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CEO MESSAGE

In its original format my message for this edition was celebratory. The delivery of this publication will coincide with the 10th anniversary of the FMPA`s launch in April 2010 and there is of course much to celebrate in terms of our achievements. But in the space of a few days it no longer seems important – or appropriate – to extol the virtues of our successes.

The Covid-19 pandemic is now firmly upon us and our attention has necessarily turned towards a focus on the devastation this is causing to our way of life, to our families, our friends, our colleagues and our members.

But it is in times of adversity that renewed vigour can emerge as a driving force and accordingly the FMPA has never been busier. In the main this has been in support of our members through discussion and dialogue, via telephone calls, emails, podcasts, and the posting of vital and key information on legal, financial and mental health support. All of which has never been needed more than at this time.

The rallying cry nationally is of course for communities to work together in dealing with this crisis and that is exactly the strategy that will work for our community of medicine and performance practitioners. We are all in this together and need to work as a team supporting colleagues who may be going through a difficult time.

There is also the belief that we will all come out of this pandemic stronger and I believe this will be the case for the FMPA. Football will return and our national game will drive the sense of optimism that will emerge. We will all be part of that recovery and I look forward to ensuring that our members are recognised for their efforts and endeavours through this unprecedented time.

On a personal note I look forward in particular to our Conference in 2021, and the opportunity to celebrate with everyone, our 11th Anniversary.

Eamonn Salmon

Chief Executive Officer
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FROM THE EDITOR

Football has never mattered less, and its absence reflects the surreal nature of the current situation we are living through. Some day it will return and we'll savour it as a beacon of normality. Right now, many of you working in football may be uncertain about your future, and fearful for the health of your loved ones. I hope this publication can provide a moment of escape from these worries. The FMPA is committed to helping all of those working in football who may be facing hardship, and Eamonn Salmon has done an admirable job in leading this over the past few weeks.

This is a new situation for everyone. The weeks and months ahead will continue to deliver new problems we have never faced before. Managing the health and fitness of players remotely will demand greater trust, communication and innovation amongst the interdisciplinary team in order to protect the welfare of players (and their families), while also ensuring they retain a performance edge once the football season resumes.

While football is largely irrelevant in the grand scheme of the COVID-19 pandemic, we should never underestimate its potential to have a positive influence. I have been impressed by the role many football clubs are taking to impart key public health messages to their followers. MK Dons' players and staff must be commended for spending their weekend checking up on older Season Ticket holders over the phone, while Ipswich Town have led the way by offering their Portman Road facilities to the NHS. All of us are in this together.

We have taken the decision not to print this edition for the first time in the publication's history. Instead, we will share it as a .pdf and open it up to anyone who would like a copy. We are hopeful it will reach as many readers as possible.

Stay safe.

Sean Carmody

Dr Sean Carmody
Editor, FMPA Magazine

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ABOUT

Football Medicine & Performance Association
6A Cromwell Terrace, Gisburn Road, Barrowford, Lancashire, BB9 8PT
T: 0333 456 7897 E: info@fmpa.co.uk W: www.fmpa.co.uk
FMPA_Official Officialfmpa fmpa_official
LinkedIn: Football Medicine & Performance Association
FMPA_Register FMPARegister fmpa_register

Chief Executive Officer
Eamonn Salmon
eamonn.salmon@fmpa.co.uk

Executive Administrator
Lindsay Butler
admin@fmpa.co.uk

Administration Assistant
Amie Hodgson
amie.hodgson@fmpa.co.uk

Project Manager
Angela Walton
angela.walton@fmpa.co.uk

Marketing/Advertising
Charles Whitney
0845 004 1040

Design
Oporto Sports
www.oportosports.com

Photography
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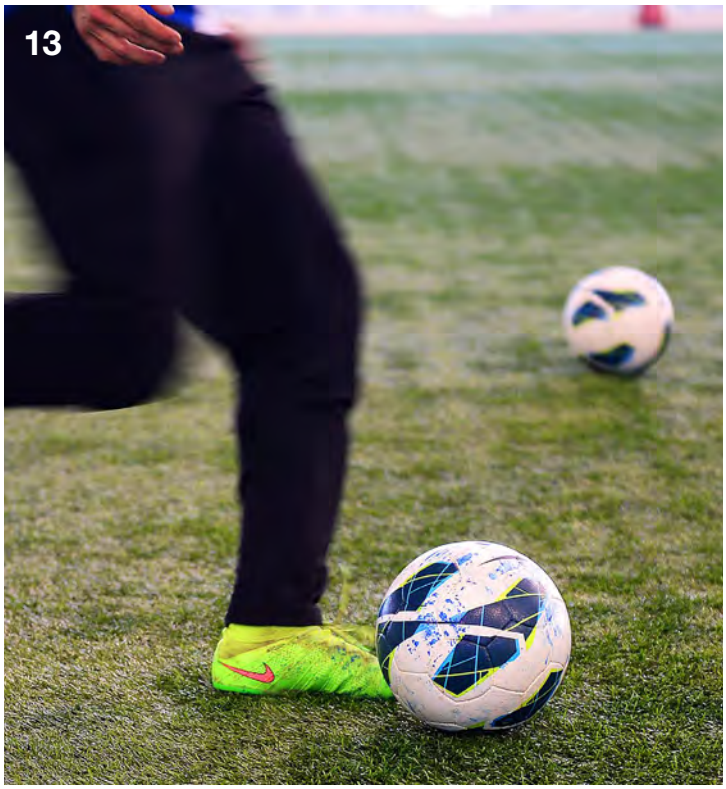
Contributors
Dr Imtiaz Ahmad, Dr. Vincent Gouttebarge, O.Hassan Ahmed, M.Fulcher, D.Malone, C.Mira y Lopez, M.E. Rho1, A.Strojna, Dr Amy Arundale PhD, Colin W. Fuller, Marcos Agostinho, Peter Krustrup, Daniel Parnell, Professor David Lavallee, Jeff Lowder, Jane Lowder, Ruth Lavallee, Buchheit M, Avrillon S, Simpson B.M, Lacome M, Guilhem G, Jack Targett, Damian Roden, Enda King PhD, Dr. Andy Franklyn Miller

COVER IMAGE
Cover artwork by Barry Masterson
Twitter: @barrymasterson
Instagram: @barrymasterson
Facebook: Barry Masterson Art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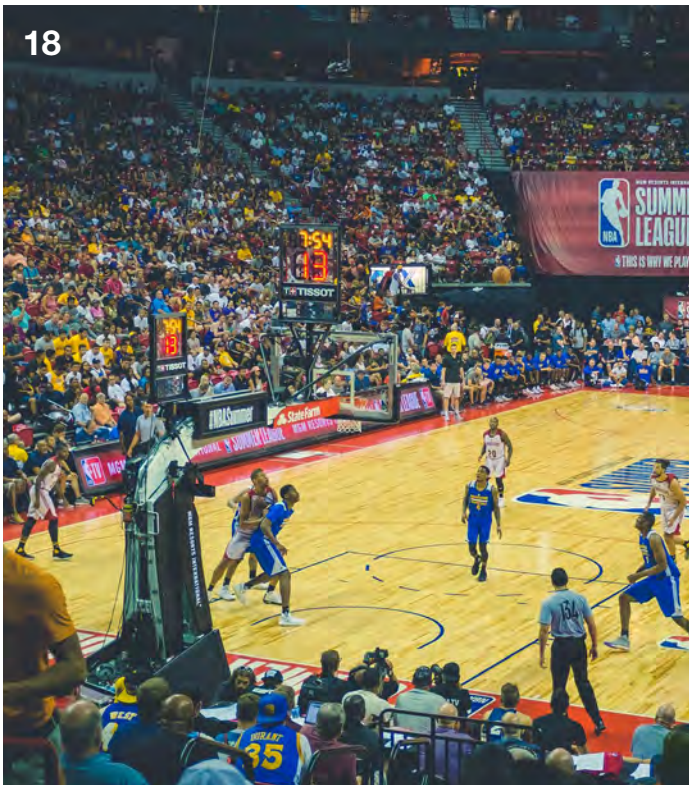
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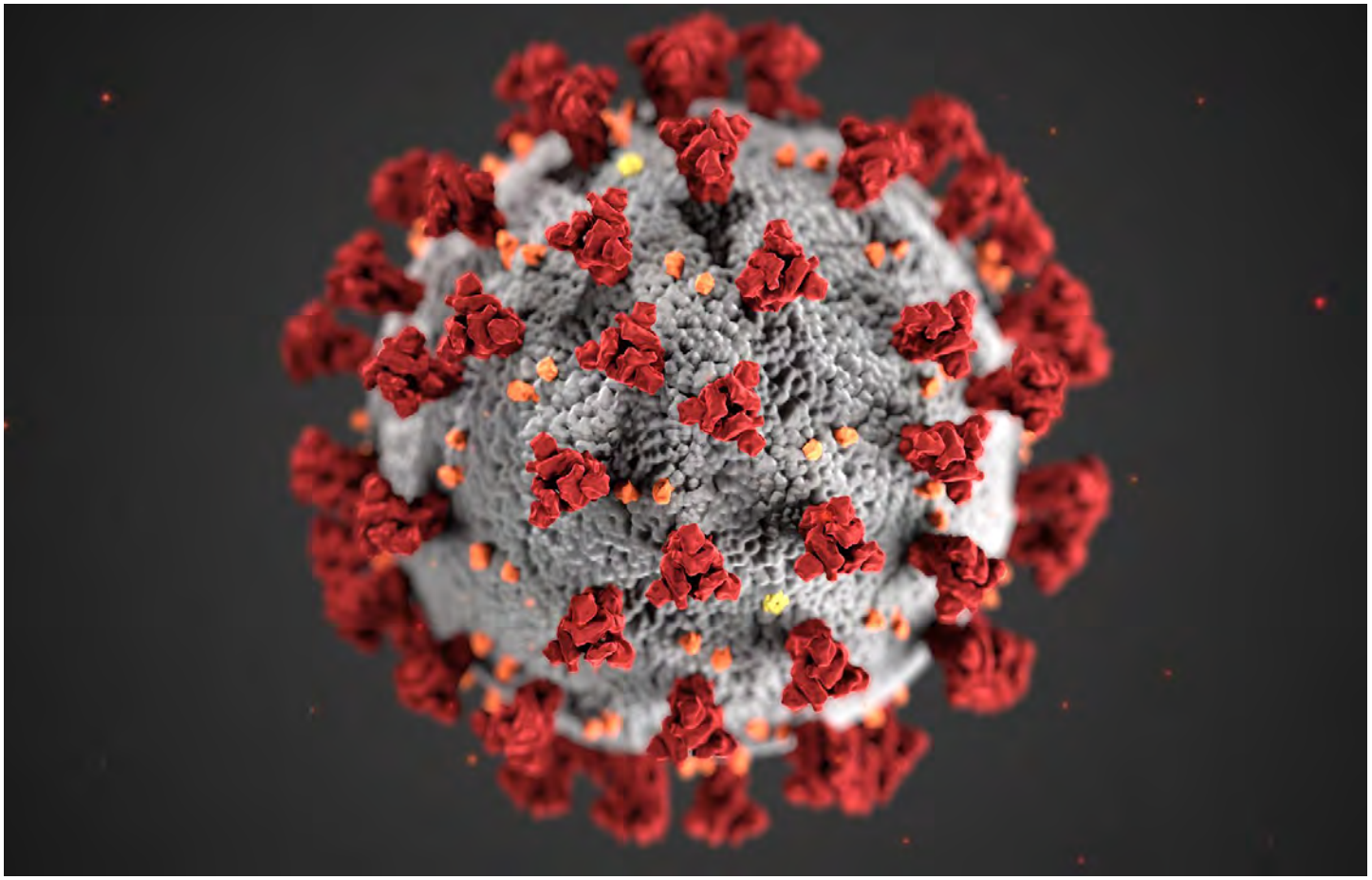

REFLECTIONS ON THE DECISION-MAKING PROCESSES DURING THE COVID-19 PANDEMIC

FEATURE / DR IMTIAZ AHMAD

Dr Imtiaz Ahmad

Head of Medical,
Queens Park Rangers FC

Our players had booked a team bonding event at Cheltenham Festival on 11.03.20. With growing public health concerns over COVID-19 we made an unpopular decision to cancel this trip, even though Government guidelines placed no restrictions over large gatherings at that point in time (1).

Football medics across with country have been faced with difficult questions in recent weeks. Can we train? Are we at risk? How do we keep players fit? Can we travel? Will the season be completed? Can we play behind closed doors? Can we test?

We've all been taken by surprise by this pandemic and have had to make key decisions for our organisations. Increasing knowledge base in this area was important from the start and the Royal College of Physicians held a comprehensive expert update Webinar for doctors on 12.2.20, which I participated in (2). Following on from this I met our Director of Football and Manager to explain that it was clear that a potentially major issue was about to develop and impact not only on football but on society at large. We decided on early quality communication with all staff and players so that they were prepared for what could happen. We developed an in-house COVID-19 protocol for dealing with suspected cases at all of our Club sites, limiting visitors to the Club and doing presentations to first team players and staff on 25.2.20 and the same for our Academy teams. We also arranged regular deep cleans of our training grounds.

Once the decision was made to postpone fixtures we decided to send players back

I am only one,
But still I am one.
I cannot do everything,
But still I can do something;
And because I cannot do everything,
I will not refuse to do the something that I can do.

Edward Everett Hale

home to their families on 13.3.20, including those players from abroad. This decision was made with the Manager and Director of Football after carefully reviewing the current situation. The EFL postponed football and matches until 23.3.20, then 4.4.20 and now 30.4.20 (3). In reality all medics who have been following this pandemic know that there is no chance of a return to football as we know it for many months (4). When the Government is making an emergency field hospital in the heart of London, the seriousness of this situation cannot be underestimated (5).

Effective communication during this time has been vital. Players were knowledgeable through media outlets but wanted to know the medical facts. As the situation developed we arranged daily meetings with the manager and Head of Medical to make sure our strategy was clear and that we could confidently tell the rest of the Club our plan. Each player was messaged directly with Top Tips and summaries of current National guidelines including details on social distancing and self-isolation (6) (7). Players were given individual home programmes and nutrition advice according to their status as injured, ill due to COVID-19, or fully fit. Social media was used for feedback and promoting public health awareness. Mental health was monitored through regular and coordinated staff contact and also an adapted version of the IOC Sport Mental Health Assessment Tool (8). We encouraged players to seek positives such as enjoying quality time with families, learning a skill such as healthy cooking or a new language.

To manage staff anxieties, the media team set up a detailed presentation and question and answer session with the Head of Medical, which has been viewed more than 20,000 times on various social media sites within the first week (9). At times managing staff was the biggest challenge as naturally people were anxious for their own health and also for their loved ones.

Football clubs turned to their medics for leadership, placing them in an influential position in decision-making at the Clubs. Whilst each Club is unique in terms of the pressure medics are put under, this really was a time for medics to give a clear opinion based on the best available evidence and help their Clubs make the right decisions.

There will be many long-lasting implications of this COVID-19 crisis in football; the return to play date is yet to be determined, completing the season in a short space of time brings challenges of maintaining fitness during that period, mental health issues and the social impact of players and staff potentially being asked to take wage cuts. It is a situation that is rapidly evolving but the impact will be wide-ranging and have repercussions at every level of the club and wider society.

I've reflected on many things during this time: how a community Club can get together and make clear plans to ensure the safety of players and staff during a crisis, the support of the Manager, Director of Football, Director of Academy, CEO and Owners to coordinate a response throughout a Club. Leadership during difficult times needs clear communication and a network of trust amongst colleagues. Maintaining a human touch is most important though, especially when people are afraid about their health, families, jobs and general security.
One of the most touching moments however was the feedback from a player who thanked me for cancelling Cheltenham even though he thought it was over the top at the time, 'You made the right decision Doc. Thank you.'

Dr Imtiaz Ahmad
29.3.20
Head of Medical QPR FC

1. https://www.gov.uk/coronavirus
2. https://www.rcplondon.ac.uk/events/covid-19-expert-update-doctors
3. http://www.thefa.com/news/2020/mar/19/joint-fa-efl-premier-league-statement-update-on-professional-football-covid-19-190320
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FIFPRO'S ADVICE TO PROFESSIONAL FOOTBALLERS DURING THE CORONAVIRUS (COVID-19) PANDEMIC

FEATURE / DR. VINCENT GOUTTEBARGE

Dr. Vincent Gouttebarge
Chief Medical Officer at FIFPRO (Football Players Worldwide)

During the current time of uncertainty due to the coronavirus (COVID-19), it's normal to feel worried, confused, stressed, sad or even angry. These are common responses to a very uncommon situation. Players should remember to stay engaged with their support system and to speak to someone if they need help. Remaining physically active is also essential: players should follow strength and conditioning programmes focusing on general endurance, football specific endurance (intermittent bouts), speed, strength, coordination and flexibility.

