Sports practitioners, athlete welfare and duties of care: A case study of the professional practice of hamstring management in English professional rugby union.

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Abbreviations

AFL	Australian Rules Football League
AROM	active range of movement
C-Protocol	conventional protocol (Askling 2014)
cm	Centimetre
CPD	Continual Professional Development
CV	Cardiovascular
DoC	Duty of Care
GPS	Global Positioning System
Hrs	Hours
Kg	kilogram
L-protocol	lengthening protocol, diver, slider, glider (Askling 2014)
M	Metre
MDT	Multidisciplinary team
MOI	Mechanism of injury
MRI	Magnetic Resonance Imaging
MTJ	Musculotendinous junction
NFL	National Football League
NSAIDs	Non-Steroidal Inflammatory Drugs
PATS	progressive agility exercises, trunk stabilisation exercises and ice
POLICE	protection, optimal loading, rest, ice, compression, elevation
PRICE	protection, rest, ice, compression, elevation
PRP	Platelet rich Plasma
RCT	Randomised controlled trials
RFU	Rugby Football Union
ROM	Range of motion/movement
SoP	Scope of practcie
TESK	Techincal Expertise and Scientifc Knowledge

Abstract

The management of hamstring injuries is complex and involves many processes and procedures. Specifically, within in professional sporting contexts there is a plethora of research that focuses on the scientific underpinnings of the management of hamstring injuries, from assessment, diagnosis, treatment, rehabilitation and injury prevention. However, little is known about how hamstring injuries are managed within the wider context of professional sports work and athlete welfare. Within recent years, knowledge is emerging on how to optimise rehabilitation following acute hamstring injury (Thorberg, Ishoi and Krommes, 2017 cited in Ishoi, Krommes, Husted et al., 2020). Within elite sport athletes will have a multidisciplinary team to provide a wide range of management strategies that are focused on returning them to play in the safest, shortest time. This thesis will focus on technical expertise and scientific knowledge and working as a multidisciplinary team and interrogate the management of hamstring injuries in elite English Rugby Union. From this thesis we will be able to build on the scientific knowledge we already have to ensure the best possible care for our athletes both in terms of processes and procedures. In this research, I adopt a Constructivist-Interpretivist approach, similar to Scott & Malcolm (2015); Arnold et al., (2019) and Kerai, Wadey, & Salim (2019) to unearth how practitioners in elite English Rugby Union treat and manage first time acute hamstring injuries. The aims of the thesis were to: 1) explore how practitioners work to manage hamstring injuries in elite English rugby union in terms of technical expertise and scientific knowledge, and within a multidisciplinary team, and 2)

Discover how hamstring injuries were managed in elite English Rugby Union from a doctor, physiotherapist, and strength and conditioning point of view.

This thesis adopts a qualitative Mixed Methods Research (MMR) design, comprising the collection and analysis of data collected via thirty-five semi structured face-to-face interviews and completion of a questionnaire with 13 doctors, 11 physiotherapists and 11 strength and conditioning staff. Specifically, I adopt a Constructivist-Interpretivist approach to explore how doctors, physiotherapists and strength and conditioners in elite English rugby union reflect upon and perceive their treatment and management of first-time acute hamstring injuries. Whereas previous studies have focused primarily on the mechanics of injury treatment, a qualitative MMR approach affords complete in depth and comprehensive understanding of some of the issues evident within professional practice. Practitioner responses were coded using thematic content analysis and analysed under the themes technical expertise and scientific knowledge (TESK) and multidisciplinary teams (MDT). Verbatim quotes from the practitioners are included to highlight key areas that both support and disagree with the literature.

This thesis concludes that the management of hamstrings injuries in elite English Rugby Union is varied from a doctor, physiotherapist, and strength and conditioning staff perspective. During the management of hamstring injuries practitioners show how they apply their high level of technical expertise and scientific knowledge to all aspects of the management process. We see that many practitioners use pain and symptoms to guide their treatments and rehabilitation rather than set timeframes highlighting that they apply technical expertise and scientific knowledge during the injury management process.

Chapter 1

Introduction

1.1 Chapter outline

Hamstring injuries are highly prevalent in many running-based sports that require sprinting, acceleration and explosive movements (Woods et al., 2004, Brooks et al., 2006, Malliaropolous et al., 2010, Ekstrand et al., 2016), Jones, Jones & Grieg et al., 2019, Danielsson Horvath & Senorski et al., 2022 and Pollock, Kelly & Lee et al., 2022). Sprinting based hamstring injuries are often due to excessive muscle strain as a result of an eccentric contraction in the late swing phase of running (Danielsson et al., 2020). They often cause prolonged periods of absence from both training and competition (Brooks et al., 2006, Malliaropolous et al., 2010 and Ekstrand et al., 2016). Hamstring injuries have been documented in epidemiological studies in Australian Rules Football (AFL) Orchard and Seward, (2002), rugby union (Brooks et al., 2006), football (Ekstrand et al., 2011) track and field Malliaropolous et al., (2010) and Pollock et al (2022) and Major League Baseball (Ahmad, Sick & Snell et al., 2014). In these sports they have been shown to account for between 6 and 29% of all injuries reported. Two distinct types of hamstring injury have been identified in the literature: high-speed running and stretch type injuries (Askling et al., 2002). However, according to a systematic review carried out by Danielsson et al., (2020) there is no consensus on hamstring injury mechanism. High-speed running hamstring injuries have been identified in sports such as rugby union, soccer, and athletics (Askling, et al., 2002; Woods et al., 2004; Brooks et al., 2006; Malliaropolous et al., 2010 and Ekstrand et al., 2011) whereas slow stretch hamstring injuries have been noted in dancers (Askling et al., 2002 and Askling et al., 2012). The focus of the thesis is to explore and analyse the complexities of the professional context in which injury management takes place, within it, I explore the wider related issues of technical expertise and scientific knowledge (TESK) and working within a multidisciplinary team (MDT).

