICC criterion of 0.75 was exceed for cSBP (ICC: 0.80 – 0.87) and AIx@75 (ICC: 0.82 – 0.88) across baseline, tilt and recovery conditions.
Conclusion: Oscillometric PWA device can be used to reliably assess cSBP and AIx responses to an orthostatic challenge.

INFLUENCE OF GENDER ON THE RELIABILITY OF CENTRAL ADIPOSITY MEASUREMENTS USING B-MODE ULTRASOUND

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Background: Visceral fat deposition varies between sexes and may explain differences in cardiometabolic risk. B-mode ultrasound indices of visceral fat have been well validated; however, to our knowledge, no data has been published to indicate whether ultrasound measures are equally reliable in both sexes.
Purpose: To determine whether the following measures are reliable for each gender: (a) maximum subcutaneous fat tissue (SFTmax); (b) intra-abdominal thickness (IAT); (c) maximum abdominal ratio (MAR); (d) minimum subcutaneous fat tissue (SFTmin); (e) preperitoneal fat thickness (PFT); and (f) abdominal wall fat index (AFI).
Methods: Eight females (23+2 y, 24.4 kg/m2) and eight males (28+6 y, 25.9 kg/m2) were tested on three different mornings within a seven day timeframe in a fasted state. Following 10 min supine rest, a series of B-mode scans were captured by recording a 10 second high resolution video clip. During each capture, participants were asked to hold their hands above their head, quietly exhale and hold their breath. IAT (curved-array probe, transverse plane) and SFTmax (linear-array probe, sagittal plane) were assessed two centimeters above the centre of the umbilicus. MAR was calculated as the ratio of SFTmax to IAT. PFT and SFTmin (linear-array probe, sagittal plane) were measured immediately inferior to the xiphoid. AFI was calculated as the ratio of SFTmin to PFT.
Results: The criterion intra-class correlation coefficient (ICC) of 0.75 was exceeded for all measures for both sexes. Females, compared to males, exhibited equitable ICC values for SFTmax (1.00 vs. 1.00), IAT (0.93 vs 0.96), MAR (1.00 vs. 0.99), SFTmin (1.00 vs. 1.00), PFT (0.96 vs. 0.99), and AFI (1.00 vs. 0.99).
Conclusion: Findings from this study suggest B-mode ultrasound can be used to reliably assess central adiposity in young adults under standardised conditions for both sexes. Ultrasound is relatively inexpensive, safe, acceptable to patients, and can be portable, making this apparatus suitable for wide-spread adoption among research academics and healthcare providers.

DOES THE INGESTION OF CAFFEINE PRIOR TO PERFORMANCE IMPROVE COGNITIVE THINKING, AEROBIC AND ANAEROBIC SPORTS PERFORMANCE? A META-ANALYSIS

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Introduction: Caffeine is one of the most popular, and widely consumed, drug in the world and has become a popular ergogenic aid for many athlete's to improve sports performances both physically and mentally.[1] The effects of caffeine in reducing fatigue and increasing wakefulness and alertness have been recognised for many years now and with caffeine being commonly found in soft drinks, tea, chocolate and coffee means that caffeine has become socially accepted in almost every country and culture.[2]
The purpose of this study was to determine whether caffeine improves cognitive thinking, aerobic and anaerobic sports performance.
Methods: A Meta-Analysis of thirteen original articles was undertaken after searching the online database EBSCO Host. The articles had to analyse the effects of caffeine and caffeine supplementation on sports performance. Both genders across a range of sports were included. To evaluate the quality of articles, articles were coded (0-3) on 12 stratification criteria giving a maximum score of 36. Effect Sizes for each article and the mean Effect Size (Cohen's "d") were calculated.
Results: 9 out of 13 articles scored over 30 on the coding stratification criteria (scores ranged from 27 – 35). Individual articles on aerobic and anaerobic sports performance with caffeine ingestion, showed an effect size greater than 0.8 (moderate effect), however overall the mean effect size across the 9 articles was 0.77 (nearly a moderate effect). Individually, none of the 4 articles on how caffeine affects the cognitive function of motor skills had an effect size greater than 0.8 (mean effect size = 0.44) a small to moderate effect. All 13 articles showed a positive effect size on sporting performance.
Conclusion: It is evident that the ingestion of caffeine 60-90 minutes prior to exercise at a dosage of between 2 mg/kg – 6 mg/kg is beneficial to an athlete's ability to improve their sporting performance. Dosages over 6 mg/kg didn't show any greater benefits. Caffeine has a positive effect on aerobic and anaerobic performance, as well as, the cognitive part of performance e.g. accuracy. All articles analysed showed a positive effect size and indicate the benefits of using caffeine as an ergogenic aid to enhance performance in competition.