Follow a routine

Your daily routines and schedules have been significantly disrupted. Find a new routine including the self-care tips below.

Maintain a healthy lifestyle - especially sleep and nutrition

Self-care is always important, but even more so during social distancing. Keep healthy sleep habits, sleep well in regular hours (7-9h per night). Try to eat healthy (fresh fruits and vegetables, familiar protein source, carbohydrate, matching energy intake to your exercise levels) and to avoid alcohol and other drugs.

Maintain general endurance

General endurance is important for overall football performance: it contributes to 80-90% of the distance covered during a match during which low speed activities are executed. General endurance is thus the basic within any strength and conditioning programme and the basis of football performance: it increases general

physical capacity, optimises recovery, contributes to injury prevention and decreases technical and tactical mistakes that might occur toward the end of matches. Players should consider some general principles in order to develop/maintain general endurance:

- Continuous effort: session usually lasting 30-60 min or covering distances from 6 to 10 km
- Low to moderate intensity: 60-80% of maximal heart rate (130-160 beats per minute depending on player's age) or easy-to-moderate intensity on RPE-scale (rating of perceived exertion)
- Training frequency: once or twice a week
- Training recovery: easy
- Beware of running on hard surfaces (eg road, pavement) which you may not be accustomed to – this may influence your risk of injury.

Maintain football-specific capacity

Contributing 10-20% of the distance covered during a match, football specific endurance is essential as it eases the execution of (very) high speed activities (running, sprinting, springing). Players should consider some principles in order to develop/maintain football- specific anaerobic capacity:

- Thorough preparation and structured/precise approach
- Intermittent effort: repeated bouts lasting up to a few minutes, with total session usually lasting 30-60 min
- Frequency and recovery: 3-4 sets of 4-15 bouts with 2-4 min (active) recovery between sets and 30-60 sec (active) recovery between bouts
- Moderate to high intensity: 80-95% of maximal heart rate (160-190 beats per minute depending on player's age) or moderate-to-high intensity on RPE-scale (rating of perceived exertion)
- Training frequency: once or twice a week
- Training recovery: one or two days
- Again, beware of running on hard surfaces which you may not be accustomed to
- Integrate football specific elements (ball drills) within bouts and/or recovery

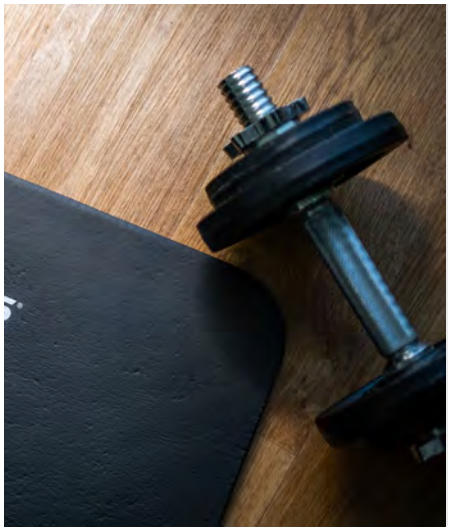
Maintain speed

For any position in the field, speed is the most significant factor for football performance. Speed in football has many different facets, among which with or without the ball, straight line or change of direction, from standing still or from walking/jogging, explosive versus progressive speed. Players should consider some principles in order to develop/maintain speed:

- Thorough preparation and structured/precise approach
- Very short intermittent effort: repeated bouts lasting up to a few seconds, with total session usually lasting 15-30 min
- Frequency and recovery: 3-4 sets of 8-12 bouts with 3-5 min (active) recovery between sets and 30-90 sec (active) recovery between bouts
- Very high intensity: 95-100% of maximal heart rate (>190 beats per minute depending on player's age) or very-high intensity on RPE-scale (rating of perceived exertion)
- Training frequency: once or twice a week
- Training recovery: one or two per day
- Integrate football specific elements (ball drills) within bouts and/or recovery

Maintain strength, coordination, flexibility

Strength, coordination and flexibility exercises can be performed outside, in the gym or at home. The International Olympic Committee (IOC) has developed a free app for elite and recreational athletes; 'Get Set - Train Smarter'. Available in different languages (Google Play and App Store), this app offers evidence-based and effective exercises focusing on strength, coordination and flexibility.



Stay connected

Social distancing should not mean social disconnection. Use apps and other technology to stay connected and be mindful that you might want to 'check-in' with your network on a more frequent basis than usual. Share feelings with a friend or family member. Rely on your support systems and maintain relationships. Schedule joint home training with a team-mate and work out together remotely via FaceTime, or WhatsApp. Re-connect with family and friends!

Take breaks

Make time to unplug and decrease sensory overload. Try to turn to activities that you enjoy. Listen to music, take a walk, watch a favourite TV show.

Work on your mental game

Focus on what you can control as we sometimes fixate on events outside of our control. Ask yourself "what can I control in this situation", set your sights on what you can control and focus on making yourself look calm and in control.

Challenge catastrophic thoughts

It is easy to assume the worst will occur and you won't be able to handle it. Instead, remind yourself of transitions and challenges you have navigated in the past. Ask yourself:
1. What is the worst case scenario?
2. What is the likelihood of this scenario?
3. Even if this were to happen, what are the realistic consequences? Could I handle it?
4. Does worrying about this outcome help prevent it from happening?

Stay informed with the latest developments

Stay informed with the latest developments from reliable sites such as the World Health Organization. But avoid reading everything on COVID-19 in the news or on social media, as this can unnecessarily amplify stress or worry.

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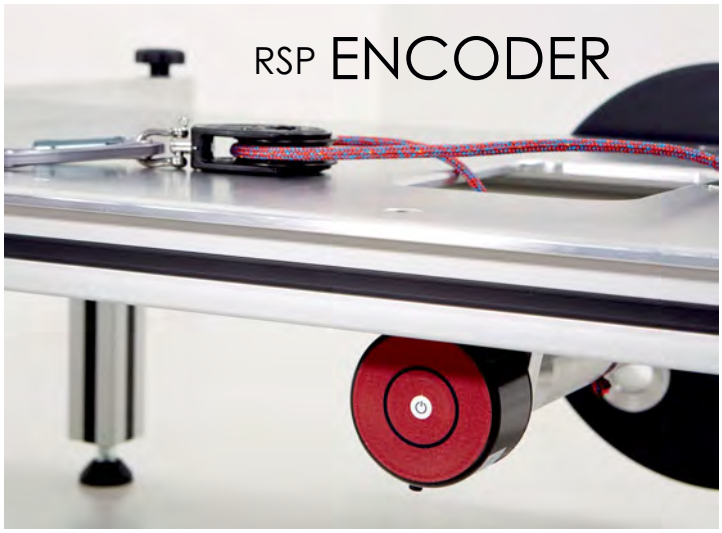

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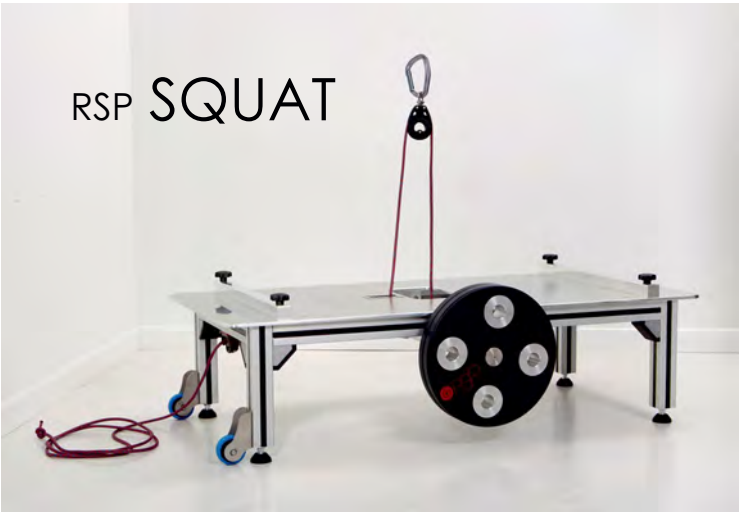

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THE INTRODUCTION OF TEMPORARY CONCUSSION SUBSTITUTIONS IN DISABILITY FOOTBALL: ARE WE 'HEADED' IN THE RIGHT DIRECTION?

FEATURE / OH AHMED[1,2,3], M.FULCHER[1,4], D.MALONE[1], C.MIRA Y LOPEZ[1,5], M.E. RHO[1,6], A.STROJNA[1,7]

1. IFCPF Medical Committee, International Federation of CP Football
2. Faculty of Health and Social Sciences, Bournemouth University, Bournemouth, England
3. The FA Centre for Disability Football Research, St Georges Park, Burton-Upon-Trent, England
4. Axis Sports Medicine Specialists, Auckland, New Zealand. New Zealand Football, Auckland, New Zealand
5. New Being News, Brazil
6. Department of Physical Medicine and Rehabilitation, Northwestern University Feinberg School of Medicine, Chicago, United States of America
7. Federazione Italiana Sport Paralimpici e Sperimentali, Rome, Italy

A need for action in Cerebral Palsy football

Cerebral Palsy (CP) football is one of many adapted formats of football which permit individuals with a wide range of disabilities to participate (FIFA Medical Network, 2019), including athletes with CP or an acquired brain injury. Although several commentary pieces related to concussion in disability sport have been published (Kissick & Webborn 2018, West et al. 2017), at present there are limited data-driven studies on concussion in disability football. The study of Weiler et al. (2018) demonstrated that footballers with a disability (including CP footballers) have baseline concussion values that are significantly different to their mainstream peers and recommended that extra consideration needs to be given when interpreting post-concussion assessments with disability footballers. In addition, the work of Griffin et al. (2017) highlighted that clinicians working within CP football expressed some difficulty in performing cognitive assessments within this population.

In December 2019, the International Federation of Cerebral Palsy Football (IFCPF) announced the introduction of a "Temporary Concussion Substitution" rule change (IFCPF, 2019a). This followed a consultation process, with input from a CP footballer representative (Harry Baker) and a professional referee with experience of CP Football (Keith Stroud). In doing so, this made CP Football the first format of football to introduce such changes. Despite other contact sports (most notably rugby) permitting teams to substitute players who are suspected of having sustained a concussion for more detailed assessment, football has yet to introduce such a temporary concussion substitution rule. Recent news releases however suggest that 2020 may be the year when temporary

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Member helpline; anxiety & mental health	Sporting Chance Clinic
How to series; personal strategies for wellbeing	L&M Consulting
Coronavirus; what you need to know	Dr Imtiaz Ahmad

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> From 2020, all IFCPF-sanctioned competitions will adhere to the Temporary Concussion Substitution."

concussion substitutions are introduced in mainstream football (IFABa, 2019).

Whilst the introduction of temporary concussion substitutions is potentially valuable at all levels of football, it is arguably essential in CP football. This format of 7-aside football is played to the International Football Association Board (IFAB) laws of the game with slight modifications (e.g. no offsides). Individuals are only eligible to participate in CP Football if they have a pre-existing brain injury- either from congenital CP, or from a Traumatic Brain Injury, or Stroke (IFCPF, 2019b). Assessing a head injury sustained by an individual who has a pre-existing head injury is a complex task with many unknown elements. Given these significant challenges, it is important to support the clinician evaluators who are charged with maintaining the safety of their players following a head injury.

How will Temporary Concussion Substitutions work?

From 2020, all IFCPF-sanctioned competitions will adhere to the Temporary Concussion Substitution (TCS) policy (IFCPF, 2019c). Any player who is suspected of sustaining a head injury should be removed from the field of play by the team medical personnel for a concussion assessment. At this point a TCS will occur, whereby a substitute will enter the field of play to replace the injured player. In keeping with the timescales in rugby and also the timeframe recommended by the Concussion in Sport Consensus Group (McCrory et al. 2017), this TCS will be permitted to play for 10 minutes whilst the injured player is being evaluated. If the injured player is deemed fit to continue within this 10-minute window then the TCS will be removed and the initial player returned to action. If the player is not fit to continue then the TCS will remain on the field of play, and if the 10-minute period expires without the injured player being passed fit to return then the TCS remains on pitch as a recorded substitution. Further information regarding the details relating to the TCS in CP football is available online (IFCPF, 2019d).

An additional consideration in CP Football are the "classifications" given to each player to ensure parity and fairness in the sport. Players are allocated to one of three classes based on their impairment status and functional ability (IFCPF, 2019b), with these classes being termed "FT1", "FT2, and "FT3". FT1 players are the most impaired, with FT3 being the least impaired. During competitive matches, each team must have one FT1 player on the field at all times and is not permitted to have more than one FT3 player on the field. When a TCS is undertaken, the player which is the TCS must be of the same classification (or lower) as the player they are replacing (i.e. an FT2 player could be substituted by either an FT2 or an FT1 but not by an FT3). These factors relating to classification have not been a barrier to the introduction of the TCS, despite adding an additional layer of complexity which is not present in mainstream football.

The next steps for Temporary Concussion Substitutions

The implementation of the TCS policy will be analysed at upcoming IFCPF tournaments by evaluating how the process is used by teams. The example of the Head Injury Assessment in rugby and the subsequent analysis by Fuller and colleagues (2016) provides an example for how this evaluation could occur. In this preliminary year of implementing the TCS, there may be issues arising which result in the modification of the TCS in future years. Given that the IFCPF TCS policy is in its infancy, adjustments and alterations to its current state are anticipated. To understand more about the thoughts of key stakeholders (players, medical staff, coaches, and referees) towards the TCS, qualitative studies are planned to obtain input from all parties.

It is hoped that the TCS may also lead to additional research in this area. At present, footballers with a disability are subject to the same return to play (RTP) timescales as their non-disabled peers. The 5th International Consensus Concussion Guidelines (McCrory et al., 2017) made specific reference to the management concussion in

youth athletes-however to date there has been no mention of the best practice management of concussion in athletes with a disability. An increased understanding of the management of concussion in athletes with a disability will enable RTP guidelines to be created which will be specific to their needs. In time this may even lead to a "DisabilitySCAT" (or equivalent), in order to best inform the management of concussion in this population. There would be many difficulties to the creation of such a tool however, given the myriad of physical and medical complexities associated with disability athletics.

The future of concussion management in football

The concept of introducing temporary concussion substitutions in all formats of football is likely to be a topic of much discussion in the coming year, and there is strong public interest in the coverage of concussions in the mainstream news and media (Ahmed & Hall, 2017). Regardless of any decisions made by IFAB at their AGM in February 2020 (IFAB, 2019b), pressure is building on many national football federations to introduce temporary concussion substitutions (The Australian, 2020). The 6th International Consensus Conference on Concussion in Sport will also take place in 2020, which is likely to provide clinicians with updated guidance in the management of concussion. The temporary concussion substitution rule was introduced to enable clinicians working in football to have more time to assess head injuries more effectively without the pressure of gameplay interfering with their decision. In the international discussion surrounding concussions in football, it should be considered that all formats of football could benefit from this rule change to optimize the evaluation and safety of our athletes.

Acknowledgements:

The IFCPF Medical Committee would like to thank Sam Turner (CEO / Secretary General of IFCPF) for helping to generate the TCS Policy, and Harry Baker (CP footballer) and Keith Stroud (referee) for their input into the design of the TCS.

> **"The concept of introducing temporary concussion substitutions in all formats of football is likely to be a topic of much discussion in the coming year."**

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LESSONS FROM BASKETBALL
REFLECTIVE PIECE

FEATURE / DR AMY ARUNDALE PHD, PHYSIOTHERAPIST WORKING WITH THE BROOKLYN NETS

My background is in football. I grew up playing and was privileged enough to play at University and in the Scottish Women's Premier League. I coached football prior to becoming a physiotherapist, and combined my love of football with my career, as I carried out a PhD focused on primary and secondary prevention of ACL injuries in footballers. Unexpected opportunities are part of life though and I now work as a physiotherapist and biomechanist in the NBA. As my second NBA season progresses, I can reflect on the aspects of the two sports that I've learned and appreciate.

The Science

On a weekly basis I receive emails from PubMed notifying me of new scientific articles. On average, the keyword "Football" gets around twenty-five to thirty-five new articles a week whereas the keyword "Basketball" gets about seven, to ten! Having grown up professionally in the world of football, I took the accessibility and quality of research for granted. If I had a clinical question I could ask networking connections from football medicine conferences, researchers including the Football Research Group (the group behind the UEFA Elite Club Injury Study), or dive deeper into the literature to find answers. Even if the research wasn't in the demographics I was searching for, I could generally find a relating study within football.