Subsequently, this chapter introduces the structure of the thesis and outlines the literature surrounding the concepts and theoretical approaches to the management of hamstring injuries. The chapter will introduce the theoretical underpinnings of qualitative mixed methods research. Within the chapter I will also cover the professional sports workers practice in pursuit of athlete welfare which includes technical expertise and scientific knowledge (TESK) of practitioners and working in multidisciplinary teams (MDT). Within the thesis we will explore these wider connections and how they are so important to consider alongside injury management.

1.2 Hamstring injuries.

The hamstrings are a complex group of muscles due to their anatomy and function. The semitendinosis and semimembranosus and long head of biceps femoris are biarticular, crossing the hip and the knee; whereas the short head of biceps femoris is uniarticular, crossing just the knee (see Appendix 1). The functions of the hamstrings are knee flexion and hip extension (Petersen et al., 2011). The biarticular nature of the hamstrings means that during running gait, the hamstrings will create both hip extension and knee flexion moments (Mann 1981). Therefore, it is possible that the functional variations within the hamstrings during running may be a contributing factor to why hamstring injuries are more susceptible and prevalent in running based sport. These variations are important and matter to practitioners as they will influence treatment plans, rehabilitation, and overall injury management within practice, as highlighted by MacDonald, McAleer and Kelly et al., (2019). Macdonald et al., (2019) worked with the clinicians at British Athletics to implement the British Athletics approach to hamstring injury rehabilitation. Alongside their rehabilitation methods they adopted the British Athletics Muscle Injury Classification (BAMIC) within their clinical practice to help manage hamstring injuries sustained by their athletes which meant they applied a structured and targeted approach to hamstring rehabilitation to different anatomical classes of hamstring injury sustained. Results of this approach are reported by MacDonald et al., (2019) who show that the implementation of BAMIC and the hamstring rehabilitation approach used by British Athletics resulted in low reinjury rates and reduced time to return to full training. However, this approach has not been tested in any other sports and therefore must be viewed in light of this single application to athletics.

It has been proposed that running related hamstring injuries occur during the initial stance phase due to the large opposing forces as the body is propelled forwards (Mann & Sprag, 1980 cited in Danielsson et al., 2020). However, according to Garrett (1996), Orchard (2002), Heiderschiet et al., (2005) and Schache et al., (2009) hamstring injuries occur in the terminal swing phase of the running gait cycle as they lengthen. Therefore, most published rehabilitation programmes have been based on lengthening the hamstrings which have shown to significantly reduce the incidence of hamstring injury (van der Horst et al., 2015 and Al Attar, Soomro, Sinclair et al., 2016). During the late swing phase, the hamstrings will simultaneously be rapidly lengthening whilst eccentrically contracting to decelerate the leg (Brockett, Morgan & Proske, 2001). Van Hooren & Bosch (2017) postulate that there is an isometric contraction of the hamstrings in the late swing phase of running gait. Therefore, the hamstrings are involved in isometric, concentric and eccentric contractions during running gait. As running is a repetitive dynamic cyclical motion, that requires the hamstrings to repeatedly contract they are likely to become fatigued (Thelen et al., 2005). Practitioners need to understand this research and evidence-based knowledge surrounding hamstring injuries to focus on their injury management. However, this is not the focus of the thesis. Instead, we will focus on understanding the complexities of the professional context in which injury management take places and the wider issues of duty of care and athlete welfare.

1.3 Management of hamstring injuries.

A lot of hamstring management literature is focused on diagnosis and classification of injury (Chan et al., 2012, Mueller-Wohlfahrt et al., 2013 and Pollock et al., 2014), treatment (Whiteley et al., 2018), rehabilitation with programmes being published for multiple sports (Heiderschiet et al., 2010 & Malliaropoulos et al., 2012, Askling et al.,2013, Sherry, Johnston & Heiderschiet 2015, Buckthorpe et al., 2018) And more recent literature from (MacDonald et al., 2019 and Ehiogu et al., 2020), injury prevention (van der Horst et al., 2014, Bourne et al., 2018 and Dunlop et al., 2020) and return to play Mendiguchia and Brughelli (2011).