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VALIDITY AND RELIABILITY OF TELEMETRYY-DERIVED HEART RATE VARIABILITY RESPONSES TO A MODIFIED TILT TABLE TEST

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Background: Heart rate variability (HRV) is commonly utilised to evaluate the parasympathetic arm of the autonomic nervous system. The "gold standard" device for measuring HRV is the electrocardiogram (ECG), but it is relatively expensive, requires trained personnel, and is impractical for use with large population studies. The recent introduction of simple, telemetry-based devices for measuring HRV has potential implications for expanded use. To the best of our knowledge, no previous studies have assessed the efficacy of using a telemetric based device for assessing autonomic responses to an orthostatic challenge.
Purpose: To assess the validity and reliability of telemetry-derived heart rate variability in response to a modified tilt-table test.
Methods: Twenty healthy adults (26.4 + 5.2 y, 45% male) were tested on 3 different mornings (7am - 10am) in the fasted state. On each occasion the participant was tested with the telemetric monitoring device (Polar RS800CX, Kempele, Finland), and on one day they were simultaneously tested with ECG (Powerlab 30 series, AD Instruments, Adelaide, Australia). Following a 10 min supine rest period, R-R intervals were recorded continuously for the three CONDITIONS: 5 min REST, 5 min TILT, and 5 min RECOVERY. Measures of the standard deviation of normal-to-normal intervals (SDNN), the root mean square of successive differences (RMSSD), and the low-frequency (LF) and the high-frequency (HF) spectral power and their ratio (LF/HF) were analysed.
Results: For all parameters, except LF/HF, there was excellent agreement between devices (r value > 0.75) for BASEINE, TILT and RECOVERY conditions. Bland-Altman analysis revealed systematically higher RMSDD, SDNN, and HF values for the telemetric device, while LF was systematically lower. For the telemetric device, repeated measures ANOVA indicated a significant large main effect (CONDITION) for RMSDD ($\eta 2p = 0.40$) and LF/HF ($\eta 2p = 0.30$), with SDNN and HF approaching significance. For the telemetric device, intra-class coefficient (ICC) values for RMSDD, SDNN and HF were all above the 0.75 criterion for each condition, indicating excellent between-day reliability. The reliability coefficient expressed as a percentage of the mean (RC%) was substantially lower (better) for RMSDD (RC% 43.8-51.9) and SDNN (RC% 43.1-51.6) compared to HF (RC% 90-120) for each condition.
Conclusion: Telemetric HRV, particularly RMSDD, can be used to provide a sensitive, valid and reliable measure of autonomic function. Further studies are required to ascertain the potential use of this device in clinical populations.

RELIABILITY OF CENTRAL ADIPOSITY MEASUREMENTS USING B-MODE ULTRASOUND

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Background: Central adiposity poses a higher risk for developing obesity related disorders than overall adiposity. B-mode ultrasound (US) measurements of intra-abdominal fat thickness (IAT) and maximal preperitoneal fat thickness (PFT) have been well validated against computed tomography and magnetic resonance imaging. Moreover, US is relatively inexpensive and can be portable, making it particularly suitable for clinical practice and epidemiological studies. Lack of widespread adoption may be attributable to lack of standard operating procedures.
Purpose: To determine optimal standard operating procedures for B-mode ultrasound assessments of IAT and PFT. Specifically, to determine whether: (1) IAT assessments are most reliable when measured between the linea alba and the (a) anterior aorta, (b) posterior aorta, or (c) vertebra; and (2) PFT assessments are most reliable when measured along the (a) sagittal or (b) transverse plane.
Methods: Sixteen healthy adults (50% female, 26+7 y, 24.5 kg/m2) were tested on 3 different mornings, separated by a maximum of 7 days. Following 10 min supine rest, a series of B-mode scans were obtained. Each scan was recorded as a 10 sec high resolution video clip, during which the participant held their hands over their head and held their breath following quiet exhalation. IAT was assessed two centimeters above the umbilicus (curved-array probe, transverse plane). PFT (linear-array probe) was measured from linea alba to visceral peritoneum in sagittal and transverse planes, immediately over and inferior to the xiphi-sternum, respectively.
Results: For IAT assessments, the criterion intra-class correlation coefficient (ICC) of 0.75 was exceeded when measured to the anterior aorta (0.95), posterior aorta (0.93) and vertebra (0.95). The reliability coefficient expressed relative to the mean (RC%) was slightly lower (better) for vertebra (9.8%) measurements compared to anterior aorta (12.4%) and posterior aorta (12.2%). For PFT assessments, the mean thickness was comparable for sagittal (1.74 cm) and transverse (1.73 cm) planes. Similarly, ICC values were comparable for sagittal (0.98) and transverse (0.98) measurements, as were RC% (6.7% and 6.9%).
Conclusion: IAT assessments are marginally more reliable when measured to the vertebra, and PFT assessments are equally reliable for both measurements planes. However, it is easier to ensure appropriate probe placement with sagittal PFT measurements. Further research is warranted to determine whether US central adiposity assessments are equally reliable for normal- and over-weight populations.