Basketball does not have the same breadth and depth of resources. Basketball and football are similar with regards to injury epidemiology and in some cases injury mechanisms. Thus, there are many occasions where I find now myself looking to the football literature for answers, as it's the closest evidence base available. I have a much greater appreciation for the research in football. Basketball needs more research on injury mechanisms, risk factors for injury, prevention, and rehabilitation. However, both sports share a common need for more research in women and younger athletes.

Resources & Development

The NBA draft occurs in late June. Each team approaches the draft slightly differently, however there are aspects that seem common between the majority of teams such as, bringing in potential draftees to watch them play, performing medicals and physical testing, interviews, and other tests/measures. I started working at the Brooklyn Nets ('Nets') two days before the 2018 draft process started. I helped take medical histories, perform physical exams, and assess movement. All of the 100+ athletes were different physically, but it surprised me that some

struggled to stand on one leg, most struggled with basic movement tasks like squats or single leg squats, and a handful lacked skills such as swimming or riding a bike. There were some athletes who had great foundations, but the overwhelming majority had specialized in basketball very early on in life and had little exposure to strength and conditioning, prevention programs, or basic sporting movements.

Prevention is a major focus of research and clinical practice in football. Observing the NBA draft process made it evident to me that there is great need for prevention research and development in basketball. The resources invested in football development, particularly in the UK, starting with young players are greater than that in basketball. Some of the resource differences extend from developmental pipelines. In contrast to the football academy system, basketball has almost two parallel pathways. Traditionally basketball has been centered around the school system where athletes develop playing for their middle and then high school teams before going to university and subsequently playing professionally. Alongside the school system is the AAU (Amateur Athletic Union). The AAU host competitions in multiple sports but are best known for their youth basketball. The AAU is the largest basketball organization in the US, hosting youth teams from across the country. Teams can be organized individually, rather than as part of a club, and often the only staff is an unpaid coach. AAU also filters players into university teams, which then feed into professional teams. Currently to play in the NBA, amateur athletes must have played at least one year in university before they can be drafted or signed.

The extent of resources available in youth and collegiate basketball teams varies widely. At youth level, it is rare for an AAU team to have any medical or performance support staff. The AAU tournaments (sometimes involving hundreds of teams) have Athletic Trainers (similar to a Sports Therapist in the UK) covering the venue, however given the lack of staffing, they are only able to provide emergency and acute care. High schools often have an Athletic Trainer, however that trainer may be responsible for all of the sport teams at the high school including but not limited to football, American football, volleyball, baseball, softball and athletics. University level basketball teams also tend to be short staffed. At the top programs in the country with the greatest financial resources, there is often one Athletic Trainer and maybe a dedicated Strength and Conditioning Coach. At smaller programs, medical/performance staff are responsible for multiple sport teams simultaneously. Therefore, there is a vast difference in how much is invested in player development, particularly physical development,

In contrast to basketball, in football there is a financial incentive to invest in development. Football teams can loan players out or earn money from transfer fees by selling players. With the prospect of generating income from developing youth players, it's in a football club's best interest to invest in their academy and foster that revenue stream. In contrast, there are no player loans or transfer fees in the NBA, thus without that revenue stream, there is less of an incentive to invest in youth development. In the future, I think we will see a change in the level of investment in basketball development, particularly as the NBA rules change, allowing athletes to skip university and go straight from high school to playing professionally. This is a potential area where basketball could learn from football by building systems to support young athlete development allowing them to have the longest, healthiest career possible.

Club Structure

Unlike the promotion/relegation structure of the English football league system, the NBA is a stand-alone league. The thirty NBA teams, regardless of their record the previous season, remain in the NBA the following season. The G-League is considered a developmental or minor league for the NBA. The teams in the G-League also remain, regardless of record. Twenty eight of the thirty NBA teams have an affiliated G-League team however, unlike the relationship between first teams and reserves/academies at football clubs, G-League teams often don't share facilities with their NBA affiliate. The Brooklyn Nets' G-League affiliate is about a one-hour drive away in Long Island and this is one of the closest distances between NBA and G-League affiliates. The G-League affiliate for the Miami Heat is in Sioux Falls, South Dakota (2,935 km away, approximately a five-hour non-direct plane trip away).

One large difference in the NBA/G-League affiliation compared to football is during the return to sport. In a football club, especially during long-term rehabilitation, a player can get training and game exposure with the Under-23s or reserve team before returning to first team action. In basketball, return to play via the G-league is both rare and complex. Due to logistical difficulties such as organizing schedules, travel and staffing, the best analogy in football would be a Premier League player making a return via a Championship club.

One or two games a week now sounds easy!

The NBA season has eighty-two games excluding pre-season and the playoffs. This averages out to 3.3 games per week, sometimes on back-to-back nights, spanning from Los Angeles to Miami to Boston, creating a significant challenge. On reflection, I now have a much greater appreciation for being able to plan a week in football with more time between match days.

Keeping athletes healthy to perform day-in/day-out is a major challenge due to the NBA schedule. Rehabilitation of an injured athlete poses other scheduling challenges. In the initial stages of rehab, the medical/performance team has to decide whether to bring the athlete on the road; weighing the benefits of keeping the athlete with the team against the risks of travel and available time for rehabilitation. In the later stages of rehab there are different challenges. With a game roughly every other day, full team training sessions may not be at high intensities or at regular intervals. Thus, returning a rehabilitated athlete into full training sessions, 5v5 play, or controlled game exposure can be difficult. As a medical/performance team we have to be creative with schedules and sometimes, rehabilitating athletes play against/with coaches to get the loads and exposures that they need.

Learning opportunities

Every sport has its positives and negatives posing different unique challenges. Regardless of the sport, communication within teams remains paramount. The Nets have created a medical/performance team composed of professionals with backgrounds ranging from football, Australian Rules football, American football, figure skating, skiing, endurance and motor sports. Our team is diverse demographically, cognitively, and philosophically. We regularly share stories about our previous sports, providing each other with opportunities to learn from our multidisciplinary backgrounds. I've also learned an incredible amount about basketball itself, from the intricacies of the rules and idiosyncrasies of the league, to the movement patterns of the athletes. I've gone from being able to create and run a return to play field session to relying on coaches to execute and play within a session. Being away from football has raised my appreciation for the sport, but I am incredibly thankful for the experiences and all that I've learned so far in basketball.

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INJURY MITIGATION IN TEAM SPORTS. PART-3: IMPROVING RESEARCH QUALITY

FEATURE / COLIN W. FULLER – COLIN FULLER CONSULTANCY

Colin W. Fuller

Colin Fuller
Consultancy Ltd
Main Street,
Sutton Bonington,
LE12 5PE
UK

This paper is based on the author's Keynote lecture presented at the 6th Football Medicine & Performance Association Conference on 17 May 2019.

Introduction

Part-1 of this series[1] reviewed models used by researchers to develop injury mitigation programmes and Part-2 outlined[2] the sport-related risk management model. The aim of this paper is to present two techniques that can be used alongside the risk management model to improve the quality of current injury mitigation research.

Injury Investigations

A poorly researched area within injury mitigation is characterisation of the events leading to sports injuries: this information is of paramount importance for developing ways of preventing similar events occurring in the future. One management technique used to characterise injury threats, consequences and barriers is the bow-tie model[3,4], which combines the benefits of event-tree and fault-tree analysis[5]. A simplified bow-tie diagram is presented in Figure 1 to illustrate the principles of the technique. The centre point of the figure shows a potential adverse event with a potential injury arising from the event. The left-hand side of the bow-tie diagram shows the immediate and root cause threats leading to the injury, while the right-hand side of the diagram shows the immediate and long-term, consequences resulting from the injury. Items on the left-hand side of the bow-tie impact mainly on the incidence of injury, whereas items on the right-hand side of the diagram impact on the severity of injury. Superimposed onto the left-hand side of the bow-tie diagram are potential barriers that could reduce the number of injuries and on the right-hand side potential barriers that could reduce the severity of injuries. These barriers equate to the preventive and therapeutic interventions included in the risk management model discussed previously in Part-2. The bow-tie summarises, in pictorial format, the threats, consequences and control barriers in place for a single event and a single injury linked with that event: a complete analysis of the risks associated with the event would clearly be more complex, as there would be other potential injuries to consider.

Bow-tie diagrams add considerable value to the risk management process. The bow-tie model provides a clear visualisation of the link between events, injuries, risk factors and mitigation measures: this makes the model a better tool for communicating risk management issues to non-experts than lists and tables of risk factors and control measures. To gain the full benefits from the bow-tie model, it is also necessary to appreciate that one bow-tie can be connected to one or more other bow-ties because a consequence included in one bow-tie may appear as a threat in another bow-tie.

Quality Management

Injury mitigation procedures, based on the sequence of prevention model, invariably involve the presentation of an exercise plan followed by a short trial to determine whether an intervention group using the plan has a lower incidence of injury than a control group following their own, normal exercise plan. This simplistic approach has many limitations, such as the assumption that one-off programme assessments provide optimised prevention methodologies, the absence of customer evaluations for suitability and compatibility with other team requirements, and the lack of a cost-benefit analysis. As discussed in Part-2, the risk management model is based on a cyclical process that involves on-going evaluations of injury risk. This approach is mirrored within Deming's quality management Plan-Do-Study-Act (PDSA) cycle (Figure 1), which was developed between 1939 and 1991 to enhance the translation of quality improvement initiatives in business into practice through a structured iterative learning process6.

The four-stage PDSA cycle can be described, in terms of injury mitigation, as follows:

- ***Plan:***
  (i) Identify the objective(s) of the intervention,

  (ii) Define the intervention and set the criteria for success,

  (iii) Plan the intervention process by identifying the who, when, where and how of the intervention;

- ***Do:***
  (i) Carry out the intervention and collect relevant data,

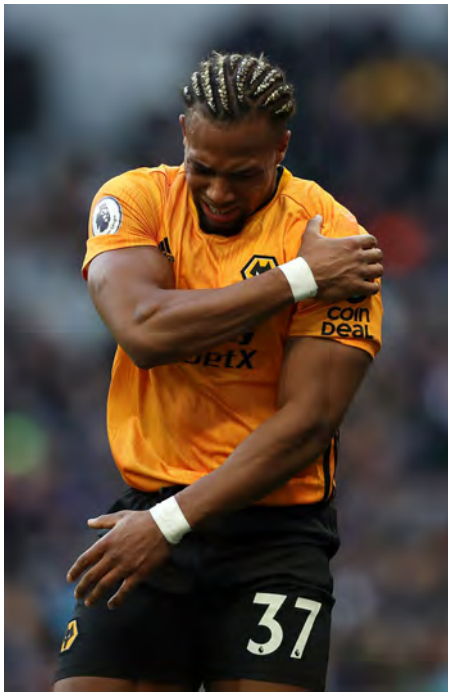
  (ii) Record problems and obstacles encountered during the intervention,

  (iii) Analyse the results;

- ***Study:***
  (i) Evaluate the results,

  (ii) Compare the results with expectations,

  (iii) Identify key strengths and weaknesses of the intervention and its implementation;



- ***Act:***
  (i) Accept and apply the injury mitigation procedure without change, or

  (ii) Abandon the intervention on the grounds it is unlikely to achieve the desired objectives, or

  (iii) Identify areas for improvement and move to the Plan stage of the next cycle.

Few sports injury mitigation studies pre-define criteria for success and many studies only report information related to the 'Do' and perhaps part of the 'Study' stages of the PDSA cycle. Adopting the principles of the PDSA process would greatly enhance the quality of current injury mitigation procedures because each subsequent cycle builds on the knowledge gained from the previous cycle. Although small, short-term, stand-alone injury mitigation studies rarely produce meaningful results, the PDSA process encourages initial small-scale, pilot evaluations as cost-effective precursors to larger studies provided they are acknowledged and implemented as such.

Speroff et al., identified 4 key questions that must be addressed in order to define the merits of an intervention study7:

- Is the study applicable in the context required?
- Are the results of the intervention valid in the context required?
- Have appropriate criteria been used to interpret the results?
- Will the intervention improve practices in the context required?

One reason why published injury mitigation interventions fail to be adopted is that sports medicine Journals generally publish simple, low quality, before and after intervention studies, rather than studies that have assessed performance over a reasonable period of time6. Furthermore, single-stage interventions are extremely unlikely to produce optimised mitigation programmes: it is always necessary to review the outcome of an intervention to identify strengths and weaknesses, such as:

- Was there a reduction in injury burden?
- Did the reduction meet expectations?
- Were the benefits achieved greater than the costs of the intervention?
- Was the compliance level satisfactory?
- Were there any adverse implementation issues?
- Could the content and structure of the intervention be improved in any way?
- Could the implementation mode be improved in any way?
- Could the benefits be enhanced?
- Could the costs be reduced?

The intervention should then build on the strengths and be modified to address the weaknesses prior to a further round of evaluation.

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FOOTBALL AS MEDICINE IN PHYSICAL ACTIVITY PROMOTION

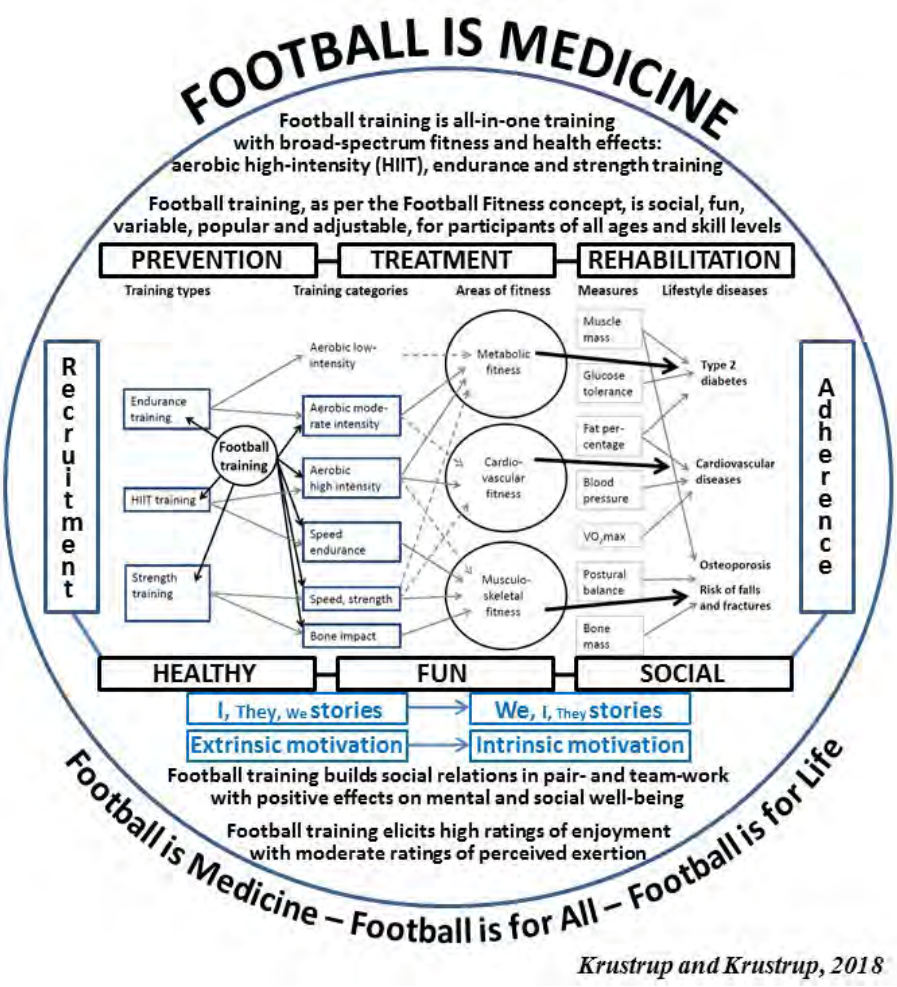
FEATURE / MARCOS AGOSTINHO, PETER KRUSTRUP & DANIEL PARNELL

Football as a competitive sport literally moves hundreds of millions of people around the world: players, coaches, referees, leaders, supporters, and more. However, there is another football: the schoolyard football, the neighborhood indoor football, the summertime beach football and the good 'ol football match with friends. It's the so-called "recreational" football that offers fun and pleasure. And health!

The first studies of recreational football appeared around 2003 in Denmark [1]. Today we know that recreational football brings broad spectrum health benefits that are transversal to both men and women, of different ages and social strata, in healthy and chronically ill people, with or without previous experience in the sport [2].

This type of football has no formal or structured form of competition and it consists of pair-based exercises and small-sided drills. It is characterized by being an intermittent physical effort of moderate to vigorous intensity with each training session leading to a considerable amount of energy expenditure and an effective combination of cardiovascular, metabolic and musculoskeletal fitness training. However, the perceived effort of the participants tends to be inferior to other equally intense activities, like strength training, running or even interval training. This may be due to a greater playful aspect of this type of football and also to the effect of the interaction between the participants, being that it is a collective modality. These aspects are very important in an active behavior that is intended to perpetuate throughout one's lifespan.

Playing football in a recreational manner can positively influence all dimensions of health: it improves physical, mental and social well-being. Regular practice of 60 minutes, 2 times a week is enough to get broad-spectrum effects for adult participants



across the lifespan, making recreational football one of the best types of fitness training! Yet, football can also be particularly beneficial for unique groups of participants.

In a pragmatic, multicentre, parallel randomised controlled trial in 5 Danish urological departments, research examined the effectiveness of a community-based football programme for men with prostate cancer [3]. Within the trial, participants allocated to football appeared to have improved hip bone mineral density and fewer hospital admissions. Men who played football more than once a week for 1 year lost fat mass and reported improved mental health.

Why is this important? It's a given that physical inactivity is a current problem in our society. In general terms, only one in four adolescents or adults meets the recommendations of the World Health Organization for the levels of physical activity. Given these recent findings, alongside the evidence collated surrounding football as medicine (Krustrup and Parnell, 2019) the potential of community-based or recreational football proved to be positive and extremely valuable [4] (see above; Krustrup model/figure).

In many countries, football is the preferred sporting activity among boys and girls. Among male adults, football and/or futsal is a favorite collective modality, making up 15% of the preferences, falling only behind to gym, running and walking activities.

In this case, football should play an important and strategic role in promoting active lifestyles. "Sport for all" has been identified as one of the seven major priorities for promoting physical activity [5]. The European Union's recommendations state that elite sport organizations can also make an important contribution by providing recreational programs for different age groups and social strata. Published guidelines already exist for clubs that want to offer health-promoting physical activity programs. These programs can include football as a physical practice in itself and/or take advantage of the club's facilitating factor in order to promote healthy lifestyles, an example being EuroFIT (European Fans in Training). Football's popularity has also been used in programs such as Football Fitness and FIFA's 11 for Health as a way of promoting healthy lifestyles in different countries.

In summary, football - as a sport, physical activity and social phenomena - can undoubtedly be one of the strongest allies of any public health strategy, be it national or international, namely through the potential increase of the population's physical activity level.

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Daryl Carter - 1st Team Physiotherapist
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Mark Hoy - 1st Team Physiotherapist
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Will Peers - 1st Team Physiotherapist
Hull City Football Club

SUCCESS IN FOOTBALL IS NO LONGER ENOUGH

FEATURE / PROFESSOR DAVID LAVALLEE, JEFF LOWDER, JANE LOWDER & RUTH LAVALLEE

Introduction

Success in football has an increasing emphasis on the process taken to achieve outcomes – or to put it simply, how success is achieved in football has become more and more important. Given the growing awareness and increasing importance of this area, we developed a tool to help sports demonstrate their commitment to the duty of care they provide in a simple and reliable way. In this article, we share insights from surveying more 70 sports over the last two years.

Duty of Care in Sport

In 2017, Baroness Tanni Grey-Thompson conducted an independent review of duty of care in sport on behalf of the United Kingdom Government. The review established a framework that, for the first time, defined seven critical factors that comprise this area. These factors are: Safeguarding; Equality, Diversity and Inclusion; Safety, Injury and Medical; Transition; Mental Health; Representation of the Participant's Voice; and Education.

The review also highlighted the shortage of data in the area, with evidence often being anecdotal and in some cases inflammatory. It emphasized the need for data from a wide range of people involved across sports. Baroness Grey-Thompson's report concluded with a number of priority recommendations, one of which was: Duty of care should be measured via an independent survey giving equal voice to all stakeholders in the system.

Harnessing Data to Progress Player Care

With a framework established, the next logical question to address was "How can good duty of care be measured in the sporting context?" This prompted the development of The Sport Census, a 2-minute survey that sports can administer, and can be accessed via any device: smart phone, tablet or computer.

The goal of The Sport Census is to provide sports with a quick and easy tool that can illuminate best practice and empower informed decision-making and proactivity through accurate data reported by relevant stakeholders.

This survey invites participants involved in sport at all levels (grassroots participants, coaches, referees, academy and professional players, parents, sports scientists and other practitioners, volunteers and others involved in football in some other capacity) to anonymously complete a series of uniform questions based on the seven critical factors identified in the Sport Duty of Care Review Framework.

A 'Key Performance Indicator' (KPI) out of 100 for each of the seven factors is arrived at by calculating average scores for each factor once all individuals complete the survey. An overall KPI is also calculated out of 100 by averaging the seven factors.

Sports are provided a data visualisation of results, including total scores for the seven factors plus an overall KPI for the entire sport. Results can be filtered by multiple variables including age, gender, disability, ethnic group, religion and by role and competition type, which can inform a high level of specificity in strategic planning for programs and support services.

Over the last two years, over 70 sports have completed The Sport Census. Sport decision makers have applied the learning from the feedback to inform and improve policies and procedures and other areas of decision-making associated with sports administration, communications, and implementation. It has also allowed sports to demonstrate the impact and return on investment of the programs and services they deliver in response to data collected on an annual basis.

The value of The Sport Census is dependent in the first instance on its ease of use, the reliability of the data it collects, and the overall information it provides for analysis in an accessible format. Feedback can help sports not only track trends and identify their next steps, but also learn how to respond and innovate with pace. The ultimate measure of its value is that decision-makers apply the learning from the feedback to inform and improve policies and procedures and other areas of decision-making associated with administration, communications, and implementation.

The Irish FA Foundation (2020) recently implemented The Sport Census. They decided to use it to acquire meaningful data on how they are perceived by their stakeholders in a number of areas of welfare and well-being. The results helped them plan their next steps in key areas and to identify where they needed to focus their attention. The Irish FA plan to use the overall information to inform their decision-making and take positive action over the next year.

Conclusion

Duty of care has climbed the property stack in the minds of everyone who is interested in football in recent years. For example, the Autumn 2019 issue of Football Medicine and Performance dedicated to mental health as well as the Winter 2019/20 issue highlighted all seven areas from Baroness Grey-Thompson's review. The opening 'From the Editor' piece in from the Autumn 2019 issue noted how "Football, in particular, can play an instrumental role in promoting mental health awareness" (p. 3).

We would go further and say football is in a position to help redefine what success and excellence in sport means by putting duty of care at the centre of what football does and delivers.

"Duty of care has climbed the property stack in the minds of everyone who is interested in football in recent years."

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THE QUADRANT OF DOOM AND HAMSTRING INJURIES: SEXY BUT TOO EASY?

FEATURE / BUCHHEIT M, AVRILLON S, SIMPSON B.M, LACOME M & GUILHEM G

Introduction

The different factors relating to hamstring injury risk have been well reviewed. They include among others; age, previous injuries, ethnicity, strength and strength imbalances, flexibility, muscle architecture, anatomy, training/competitive load (often high-speed running) and fatigue [1-3]. Recently, there has been a growing emphasis on two of those factors, namely hamstring strength and fascicle length [4-6]. This is related to the fact that these two muscle properties are modifiable factors strongly related to the capacity of the muscle to withstand repeated eccentric contractions during potentially harmful actions such as sprinting. In fact, it has been suggested that players with weak knee flexor eccentric strength (as measured using a Nordbord, Vald Performance, Brisbane, Australia) and short biceps femoris long head (BFlh) fascicle length may be at much greater risk of injury than players with strong knee flexors and long fascicle length [6]. This has led some authors to present the data in the form of a "quadrant of doom" [1], where the overall risk of an individual sustaining a hamstring injury is shown graphically, while plotted as a function of both hamstring strength and fascicle length. It is therefore understood that athletes should escape from the lower left quadrant (high risk), and enter the top right panel of the graph (lower risk), likely via eccentric-biased training [7]. The idea behind the quadrant is evidence-based and sensible [8], and the highly practical aspect of those strength and structural measures make the approach very appealing for practitioners. Nonetheless, we wished to comment on two important and still overlooked methodological aspects that deserve more attention to make the most of the utilisation of the quadrant: 1) the possible impact of body mass (BM) on Nordbord performance [9-11] 2) the current limitations of the muscle architecture measurements inferred from static ultrasound images and 3) possible differences in individual muscle properties and their relationships with hamstring ability to withstand active lengthening [12, 13].

The impact of Body Mass on Nordbord performance.

The need to consider players' BM when it comes to assessing Norbord performance is straightforward for most practitioners (Figure 1), and is not a new finding in the scientific literature either [9-11]. At least three independent studies have now reported moderate-to-large relationships between Nordbord performance and BM, and have shown -although correlations don't imply causality- that Nordbord performance likely increases consistently by 3 [11] to 4 [9, 10] N per kg of BM. This is not surprising, for at least two reasons: 1) for most neuromuscular-related types of measures, including hamstring strength [14], muscle mass is generally beneficial for performance [15] and 2) because of the upper body inclination when leaning forward during the Nordic exercise, heavier and/or taller players with a longer lower-leg lever (distance from knee joint axis of rotation to the ankle strap) may apply higher levels of force to the dynamometers. Greater Nordbord performance in heavier

players may be in turn interpreted as a greater eccentric knee flexor strength, which may be independent (at least partially) of their true strength. It is however important to note that the beneficial effect of a greater BM on Nordbord performance may only be apparent for the players that are strong enough to perform the exercise in a controlled manner, since more load added to the chest in athletes with weak knee flexors eccentric strength will likely only make them fall faster, with no effect on Nordbord performance. However, and while we agree that the suggested normalising procedure [10] still lacks prospective evidence, until a new solution is provided, scaling Nordbord performance for BM remains the most practical way to account for this likely confounding factor. While we also agree that the value of the reductions reported in those three studies (3 [11] to 4 [9, 10] N per kg of BM) may not be as steep in more homogenous/different players groups (unpublished data from [6]), we still believe that this relationship should be tested and then accounted for if present (irrespective of its magnitude). Surprisingly, despite this evidence, most researchers have continued to report absolute strength values (N) in their studies [1, 4-6]. They have also used a unique absolute eccentric strength threshold value to identify players with increased hamstring injury risk (i.e., 265 N) [16] or to design the quadrant (i.e., 337 N, in Figures 2 and 3 in ref [1]), without taking their own BM into consideration; therefore, this procedure remains prone to approximations. It is also important to note that simply dividing eccentric strength by units of BM (i.e., N/kg) [9, 16] is unlikely optimal either. The levels of correlation (and slope magnitudes) reported in players of different ages and sports [9, 10] suggest that the relationship between eccentric knee flexor strength and body size (and likely muscle architecture, see next section) is complex, and likely be specific to the group of players considered (i.e., group-based allometric scaling parameters [17]). Overall, this data suggests that BM should not be overlooked when monitoring Nordbord performance, which may limit, at least in theory, the usefulness of the "quadrant of doom" as currently presented [1, 7]. Further studies are nevertheless required to confirm whether BM-adjusted strength values improve injury risk prediction in elite soccer players.

To further illustrate our point, we used data recently collected in young elite footballers [18] and reproduced a typical "quadrant of doom" [1] using the suggested absolute strength threshold (i.e., 337 N Figure 2, left panel). While we agree that the value of such a cut-off is often sample-dependent, the point we are trying to make here is likely valid irrespective of the actual value chosen. Following this initial reasoning, player #19 (56 kg, knee-flexor strength: 316 N; BFlh fascicle length: 8.1 cm, bottom left quadrant) was reported to have a higher risk of injury than player #2 (73 kg, 384.5 N; 7.5 cm, lower right quadrant). However, after adjusting players' knee flexors strength to their BM [17], completely different figures were apparent, with risk profiles being drastically different, i.e., player #19's relative strength (compared with body-mass expected performance): +27.1%, player #2: +16.6%. While player #2 remained in the same quadrant, player #19 moved into the lower right quadrant, which likely signified lower injury risk. With this particular player (#19), for example, practitioners (ourselves in this case!) would clearly face a dilemma when assessing his injury risk.

Hamstring muscle properties and their relative susceptibility to injury. The second methodological point that we wished to comment on is related to the other axis (i.e., fascicle length). There are several points that deserve consideration:

"Overall, this data suggests that BM should not be overlooked when monitoring Nordbord performance, which may limit, at least in theory, the usefulness of the 'quadrant of doom' as currently presented."

a. In fact, players' anthropometrical profile not only impacts on muscle mass, but also on muscle geometry and size, since fascicle length, muscle thickness and pennation are interconnected factors. For example, the fascicle length of a fusiform muscle such as the semitendinosus is likely directly related to the length of the femur and in turn, to the player's size [19]. This suggests that taller players are likely to present with longer fascicle length, which may have nothing to do with the muscle's ability to withstand active lengthening per se. Therefore, as for strength measures, body size likely confounds the relationship between fascicle length and players' actual injury risk. Normalizing fascicle length for muscle length [6, 19] may therefore constitute, at least in theory, a first improvement to the only use of absolute fascicle length [1]. In contrast to this reasoning however, normalized measures of fascicle length were pretty similarly related to injury rates in the unique study to date in soccer players [6]. It is however worth noting that overall group-based results may not always apply to extreme case scenarios (Figure 1); therefore, additional studies in players of varying sizes are necessary to clarify this point.

b. Importantly, fascicle length measurements of pennate muscles such as the BFlh with a 4.7-cm probe also require a substantial extrapolation (≈60% of the entire length for a 11.8 cm-long fascicle [20]), which can lead to a 3 [20] to 5 [21] % error that is unfortunately greater than the smallest important effect (i.e., 0.2 × between-subject SD [22], estimated to be around 2% in our population [18]). This poor signal/noise ratio shows the limitation of using a single fascicle length measurement on the basis of a single B-mode image to draw the quadrant. To improve precision and in turn, confidence in their assessment, practitioners may therefore need to use i) repeated measures that can decrease the noise by a factor of √n [23] or ii) alternate muscle architecture measurements using MRI [24], diffusion tensor imaging [25] or extended field of view (EFOV) measures [18] for example. This latter mode uses an algorithm that fits series of images, allowing scanning of entire fascicles within one continuous scan. This technique may therefore enable practitioners to avoid any extrapolation of non-visible parts of the muscle and provides improved measurement accuracy [21, 26]. Using a scan that follows fascicle orientations along their path (non-linear EFOV) can further account for fascicle curvature and improve the imaging of the fascicle, particularly in the distal regions, resulting in higher reliability compared to single B-mode images or linear EFOV (Pimenta et al. 2018). Interestingly, this method revealed reasonable increases in BFlh fascicle length (~+0.5 cm i.e. +5%) in elite football players after 6 weeks of eccentric-biased hamstring training [18].

c. Despite the evidence showing the relationship between injuries and fascicle length measured in a relaxed state [1] (i.e., in a resting position as we have also done, Figure 2) it is worth noting that such an assessment is unlikely to accurately represent an individual muscle's ability to withstand an active lengthening. This is particularly true for a muscle group with such a complex and heterogeneous architecture as the hamstring [19, 27], which may likely involve fascicle rotations during contractions [28]. In addition, while it is true that fascicle lengthening is related to functional alterations induced by exercise [29], the elastic properties of tendinous tissue may mitigate the extent of fascicle strain [30, 31]. Moreover, fascicle length was considered for BFlh only, whilst knee flexor strength measured at the joint level reflects the contribution of all synergists and antagonist muscles. In fact, for the same joint motion, the semitendinosus likely displays less relative strain than the other hamstrings probably owing to a greater length, longer fascicles and, possibly, a longer tendon [19]. Using kinematics and ground reaction force data integrated with a three-dimensional musculoskeletal computer model, Schache et al. [13]