COPING STRATEGIES AMONGST NEW ZEALAND RUGBY PLAYERS DURING THEIR CROSS-CULTURAL TRANSITION TO JAPAN

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As a result of globalisation, the number of international athletes who compete outside of their home country has dramatically increased over the past few decades. For example, in 2010 there were 325 New Zealand rugby players playing their trade overseas, including 72 players based in Japan. Research evidence has demonstrated that people experience a number of difficulties during the process of cross-cultural transition that can potentially cause negative consequences such as decreased psychological well-being (eg, Yeh, Arora, Inose, Okubo, & Greene, 2003). However, previous sport psychology literature has not examined how international athletes cope with stressors associated with their cross-cultural transition. Utilising Berry 's (1992, 1997) acculturation framework, the purpose of this qualitative study was to identify the coping strategies utilised by New Zealand rugby players in Japan. Professional elite rugby players (n=10) currently living and competing in Japan participated in one-on-one, in-depth interviews, which were subsequently transcribed verbatim and content analysed.
The results revealed four major themes of coping strategies, including (i) social support, (ii) strategies to overcome language/cultural barriers (iii) emotion-focused coping, and (iv) problem-focused coping. The findings indicated that these 10 rugby players used numerous coping strategies in response to stressors they encountered during their cross-cultural transition. In particular, social support appeared to play a significant role in facilitating positive adaptation. Practical recommendations will be outlined for players, coaches, and support staff regarding specific stress management and social support strategies to expedite a player's positive adaptation.

RELIABILITY OF OSCILLOMETRIC CENTRAL BLOOD PRESSURE AND ARTERIAL WAVE REFLECTION READINGS: EFFECTS OF POSTURE AND THE FASTED STATE

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Background: Pulse wave analysis (PWA) has emerged as a non-invasive, valid and reliable technique to investigate central hemodynamic properties, including central systolic blood pressures (cSBP) and systemic arterial wave reflection (augmentation index, AIx). Recently, oscillometric devices have entered the market, presenting a user-friendly and a practical option for use in the clinical setting. Prior to clinical adoption, it is imperative to ascertain measurement precision and ecological validity. Two real-world scenarios that may impact measurement precision within clinical practice include posture and the fasted state.

Purpose: To examine whether i) posture and ii) the fasted state affect the between-day reliability of oscillometric cSBP and AIx recordings.

Methods: Twenty healthy adults (50% female, 28+5 y) were recruited. Participants were tested on 6 different mornings between the hours of 7am and 10am: 3 days in the fasted state and 3 days in the non-fasted state. On each occasion the participant was tested in the supine and seated position. A maximum of 14 days separated all measures. Central hemodynamic variables were assessed on the left arm using an oscillometric device. The AIx was normalised to a heart rate of 75 bpm (AIx@75). The effects of POSTURE and FASTED state were assessed using repeated measures ANOVA. Reproducibility of parameters was assessed using intra-class correlation coefficient (ICC) and the reproducibility coefficient (RC).

Results: No interaction effect was found for any central hemodynamic variable. For cSBP, there was no main effect for FASTED but there was a large effect for POSTURE ($\eta 2p = 0.40$), with cSBP increasing by 3.5 (CI: 1.4, 5.5) mmHg. For the AIx@75 there was no main effect for POSTURE but there was a large main effect for FASTED ($\eta 2p = 0.22$), with AIx@75 decreasing by an absolute 3.0 (CI: -0.4, 6.4) %. The criterion ICC value of 0.75 was exceeded for both cSBP (ICC = 0.89) and AIx@75 (ICC = 0.79) for the supine-fasted condition, indicating excellent between-day reliability. For cSBP the RC was lowest (best) under the supine-fasted condition and greatest (worst) for the seated-non-fasted condition. For AIx@75 the RC values tended to be slightly higher (worse) for the seated compared to supine position.

Conclusion: Findings from this study suggest that oscillometric PWA can be used to reliably assess central hemodynamic variables in health young adults under standardised conditions.

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