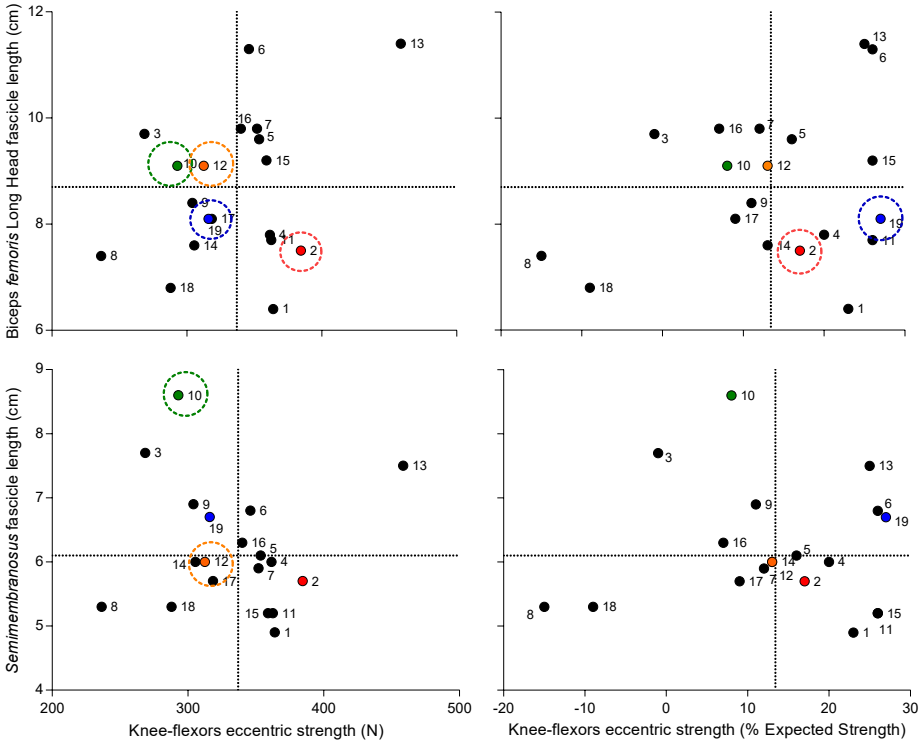

Figure 2. In-season values of elite U19 soccer players (17.5±0.7 yrs, 175.7±5.0 cm and 64.7±4.9 kg, training 10 hrs a week) for biceps femoris long head (upper panels, BFlh, y-axis) and semimembranosus (lower panels, y-axis) fascicle length and eccentric knee flexor strength (Nordbord performance, x-axis) expressed in absolute (left panels) and relative to body mass (right panels). The eccentric knee-flexor strength testing was performed as previously described (10). As between-leg differences were beyond the scope of the current study, the average strength of both legs was used for analysis (10). The data relative to body mass are expressed as the % difference vs. body-mass expected value using the following equation: eccentric strength (N) = 4 × BM (kg) + 26.1 (10). While we agree that the adjustment of Nordbord performance for BM may be optimal using population-specific equations (10), we chose to use this generic equation since this is what most practitioners would use initially, before getting their own equation. We also believe that using a group-specific equation would not change the main message of the present example. Muscle fascicles were imaged using a 42-mm linear probe (2–10 MHz, SL10-2, Supersonic Imagine, Aix-en-Provence, France) coupled with an ultrasound scanner (Aixplorer V11, Supersonic Imagine, Aix-en-Provence, France) (18). Given that the field-of-view of the probe was too narrow to image an entire fascicle, we used an inbuilt panoramic mode of the ultrasound device. This mode uses an algorithm that fits series of images, allowing scanning of entire fascicles within one continuous scan. This technique enabled us to avoid any extrapolation of non-visible parts of the muscle and improved measurement accuracy (21). We used this scan to measure the length of two fascicles per muscle. The two values were then averaged to obtain a representative value for the whole muscle. Reliability assessment in our laboratory (n= 12, test-retest within 24h) showed small and trivial day-to-day variations in BFlh length (typical error: 0.38±0.15 cm, 4.9±2.0%). Dotted lines for strength are based on recommend thresholds (1). Because of the difference in methods used to measure BFlh length in comparison with the literature, the dotted line was based on the median value of the current group (i.e., 8.7 cm).

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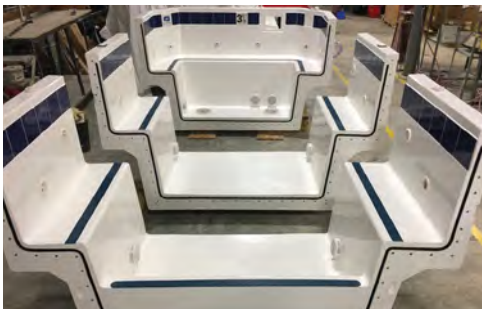

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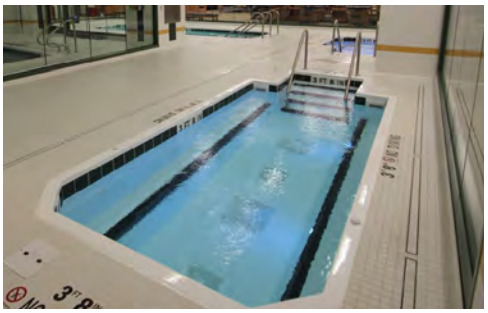

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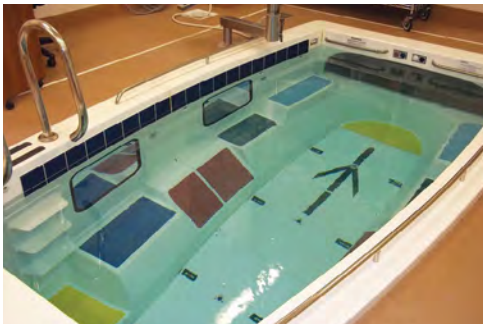

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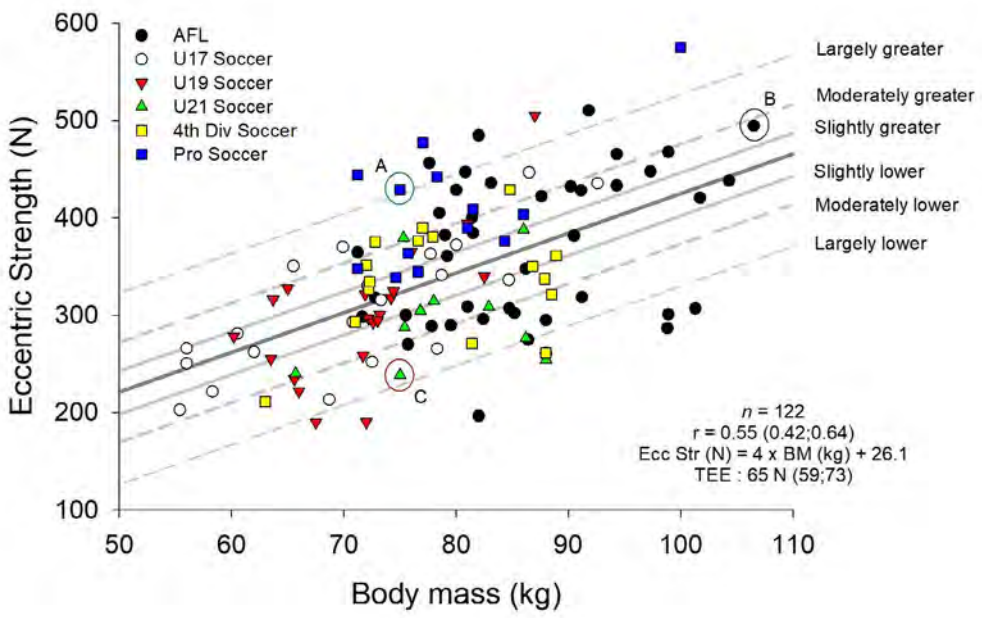

Figure 1. Relationship (r with 90% confidence intervals) between eccentric knee flexor strength and body mass (BM) in six teams. TEE: typical error of the estimate, with 90% confidence intervals. The different lines represent threshold for slightly, moderately and largely lower/greater values than BM-expected strength, based on Cohen's effect size principle. For individuals, difference vs. group mean are generally considered as substantial when the probabilities are ≥75%, which occurs when the difference is greater than the sum of the smallest worthwhile difference (SWD, = TEE/5) and the typical error of measurement (TE, from reliability studies). Reproduced with permission from (10). While player B (106 kg) demonstrates one of the highest level of absolute strength (495 N), in comparison with his BM-expected strength (451 N), his relative strength (+10%) is actually lower than that of player A (75kg, 429 – 326 N = +32%).

suggested that during sprinting, "the BFlh exhibited the largest peak strain, the semitendinosus displayed the greatest lengthening velocity, and the semimembranosus produced the highest peak force, absorbed and generated the most power, and performed the largest amount of positive and negative work". These findings highlight nicely the distinct contributions of each muscle head to lower-limb kinetics during running. Recent studies have also demonstrated that the distribution of force between the heads of the different thigh muscles is often highly variable between individuals [32]. The direct consequence of this is that the relative load sustainable by each hamstring head for the same (measured) knee flexor strength may also vary between players [33]. Therefore, since the relationship between fascicle length, muscle strength and strain during active lengthening is probably muscle head- and player-dependent, the use of a single measure (i.e., fascicle length) on a single muscle (e.g., BFlh) to assess injury risks remains imperfect, even though a majority of injuries incurred during high speed running occur within the BFlh. Although the single-muscle approach is appealing and particularly adapted to on-field conditions encountered in elite sport, further investigations are required to better understand the individual relationships between the properties of muscle-tendon unit and force-generating capacity of each hamstring muscle. The consideration of these biomechanical features may in turn contribute to a better evaluation of the injury risk of each individual muscle and a greater individualization of prevention programs [12]. In fact, assessing the properties of each hamstring muscle should give us more information and may be, in turn, more useful in preventing injuries.

d. In practice, the aforementioned differences in muscle properties within the hamstring group are another important limitation to the use of the quadrant as currently presented (Figure 2). In fact, because of the variations in length and structure between the hamstring muscles, a player's position within the quadrant may vary as a function of the muscle considered. For example, player #12 moves from the bottom left (higher risk) to the upper left quadrant (lower risk) when considering the semimembranosus or the BFlh, respectively. Player #10 remains in the same quadrant but moves from a position close to the lower quadrant (semimembranosus) to the highest y-axis position of the group (BFlh). As for absolute vs. relative strength, the fact that players may move from a quadrant to another in relation to the muscle considered represents an important challenge for practitioners seeking a robust means of assessing injury risk.

Additional considerations. Lastly, as the "quadrant of doom'' is only a two-dimensional representation of hamstring injury risk, other important risk factors such as age and previous injury history [6] can't be integrated into the 'picture'. This is another important limitation of the "quadrant of doom'' as currently presented.

Conclusion. To conclude, while our intention is definitely not to discard the proposed approach (quadrant) and on-field methodology (easy and quick Nordbord testing and echography measures) that are particularly relevant for practitioners, we wished to highlight some of the limitations that may need to be considered for a better understanding of players' potential injury risk. The example presented in the present paper (Figure 2) suggests the need for considering at least (i) BM when assessing knee-flexors eccentric strength using a Nordbord [9-11] and (ii) individual muscle-tendon properties when estimating hamstring ability to withstand active lengthening. More specifically, we believe that the effect of these two intrinsic factors should not be overlooked when assessing injury risk using a quadrant [1]. Understanding these limitations should help practitioners to make better decisions and implement targeted injury prevention interventions for high risk players.

Key points

- The idea behind the "quadrant of doom" is evidence-based and sensible, and the highly practical aspect of those muscle strength and architecture measures make the approach very appealing for practitioners.
- However, the importance of body mass should not be overlooked when monitoring Nordbord performance, which may limit the relevance of the "quadrant of doom" as currently provided with absolute strength values.
- Similarly, since body size may also directly affect muscle length, it is intuitive to normalize the fascicles length used in the "quadrant of doom" for their relative muscle length.
- The measurement of fascicle length with the 2D static image technique likely overestimates fascicle length when compared to extended field of view techniques, thereby affecting the subsequent muscle function and injury risk estimates.
- Since the relationship between fascicle length, muscle strength and strain during active lengthening is probably muscle head- and player-dependent, the use of a single measure (i.e., fascicle length) on a single muscle (e.g., biceps femoris long head, BFlh) to assess the overall injury risk of the hamstring group remains questionable.
- Considering that the "quadrant of doom" is a two-dimensional representation of hamstring injury risk factors, other important risk factors such as age and previous injury history can't be integrated into the 'picture'; this can bias the risk evaluation.
- Although sound in theory, whether the aforementioned theoretical arguments substantially improve the prognostic value of the "quadrant of doom" when it comes to predicting injuries remains to be investigated with real data. More research is still warranted to both improve 1) our understanding and use of Nordbord performance in relation to body mass, and 2) the prognostic value of isolated muscle properties in relation to the overall hamstring group.

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FEATURE / BRISTOL BEARS – JACK TARGETT

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"Initially, I didn't know what to expect," admits Jack Targett, Bristol Bears' Head of Recovery and Medical Logistics. "I hadn't really heard too much about laser therapy, so this was something new to me and pretty much all of our team. It was good to learn that you could use the system after surgery.

"I've predominantly been using the laser on Achilles injuries," he continues.

"We've had really good results. We've had three people benefit in particular; two with Achilles tears and one with Achilles tendinopathy. With injuries of this sort, players find that they're sore in the morning, very stiff, and it's hard to walk.

"We've used the laser system on them before the warm-up. During the prep window, where players do any individual work such as stretching before the warm-up, the players with Achilles injuries will come in and we would use the laser machine on them. They would find that the machine warmed their Achilles during their stretches ahead of the warm-up and reduced pain. That's enabled them to get ready for rugby at the end of the warm-up, rather than what was happening before when the players required essentially an extended warm-up to get them ready for rugby."

Jack is also quick to address the convenience of the LightForce® FXi , which has also ensured that even more valuable time has been saved as players prepare themselves for training or matches.

"The laser unit is incredibly easy to use," Jack says. "An Achilles protocol with this high-powered system only lasts three minutes and 18 seconds; I remember it by heart now because I do it so often. That time is nothing. It saves so much more

time than previously with an extended warm-up and it ensures the players feel the laser's benefit. Players have found it beneficial in their training day-to-day, but especially going into a game. They go into a session feeling pain free or as close to pain free as possible."

The feedback from the Bristol players that have utilised this new therapy has been just as glowing as that provided by Jack. Citing immediate benefits, players have revealed that they're able to achieve close to maximum performance off the back of treatment and indicated that delayed soreness post-session – once commonplace – is no longer an issue.

"The feedback from players has been fantastic," reveals Jack. "They've said that they have felt the benefit of the therapy immediately after treatment. I know that we had one player with an Achilles injury that was probably a 4/10 prior to treatment – and he felt it drop to a one or a two. He felt that he would be able to train a lot easier. He's quite a quick player and he felt that he could reach pretty close to his max speed without any issues. He also felt that the injury wasn't as sore AFTER the sessions. Without the treatment, he would comment that he'd really stiffen up for a couple of hours after training, before becoming quite sore. He told me this wasn't the case when the laser was used before training.

"Use of the laser has now become a part of the daily routine, around three or four days a week when the players train, for the lads with Achilles injuries, alongside ahead of games on gameday."

Following such a positive impact in a short space of time, the use of the LightForce® FXi system is something that Bristol Bears will now be extending, with Jack and his team keen to discover how laser therapy can benefit other acute sporting injuries.

"I think we're interested to see how the laser works on more acute injuries, to gain some knowledge in that area," Jack confirms. "We're definitely interested to see whether the laser would have the same positive effect on a knee tendon injury. With soft tissue injury, does it speed up the repair of the tissue? Those are questions we're keen to explore and answer. We've used the laser on a couple of guys that have complained of tightness in their muscle before a session and they've felt that the laser enabled the muscles to feel immediately looser and warmer."

For more information on LightForce® laser therapy, please visit www.litecure.com/medical/

"Use of the laser has now become a part of the daily routine, around three or four days a week when the players train, for the lads with Achilles injuries, alongside ahead of games on gameday."

‘AVAILABILITY EQUALS WINNABILITY’

THE EFFECTS OF A PERIODISED TRAINING MODEL ON PLAYER AVAILABILITY IN ELITE SOCCER – A CASE STUDY (PART 1)

FEATURE / DAMIAN RODEN

There are many different opinions regarding how teams should train and what a typical training week should consist of all with merits and shortcomings. Providing there is sound rationale behind the philosophy, players remain injury free and maintain a high level of performance throughout the season, it may be argued that the correct approach is being implemented.

In November 2019 Seattle Sounders cruised to victory in the MLS Cup Final, winning the last six games in style and lifting the most prestigious trophy in US Soccer in front of 70,000 home fans at Century Link Stadium. The journey however started a long time before that with the introduction of a periodised training model.

Having been outclassed and overpowered in the MLS Cup Final in 2017 with a number of key players missing through injury, the Sounders acquired the services of Performance Director Damian Roden, with the remit of improving both the physicality and availability of the squad.

Commencing his role three months into the season and following a pre-season that included players returning to training significantly overweight, an ACL rupture to their star player, several soft tissue injuries and just one win in the first ten games, there was work to do.

PROCESS

With a surprisingly limited and ageing training facility, little nutrition provision and without access to their own gym, the first step was to establish a more inspiring environment, a more demanding and intense training culture, provision of breakfast and lunch on site to support such an increase in intensity, and the erection of a tented gymnasium area to enable the team to prepare more professionally.

The second step was to introduce a periodised training model and communicate the principles behind the model, how it would be applied and the anticipated outcomes to the players, coaches and support staff. Given the demands of the periodised training model and the increase in intensity to what the current group of players were used to, the third step was to introduce weekly ‘player readiness’ assessments prior to the commencement of each training week and daily ‘activation’ sessions to prime players for training at a higher intensity.

The ultimate aim of this approach was to raise the intensity in which the team was able to perform and increase player availability.

'Damian came in with a plan, implemented it and made us better... he played a big part in winning the title.'

Garth Lagerway,
General Manager,
Seattle Sounders FC

The following article discusses the principles behind the periodised training model that was introduced from May 2018 to November 2019 with Seattle Sounders Football Club, exactly what was delivered each day of a typical training week and why, and finally the outcomes that were observed as a result of implementing the training model in this way

FIGURE 3: Typical Training Week	
Saturday	Match
Sunday	Recovery Training
Monday	Day Off
Tuesday	Technical Training
Wednesday	Conditioning Training
Thursday	Tactical Training
Friday	Tactical Training
Saturday	Match

WHAT IS PERIODISATION?

Injuries and poor performances may be attributed to a lack of periodisation or a failure to comply with underpinning principles relating to it. So periodisation is a method used to effectively improve the quality and fitness of players for the complete season but also to ensure that players are always available for training and games.

If players are always available for training, coaches can spend more time coaching, improve communication and decision making between players, and help them develop a greater understanding of how to execute the playing style.

To ensure this happens it is important to look at the structure of a typical training week and understand some underpinning principles when planning the week.

As you can see in Figure 3 a typical week is when there is a game on a Saturday, no midweek game and another game the following Saturday.

PRINCIPLE 1: RECOVERY

MATCH – RECOVERY – DAY OFF

Given the intensity of the game at the highest level, during a match, players' energy stores are depleted, muscle fibres are damaged and waste products (lactic acid and other by-products) build up within the muscle that need to be removed.

From a physiological perspective, it takes at least 48 hours before energy stores are fully replenished and for the body to fully repair itself, so the focus of the first 2 days after a game should therefore be on helping the body to recover.

Players are likely to be feeling tired and sore the day after a match, but it is important that they perform some form of activity that encourages blood flow to and from working muscles in order to remove waste products and also supply rejuvenated blood containing essential nutrients (carbohydrate, protein, etc.).

A combination of a structured 'cool down' immediately after a match and a light warm up including mobility exercises and extensive simple passing exercises the following day will aid the recovery process. Similarly, activities such as jogging, cycling and swimming provide an effective alternative to football exercises.

From a players' perspective it is essential that they consume as many healthy calories as possible in the form of at least four balanced meals that consist of carbohydrate to replenish energy stores, protein to help rebuild damaged muscles, vitamins and minerals to help protect the body, essential fats to reduce inflammation and plenty of fluids to aid hydration.

As discussed players are likely to feel tired the day after a game, but are often more tired and sore two days after a game. This period is the time when the body needs as much energy as possible to go to repairing damaged muscle tissue, so players should have a day off to reduce the amount of energy they use.

Again it is important that players understand the need to consume four large balanced meals to ensure that the recovery process is complete.

The day off will also allow players to switch their thinking away from football and return to training the following day refreshed and ready to focus on preparations for the next match.

PRINCIPLE 2: TEAM ORGANISATION

TACTICAL – TACTICAL – MATCH

In preparation for a match, the focus of the last two days of the training week should be on organising the team tactically in order to overcome the opposition.

The main reason for this is that players need to be clear in their thinking about what their roles are in possession, out of possession and in transition, but it is also too close to a game to be focusing on any aspect of conditioning.

It is important that players' conserve energy during these two days to ensure that energy levels are high during a game and that players feel fresh going into the game.

Training intensity particularly the day before a game however should still be high albeit for short periods to ensure players do not go into a game playing 'slow' football.

PRINCIPLE 3: CONDITIONING

DAY OFF – TECHNICAL – CONDITIONING

Following a day off, whilst most players will have recovered and will be free from soreness, some players may still be carrying knocks from the match or still be feeling a little stiff.

For this purpose, the aim of the first training session after a day off should be on helping players regain coordination and restart the engine in preparation for more intense work the following day during the conditioning training session. A warm up that helps player improve mobility, extensive passing exercises and possession games will allow players to find their rhythm safely again.

Having completely removed all waste products, overcome any knocks, fully replenished energy stores and regained coordination in the technical training the day before, players should be feeling extremely fresh. The emphasis of the conditioning training session should therefore be on placing an overload on the players by way of sprinting exercises and football conditioning games. Similarly, the conditioning training session is the safest time to perform any other explosive actions such as crossing, shooting, jumping and landing as players are at their freshest.

By structuring principle three in this way and performing the conditioning training after a technical training session also gives the full squad the best opportunity to take place in the session to constantly improve fitness levels throughout the season.

FIGURE 4: Training Week Principle 1 : Recovery	
Saturday	Match
Sunday	Recovery Training
Monday	Day Off

FIGURE 5: Training Week Principle 2 : Team Organisation	
Thursday	Tactical Training
Friday	Tactical Training
Saturday	Match

FIGURE 6: Training Week Principle 3 : Conditioning	
Monday	Day Off
Tuesday	Technical Training
Wednesday	Conditioning Training

PERIODISATION: APPLICATION

Regardless of playing position, performing high intensity intermittent activity for a period of 90 minutes on a match day will undoubtedly place a physiological demand on players. Depletion of energy stores, micro trauma (damage) to muscle fibres and build-up of metabolic waste that causes further damage are therefore key elements that need to be overcome in preparation for the next training session or game. With this in mind coaches need to plan each training session meticulously to ensure that the correct type of training is performed or avoided at the correct time.

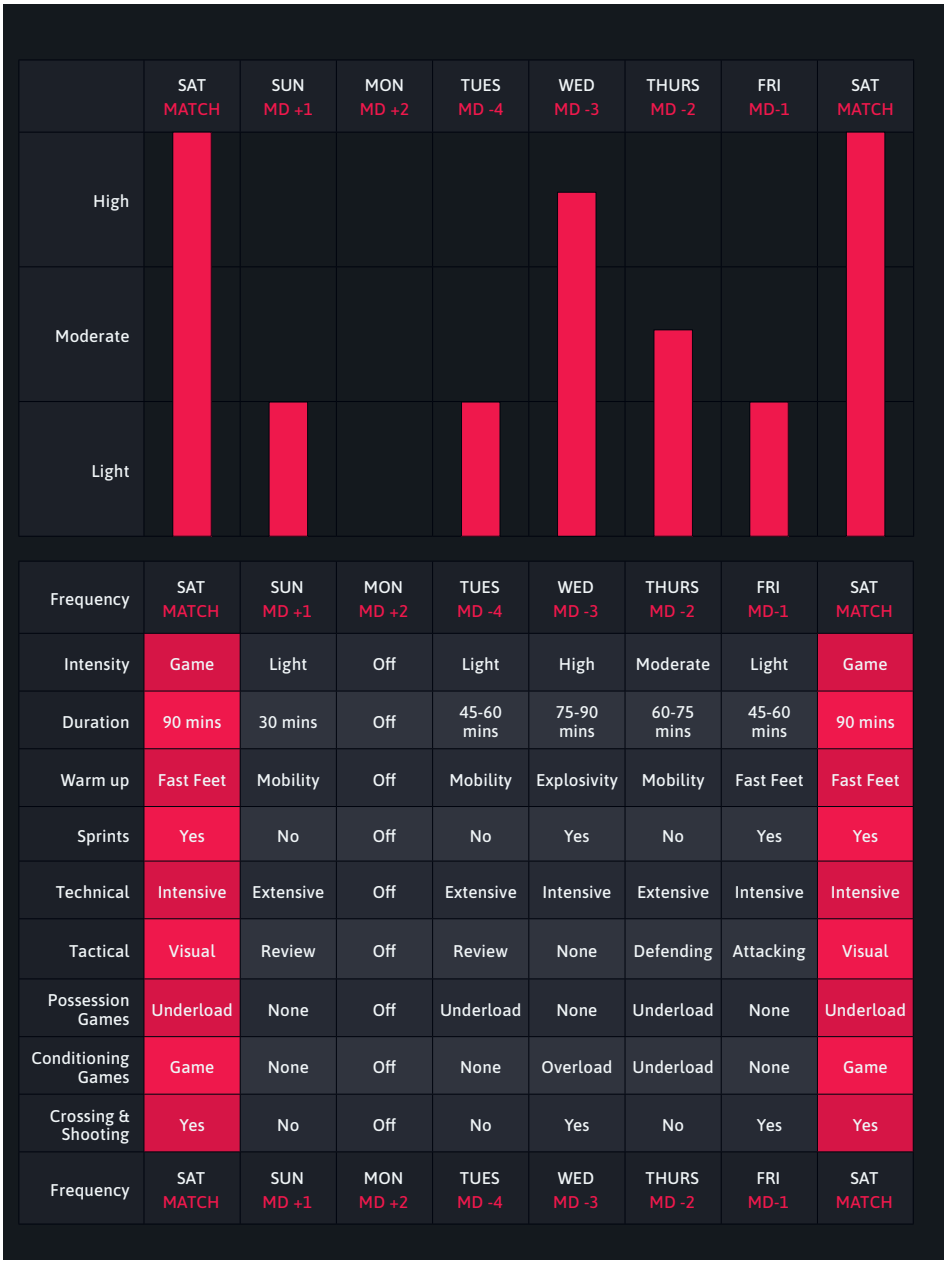
The following information illustrates the recommended intensity of each training day using a bar chart to highlight when it is appropriate to work at a high intensity and when it is appropriate to work at a moderate or light intensity in order to peak in the game.

Similarly, every component of training that coaches use universally has been categorised together with specific 'guidelines' as to how and when it is appropriate to perform each specific component to ensure players perform what they need to perform to be fully prepared each week but also to ensure they are fresh each week leading into the game.

Adherence to such guidelines ensure that the quality of each training session is high, players remain injury free, they get the desired training effect from each conditioning training session and as previously discussed peak at the most important time of the week - Match day.

MATCH DAY + 1 : SUNDAY

RECOVERY TRAINING



Frequency	SAT MATCH	SUN MD +1	MON MD +2	TUES MD -4	WED MD -3	THURS MD -2	FRI MD-1	SAT MATCH
Intensity	Game	Light	Off	Light	High	Moderate	Light	Game
Duration	90 mins	30 mins	Off	45-60 mins	75-90 mins	60-75 mins	45-60 mins	90 mins
Warm up	Fast Feet	Mobility	Off	Mobility	Explosivity	Mobility	Fast Feet	Fast Feet
Sprints	Yes	No	Off	No	Yes	No	Yes	Yes
Technical	Intensive	Extensive	Off	Extensive	Intensive	Extensive	Intensive	Intensive
Tactical	Visual	Review	Off	Review	None	Defending	Attacking	Visual
Possession Games	Underload	None	Off	Underload	None	Underload	None	Underload
Conditioning Games	Game	None	Off	None	Overload	Underload	None	Game
Crossing & Shooting	Yes	No	Off	No	Yes	No	Yes	Yes
Frequency	SAT MATCH	SUN MD +1	MON MD +2	TUES MD -4	WED MD -3	THURS MD -2	FRI MD-1	SAT MATCH

> Providing there is sound rationale behind the philosophy, players remain injury free and maintain a high level of performance throughout the season it may be argued that the correct approach is being implemented."

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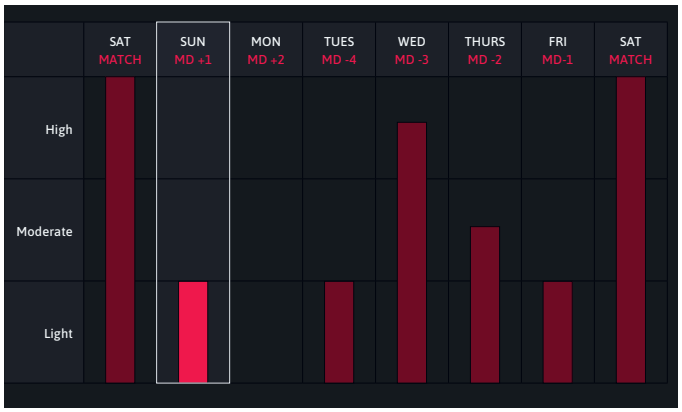
MATCH DAY + 1 : SUNDAY
RECOVERY TRAINING



WHAT COACHES CAN EXPECT FROM PLAYERS:
Many players find it difficult to sleep after a game and will feel tired the next day. Energy levels will be low and most players will be experiencing stiffness and soreness in muscles and joints.

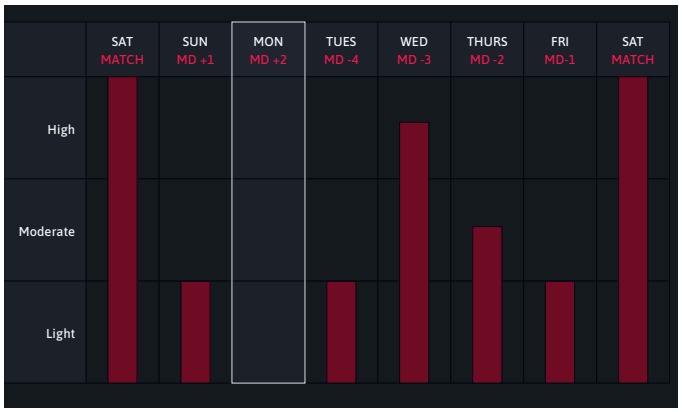
Intensity	Light
Duration	30 mins
Warm up	Mobility
Sprints	No
Technical	Extensive
Tactical	Review
Possession Games	None
Conditioning Games	None
Crossing & Shooting	No

WHAT PLAYERS CAN EXPECT FROM COACHES:
Performing some form of exercise that encourages blood flow to and from working muscles will help to remove the build up of waste that accumulates during a game.

Providing players are pain free and able to perform weight bearing exercise, participating in functional movements albeit in a controlled environment, at low intensity and for a short duration will help to realign muscle fibres specific to the way in which they are required to work when playing football.

A hip mobility warm up and extensive technical practice should be sufficient to help players recover without consuming too much energy. Any explosive actions such as sprinting, crossing, shooting should be avoided.

MATCH DAY +2 : MONDAY
REST



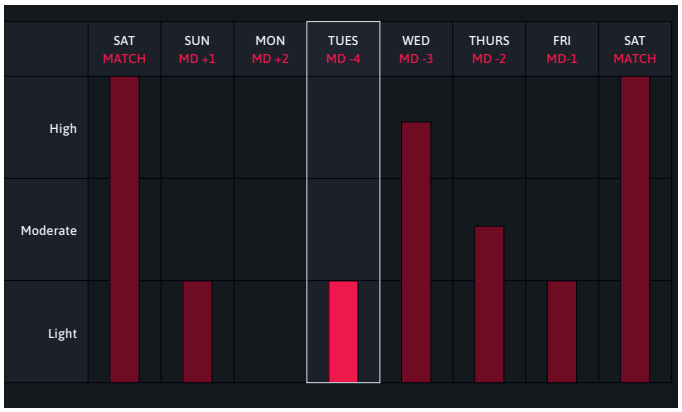
WHAT COACHES CAN EXPECT FROM PLAYERS
48 hours post game is a critical period for the body as it needs as much energy as possible to go to repairing damaged muscle fibres. Many players will be experiencing DOMS (Delayed Onset of Muscle Soreness) and may also start to feel the effects of any knocks from the Saturday game.

Having performed a recovery training session to help combat the physiological load on the body, the day after the game, it is important that players relax and switch their thinking away from football and spend time with family and friends in a change of environment.

Regardless, it is important for players to understand that they need to be professional and consume the correct type and quantity of food and fluids throughout the day to fully replenish energy stores and repair damaged muscle fibres.

Intensity	Off
Duration	Off
Warm up	Off
Sprints	Off
Technical	Off
Tactical	Off
Possession Games	Off
Conditioning Games	Off
Crossing & Shooting	Off

MATCH DAY - 4 : TUESDAY
TECHNICAL



WHAT COACHES CAN EXPECT FROM PLAYERS:
Following a day off players are potentially the least mobile and least flexible as muscles tend to shorten following vigorous activity (game) and a period of relative inactivity.

Some players may still be carrying knocks from the Saturday game and the Central Nervous System may still be 'fatigued' which means that the message from the brain to the muscles are delayed.

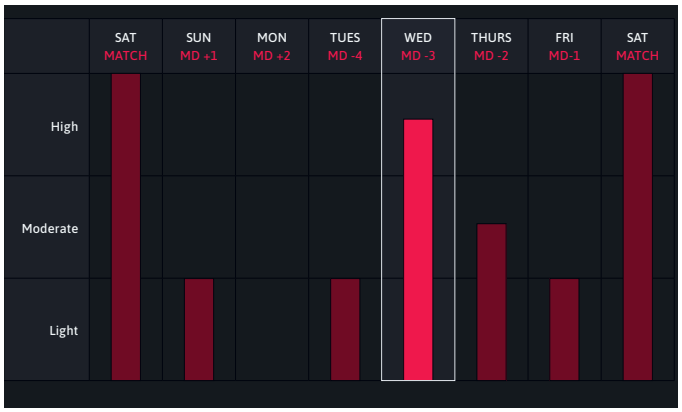
WHAT PLAYERS CAN EXPECT FROM COACHES:
The emphasis of this session should be on 'restarting' the engine, regaining coordination whilst consuming as little energy as possible to ensure full recovery prior to the conditioning training session the next day.

Intensity	Light
Duration	45 - 60 mins
Warm up	Mobility
Sprints	No
Technical	Extensive
Tactical	Review
Possession Games	Underload
Conditioning Games	None
Crossing & Shooting	No

A hip mobility warm up to increase range of movement, an extensive technical practice to ease players back into football movements, a tactical review based on observations from the previous game and possession games in underload should be performed.

Coaches should however avoid any explosive actions such as sprinting, jumping, crossing and shooting where possible to avoid unnecessary injury.

MATCH DAY -3 WEDNESDAY
CONDITIONING



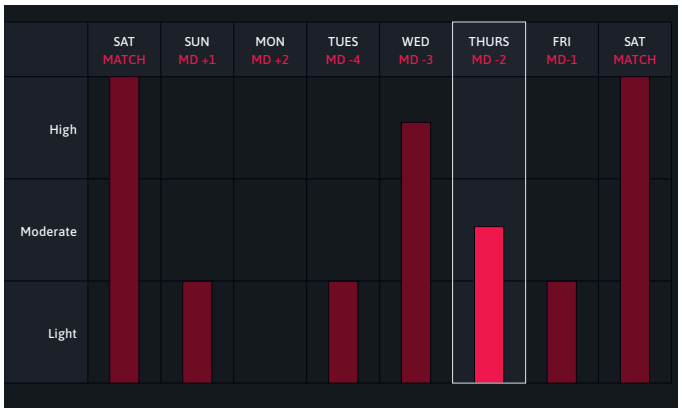
WHAT COACHES CAN EXPECT FROM PLAYERS:
Players should now feel fresh having fully recovered from Saturdays' game. There may still be players who are still carrying knocks who need to be given special consideration, but having participated in light intensity training the day before most players should have removed any remaining waste products, have sufficient tension in their muscles, and regained coordination.

Intensity	High
Duration	75 - 90 mins
Warm up	Explosivity
Sprints	Yes
Technical	Intensive
Tactical	None
Possession Games	None
Conditioning Games	Overload
Crossing & Shooting	Yes

WHAT PLAYERS CAN EXPECT FROM COACHES:
The emphasis of this session should be on high intensity short duration bouts of football specific practices. A high tempo warm up containing some jumping and landing, an intensive technical practice, sprinting, shooting and conditioning games should therefore form the basis of each conditioning session.

It is important that coaches avoid too many practices prior to the conditioning games as these should be the main focus of the session to enhance football fitness.

MATCH DAY - 2 : THURSDAY
TACTICAL



WHAT COACHES CAN EXPECT FROM PLAYERS:
Players are potentially less mobile and less flexible than normal following the conditioning session and some players may also be experiencing stiffness in joints and muscles.

Similarly, the Central Nervous System may still be 'fatigued' which means that the message from the brain to the muscles will be delayed.

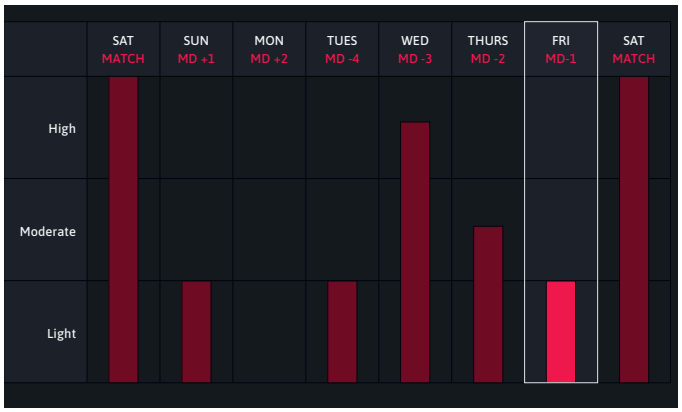
Intensity	Moderate
Duration	60 - 75 mins
Warm up	Mobility
Sprints	No
Technical	Extensive
Tactical	Defending
Possession Games	Underload
Conditioning Games	Underload
Crossing & Shooting	No

WHAT PLAYERS CAN EXPECT FROM COACHES:
The emphasis should be on 'restarting' the engine again, regaining coordination and performing any high intensity activities in short blocks.

A hip mobility warm up, extensive technical practice, team organisation should be performed in addition to either possession games or conditioning games in underload.

Sprinting, crossing & shooting and any other explosive actions should be avoided to prevent any unnecessary injuries.

MATCH DAY - 1 : FRIDAY
TACTICAL



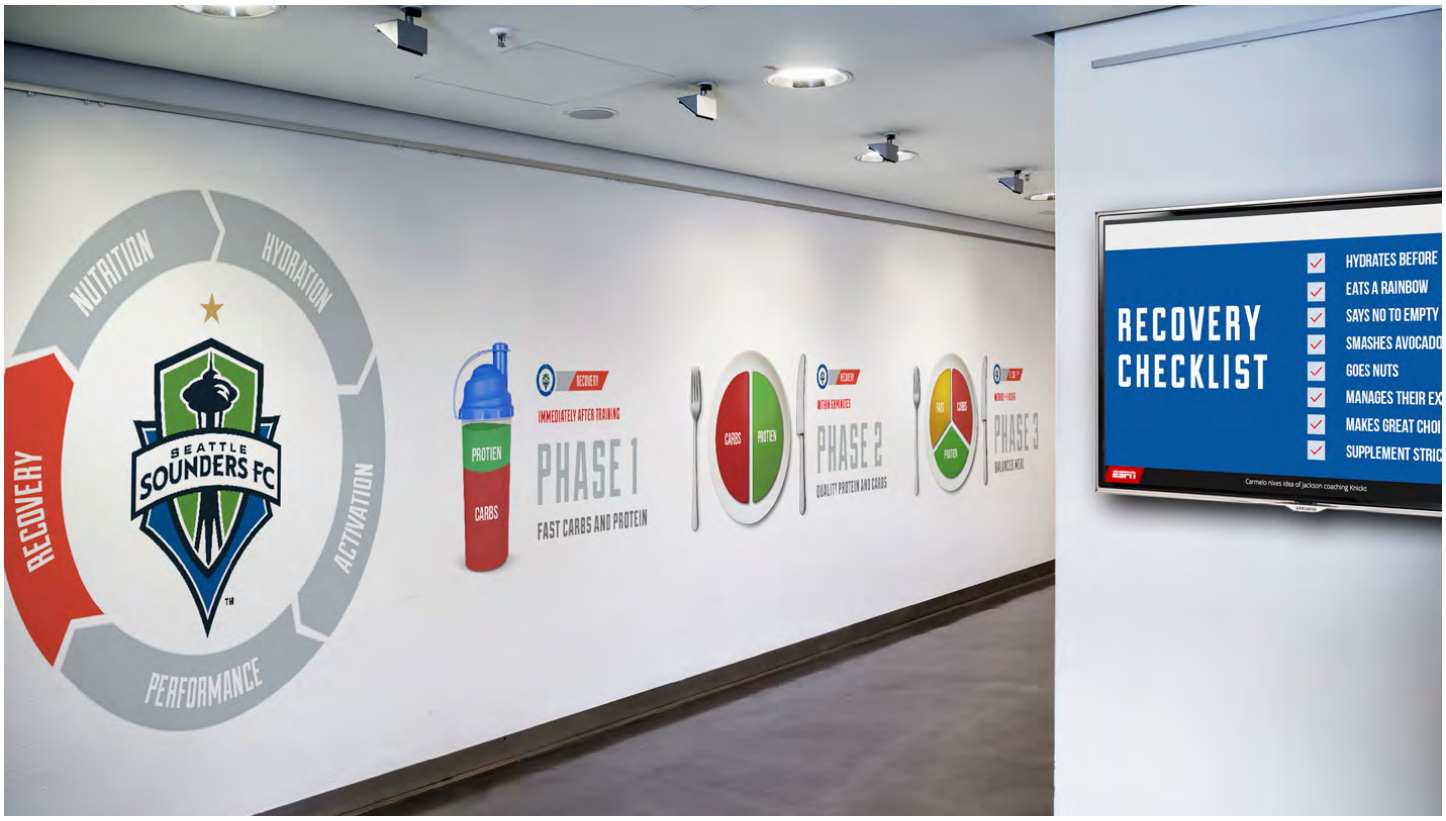
WHAT COACHES CAN EXPECT FROM PLAYERS:
Players should feel fresh and full of energy. Having increased blood flow and worked for a short duration the day before players should also have got rid of any soreness

WHAT PLAYERS CAN EXPECT FROM COACHES:
The emphasis should be on getting the body to think and move fast to prepare for a fast start to the game the following day.

A fast feet warm up, an intensive technical practice, team organisation and large sided games should be performed.

Similarly, as players are at their freshest it is safe to perform crossing/shooting exercises albeit as part of the session but the number of actions should be kept low with lots of rest.

Intensity	Light
Duration	45 - 60 mins
Warm up	Fast Feet
Sprints	Yes
Technical	Intensive
Tactical	Attacking
Possession Games	None
Conditioning Games	None
Crossing & Shooting	Yes



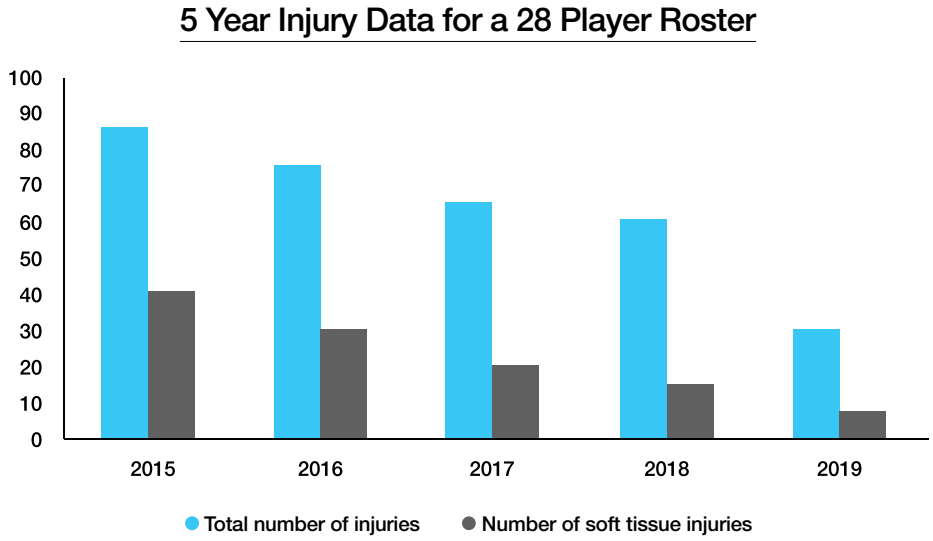
PERIODISATION: OUTCOMES

Whilst it took a while to convince coaches, players and support staff of what was a 'foreign' concept and way of working, once everyone 'bought in' and understood the principles behind the periodised training model, the effect of the model was evident to see.

In 2018 having won only one of the first ten games the team recorded the best half season in MLS History (14 wins, 1 draw, 2 defeats), the most consecutive wins in MLS History (9 wins in a row) and recorded their highest points total and highest finish in the Clubs recent history. (59 points and 2nd place in the Western Conference)

In 2019 in comparison to the previous five seasons where a minimum of five players started the season unavailable through injury, the team were at full strength with every player available to start the season. The club recorded the best start in MLS History winning five out of the first six games, maintained and finished in second place for the second consecutive season and won the MLS Cup with every player available for selection and the highest player availability in the clubs' history.

This included a 45% reduction in total number of injuries (40 in 2019 versus an average of 72 in previous five seasons) a 70% reduction in soft tissue injuries (8 in 2019 versus an average of 26 in previous five seasons) a 61% reduction in training days missed (191 in 2019 versus an average of 393 in previous five seasons) and a 50% reduction in MLS games missed (54 in 2019 versus an average of 108 in previous five seasons).



'Availability equals Winnability.. In any team, in any league in the world, if you have your best players available you have the best chance of winning.' Damian Roden

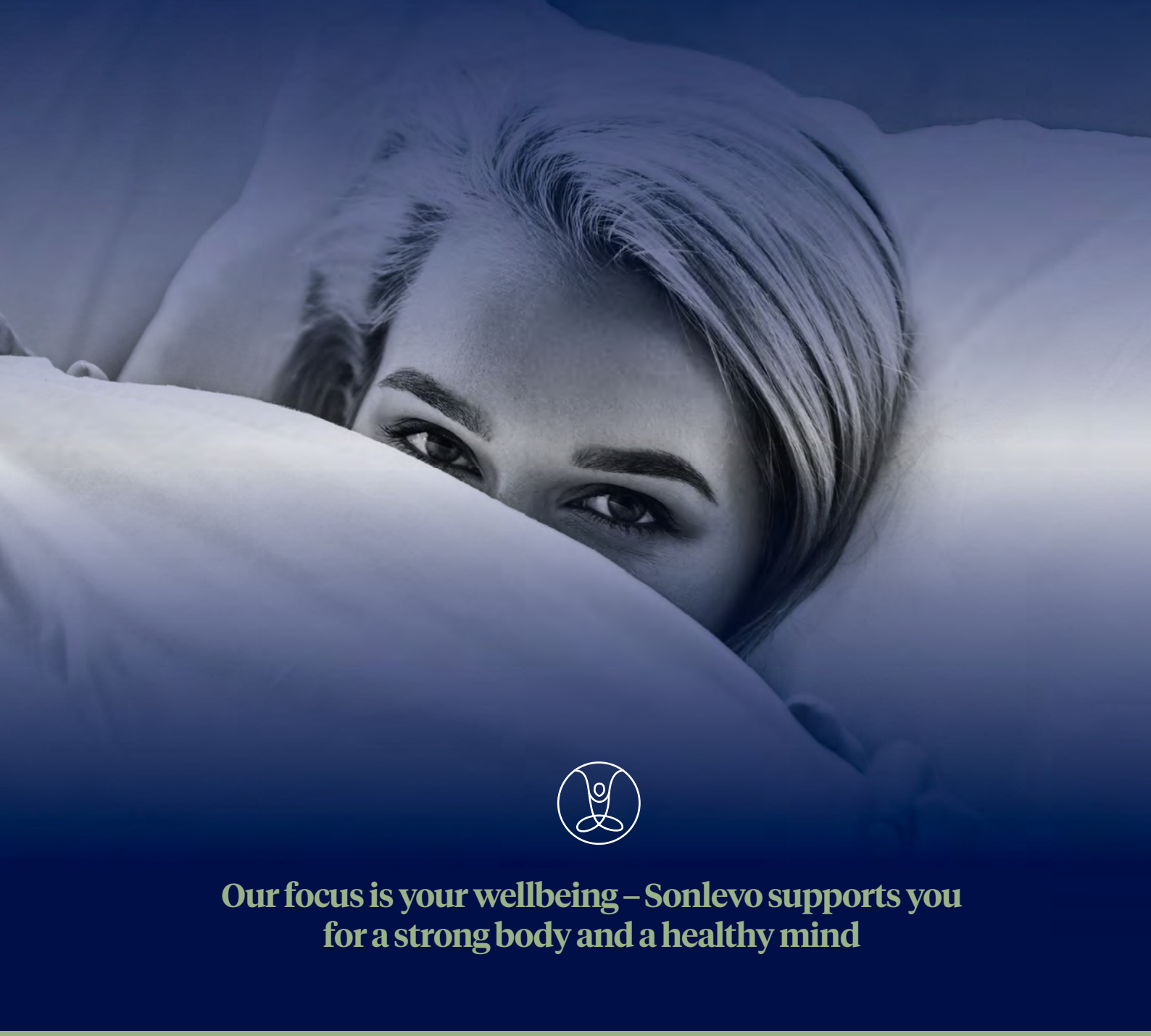
THE NEXT INSTALMENT

This article was the first of three parts of a case study relating to the effects of a periodised training model on player availability.

Part Two of the case study goes into detail on the 'player readiness' approach that was used and highlights the principles behind the approach, exactly how it was used and why. Part Two can be seen in the next edition of the FMPA magazine.

ABOUT THE AUTHOR

Damian Roden is one of the most highly regarded Performance Coaches worldwide having implemented his approach successfully for over 15 years in the Premier League, with National Teams and more recently in the MLS. If you are interested in learning more about Damian's expertise please visit www.fitforeverygame.com or follow him on twitter @damian_roden



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ATHLETIC GROIN PAIN – TIME TO MOVE FROM AN ANATOMICAL TO A BIOMECHANICAL APPROACH?

FEATURE / ENDA KING PHD & DR. ANDY FRANKLYN MILLER

Athletic groin pain (AGP) is often a frustrating challenge facing medical teams in elite football due to diagnostic confusion, a lack of clarity around the most effective management strategies, and the lack of outcome consistency. At the Sports Surgery Clinic in Dublin, over 400 patients with AGP are seen per year. The clinic is combining biomechanical analysis and academic research, with the aim to improve understanding of these challenges and further enhance AGP management.

AGP is an umbrella term used to describe the chronic presentation of pain and dysfunction in athletes around the anterior hip, pelvis and abdominal muscles.[5] The prevalence of groin pain symptoms is high in elite football,[1] with many continuing to play with ongoing symptoms[4]. Players that do have to stop playing often miss considerable amounts of playing time.[3] A reduction in player availability, alongside a high training load and a busy fixture list, reduce time for recovery and the ability to cope with the external demands to play and perform, make it a challenging environment to manage AGP athletes. Much of the initial challenge is around the clarity of a diagnosis. In acute groin injury this is often easily identified through clinical examination and imaging.[3, 17] On the other hand, chronic presentations are far more challenging diagnostically. The most prevalent diagnoses reported vary from sportsman's hernia and its various versions[13] (although its existence has been questioned)[18] , adductor related groin pain,[9] and pubic aponeurosis.[5] This is further complicated by most athletes reporting multiple sites of symptoms9, with a high co-prevalence of radiological femoroacetabular impingement.[20] Given that the majority of management strategies are dictated according to the derived anatomical diagnosis, the variation in the research can lead to a plethora of management strategies for what are, ultimately, the same group of athletes.

This difference in diagnosis may be due in part to misinterpretation of pain provocation tests, poor correlation between radiology and clinical findings, and to training and clinician bias. There is poor specificity of the pain provocation tests.[5] While a squeeze test or resisted sit up may re-produce an athlete's symptoms,[10] it loads the entire medial groin and anterior pelvic ring and often reproduces low abdominal, pubic or adductor symptoms in isolation or combination. This is further compounded by athletes reporting multiple sites of symptoms, especially in more chronic presentations. Clinical palpation of the region can often be challenging given the number of overlapping structures, such as the pubic tubercle and pubic symphysis. This can make identification of discrete structures challenging. Reliance on MRI reports can lead to a number of radiological "false positives", due to the high level of "abnormal" findings on scanning at the pubis2 and hip[6] in asymptomatic athletes. Falvey et al. reported on the largest cohort of AGP athletes in the literature. They attempted to reduce the variance of AGP by localising the athlete's

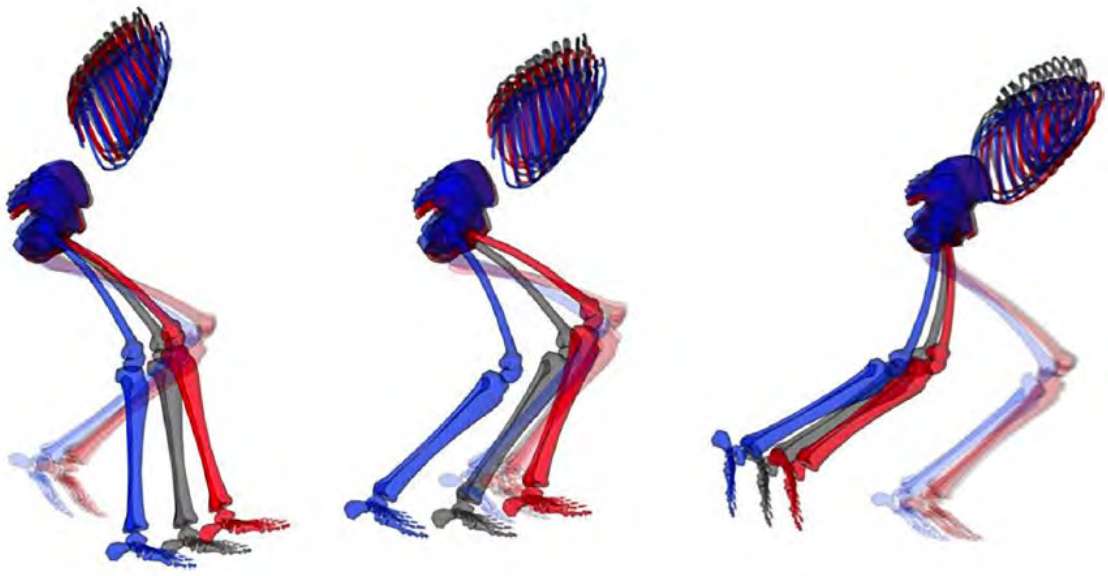
symptoms through pain provocation tests, reproducing those symptoms on clinical palpation through a systematic process, and then confirming the radiological diagnosis at the site of those pain provocation and palpation tests to minimise error and clinical bias.[5] Although the athlete may still have multiple sites of symptoms, this system reduced potential error from diagnosis based on clinical examination or radiology in isolation.

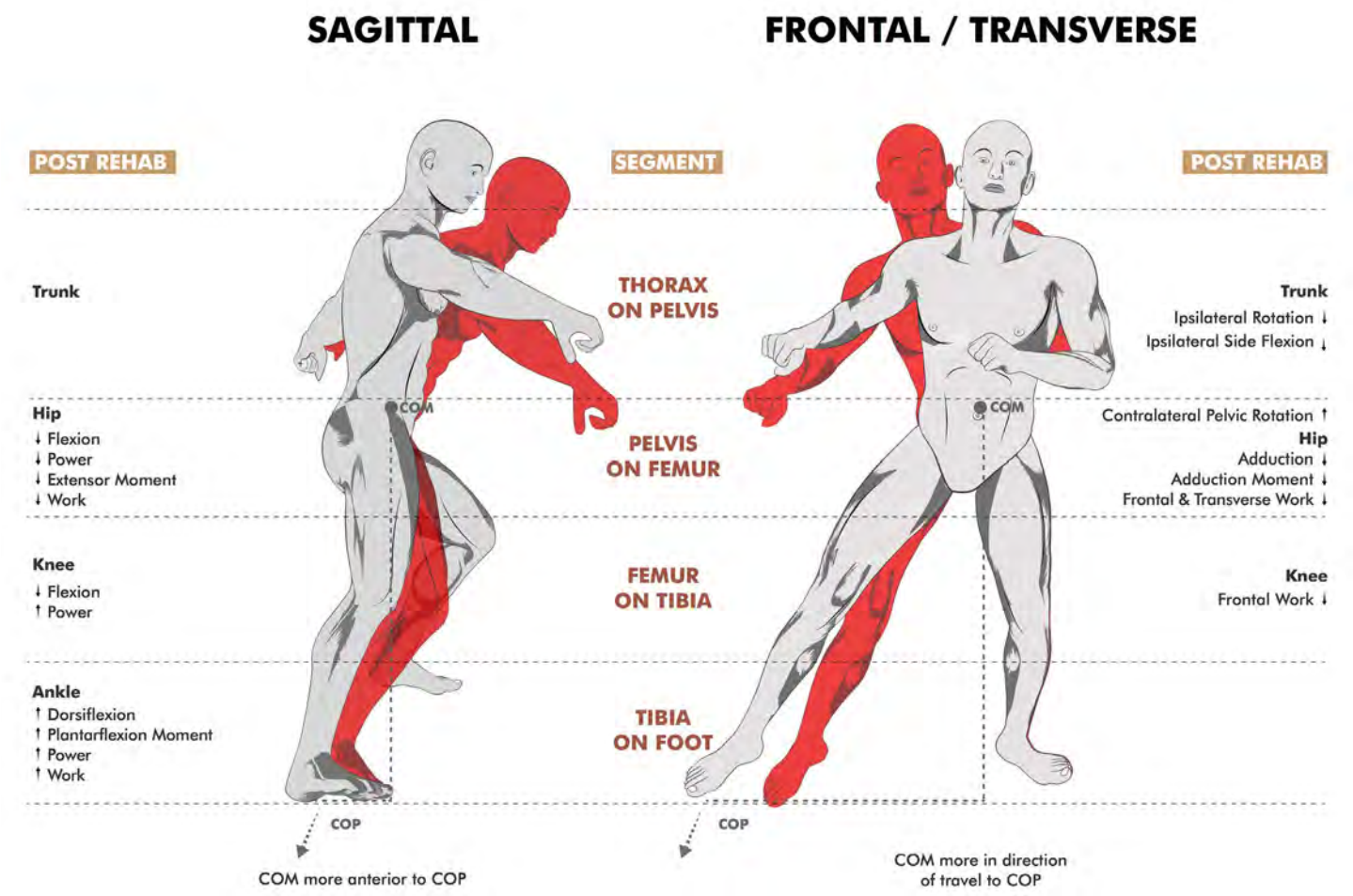
Given the challenges in the accuracy and specificity of diagnosis for athletes with AGP, it is not surprising that there is a lack of clarity on the most effective management. Historically, there has been an anatomical approach to management, with strategies including rest, steroid injections, surgery or exercise.[12, 18] It is now known that these approaches have a number of challenges. Firstly, given that the majority of chronic presentations have multiple symptom sites, it is difficult to identify injection site, surgery location or efficient exercise types. Secondly, placing an anatomical diagnosis on an athlete does not exactly tell a clinician about how an athlete moves, their physical strengths and weaknesses, or the demands of their sport and what is needed in a rehabilitation programme. If every footballer is given an "adductor related groin pain" rehabilitation programme, it cannot be assumed that all athletes have the same strengths and weaknesses, and therefore will all react to the programme in the same way. At the Sports Surgery Clinic, research has focused on moving away from management of AGP driven by the anatomical diagnosis (focusing on the site of pain), and focusing rehabilitation around athlete biomechanical diagnosis (focusing on how they move). This individualised approach to rehabilitation helps to profile the athlete to identify and target the deficits specific to their presentation which are driving their symptoms.

The main aggravating activities for those with AGP are similar for acute and chronic injuries including jumping, sprinting, kicking and change of direction. If these are the primary movements that lead to symptoms, then the ability to accurately assess these movements may be key to identifying the drivers of symptom generation in the area. In addition, the ability to re-assess is highly important to assess whether rehabilitation programmes have changed those movement strategies. The influence of anterior pelvic tilt on load through the symphysis pubis and femoracetabular impingement has been demonstrated previously.[1, 16] In addition, modifications to pelvic position relative to the femur have been demonstrated to influence muscle activity around the hip.[14] Too often athletes opt for alternative treatments, having "failed" rehabilitation, or for perceived expediency.

On examining the role of biomechanics in AGP, Franklyn-Miller et al assessed change of direction mechanics in a large cohort of athletes presenting with AGP. It was found that those suffering with AGP symptoms had three main movement strategies or clusters (fig 3).[7] Cluster 1 was characterised by increased ankle eversion and knee external rotation, ipsilateral trunk rotation and reduced trunk rotation in the direction of intended travel, with greater knee work. Cluster 2 was characterised by an increase in hip flexion, anterior pelvic tilt, pelvic drop, increased trunk flexion and ipsilateral side flexion, with greater hip work. Cluster 3 was characterised by increased ankle dorsiflexion, contralateral trunk lean and rotation increased ankle work. Interestingly, there was no relationship between the anatomical diagnosis and cluster membership. Rivadulla et at al demonstrated that athletes with AGP and healthy pain-free athletes have the same three change of direction movement clusters, but are different in their distribution of cluster membership (those with AGP have higher membership of Cluster one).[15] Both groups are consistent in staying within that movement strategy during a change of direction task. This potentially suggests that athletes have a preferred strategy for change of direction and that this could be targeted during rehabilitation. During a hurdle hop, Gore et al. examined differences in stiffness across the kinetic chain. It was found that reduced hip abduction stiffness and ankle plantarflexion stiffness between AGP and healthy athletes may have an influence on loading through the groin, during landing and mid stance running.[8] A key finding of the study was the differentiating role of the ankle and torso, which are often ignored in traditional rehabilitation programmes, where the focus has been on the adductor complex.

Exercise has been long shown to be effective in the management of these athletes,[11, 12] however, programming has often been dictated by the anatomical diagnosis. To assess a change of approach from rehabilitating based on anatomical diagnosis, to a biomechanical approach targeting intersegmental control throughout the kinetic chain, King et al. rehabilitated 200+ athletes presenting with AGP. The study included all categories from the pubic bone/symphysis, iliopsoas, adductor, abdominal and hip. The programme was divided into 3 phases: Level 1 - Intersegmental strength and control targeting compound movements such as squats, deadlift and lunge focusing on intersegmental control in particular at





the lumbopelvic and thoracolumbar regions then adding weight to increase intensity for strength gains. This is complemented by exercises targeting particular segments (i.e. thoracolumbar rotation control through abdominal exercises and hip frontal plane control through hip hitching). Level 2 - Linear running mechanics which target ankle stiffness, anterior pelvic tilt at mid stance and toe off, pelvic drop during midstance and trunk ipsilateral side flexion, and rotation while commencing linear running volume at submaximal speeds. Level 3 - Change of direction mechanics targeting trunk/hip/foot transverse plane control and trunk/hip and knee frontal plane control and the ability to keep centre of mass (CoM) within base of support, while commencing maximal velocity running and additional submaximal running volume as tolerated. Progression through the exercises and phases is based on physical competency (i.e. the ability to execute with appropriate technique) and how the pain provocation tests respond (i.e. pain free squeeze at 45 degrees before commencing CoM exercises), not based on how long they have had symptoms or have been rehabilitating for. This approach generated a pain free return to play rate in 9.8 weeks, with large effect size changes across the Copenhagen Hip and Groin Score (HAGOS). A key finding was the lack of relationship between the anatomical diagnosis and the time to pain free return to play (RTP), and the lack of relationship between length of symptoms prior to rehabilitation and time to pain free RTP. If the source of symptoms and the duration of symptoms are not related to recovery, the speed at which the biomechanical factors can be addressed may be the limiting factor to how quickly an athlete can recover. This research was carried out on sub-elite athletes, with one review appointment for an hour every 2 weeks complemented with an independently executed exercise programme. The ability to re-assess, regularly coach to improve exercise execution and progress the exercise intensity, is key to rapid progress through the programme. Elite athletes in a club environment, or in residential rehabilitation, can be expected to accelerate through the programme in almost half that time.

As well as the clinical outcomes, there were a number of biomechanical changes that occurred from pre to post rehabilitation in this cohort (fig 4):

i) Reduced ipsilateral trunk side flexion
ii) Increased pelvic rotation in the direction of travel
iii) Greater COM translation in the direction of travel
iv) Reduced knee flexion
v) Increased ankle plantarflexion
vi) Shorter ground contact times

Moreover, Gore et al. have shown that biomechanical changes within each cluster during CoM are related to improvement in HAGOS Sport subscale post rehabilitation, and that those changes are specific to each cluster. This suggests that individual athletes respond differently to a rehabilitation programme targeting on intersegmental control and may pave the way for individualised rehabilitation going forward. In Dublin, the system for generating a profile of athletes is called SSC Lab, and the residential rehabilitation programmes use this individualised profile to create bespoke programmes which can then be coached and periodized in the residential rehabilitation facility (fig 5 & 6). This approach ensures that rehabilitation is based on the individual athlete's deficits, not their anatomical diagnosis. This will facilitate effective and efficient recovery from AGP.

Although the focus on the above has been mostly on anatomy and biomechanics, it is important to be aware that AGP is highly influenced by external load. That is not to suggest that load is the problem, but ultimately the athlete's ability to tolerate that load. It is often found that the "high risk" players, such as young athletes

coming through from the academy, those that have had a change of manager or coach leading a new training regime, and those that are coming back from a different long term injury, are susceptible to AGP, and so re-introduction of training load is key. The more efficient an athlete is biomechanically, the more "room for error" they may have when those higher bouts of load come.

In summary, AGP can be a challenging condition to manage. This is especially true in elite sport, when the load demands and urgency to get players back on the field are high. For the most successful management, a systematic approach to arriving at an anatomical diagnosis is required. Independent of the anatomical diagnosis, a systematic approach to profiling the athlete to assess their strength, power and intersegmental control during compound movements, linear running, change of direction and sports specific tasks is key. Finally, constantly re-assessing athletes biomechanical outcomes ensures that rehabilitation is having the desired adaptation to ensure the most efficient return.

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