The studies mentioned above tend to focus on a single area of the management process rather than encompassing all aspects of hamstring injury management. The only study to include all aspects of the injury management process is a study by Pizzari, Wilde & Coburn (2010) who look at the of management of hamstring injuries in Australian Rules Football. Therefore, this thesis covers a clear gap in the literature as there are currently no studies that look at how hamstring injuries are managed in rugby union. It will also bridge a gap in the literature as little is known about the process and complexities faced by the athlete's entourage and what happens behind the science in elite English Rugby Union. Therefore, we will look at the following: the current practices employed by rugby union clinicians (doctors and physiotherapists) and strength and conditioners working in elite English rugby union. The management of hamstring injuries for this thesis encompasses assessment, treatment, rehabilitation and return to play and injury prevention. We will also explore how technical expertise and scientific knowledge applied by practitioners, how do they work as multidisciplinary team? It is important to consider these aspects of injury management as they may improve management process and practices within elite sport. The focus of the thesis will be to unravel and explore these areas of the management of hamstring injuries. Successful management of hamstring injuries relies on the practitioner to apply their technical expertise and scientific knowledge to return the player to sport as quickly as possible, but still within physiological healing timescales. Practitioners are required to work with autonomy and within their scope of practice when applying their knowledge at various stages of the management process. For example, when understanding mechanism of injury, performing an assessment that leads to a diagnosis, when planning and implementing treatment and rehabilitation, when conducting return to play testing and finally when trying to prevent both first-time hamstring injuries and the more problematic recurrent injures. They are required to do this under pressure in a high pressure and fast paced environment (Arnold et al., 2019). Making mistakes and wrong decisions can be costly and may lose the practitioner their job and possibly their reputation. However, we should avoid the win-at-all-costs mentality and mindset despite the pressures placed upon practitioners to return players to sport as quickly as possible.

Practitioners should put player welfare first and adhere to ethics and principles of duty of care during the injury management process. There has been an increased amount of research and exposure towards professional ethics and duty of care and player welfare since the Duty of Care report published by Grey-Thompson in 2017, for the full report see Duty of Care in Sport Review – GOV.UK (www.gov.uk). The report was welcomed by many sporting bodies and disseminated seven recommendations that would enhance duty of care, player welfare and wellbeing in sport. If not consider by practitioner there may be profound consequences for both the player and the practitioner. Duty of care is of utmost importance when managing injuries, practitioner should seek to provide the best possible care, seeking evidenced based management protocols and procedures that fall within their scope of practice and expertise. These decisions should be individualised to the athlete and take in to account the injury, time, facilities, resources, and many other factors. Evidence based practice is vital for successful management of injuries and enhancing athlete care (Bleiker, Morgan-Trimmer & Hopkins, 2019). This study does not focus on duty of care, but it does play a part in the management of injuries and therefore recognised as an important process and within the wider context of injury management.

Carlson (2008) and more recently MacDonald et al., (2019) and Pollock et al., (2022) highlight that the complex nature of hamstring anatomy, hamstring injury, rehabilitation and return to sport should be individualised to both the sport, position and classification of injury. The management, in particular rehabilitation of hamstring injuries has seen notable advances over time. Advances in the rehabilitation of hamstrings have seen more focus on rehabilitation programmes based on the specific injury diagnosis and classification (Pollock et al., 2022) as implemented by Macdonald et al., (2019). Developments have also been made in terms of functional exercises and exercises that include adjacent muscles, rather than working on the hamstrings in isolation (Sherry & Best, 2004, Heiderschiet et al., 2010 and Macdonald et al., 2019) as well as exercises that include the core and involve neuromuscular control of the lumbopelvic region (Sherry & Best, 2004 and Orchard, Best & Verrall, 2005) and the introduction of more eccentric focused exercises to lengthen the hamstrings under tension (Brockett, Morgan & Proske, 2004; Askling et al., 2013 and Askling et al., 2014). Recently, running has gained increased attention in the rehabilitation of hamstring injuries, research is focused on optimal running loads, distances and speeds for hamstring rehabilitation so that athletes are returning to sport conditioned but not overloaded (Duhig et al., 2016 and Whiteley et al., 2018). However, injury rates remain high across most running based sports, according to recent research by Ekstrand, Walden & Hagglund, (2016) which shows there has been a 4% annual increase in hamstring injuries during training in elite men's football since 2001 despite a plethora of research surrounding them (Ekstrand et al., 2013). Although many studies focus on football (Woods et al., 2004, Ekstrand et al., 2011, Hagglund et al., 2013 and Ekstrand et al., 2016), rugby has reported similar injury rates (Brooks et al., 2006) however, the sports are not comparable in terms of physicality, physiology and anthropometric measurements, therefore comparisons in management process and protocols cannot be directly compared.

There is considerable discussion on how to optimise assessment, diagnosis, treatment, and rehabilitation of hamstring injuries (Mueller-Wolfhart et al., 2013). Due to inconsistencies in the grading of hamstring injuries, injury incidence reporting, and a lack of consensus regarding the best methods of managing hamstring injuries: assessment, diagnosis, treatment, and rehabilitation remains a challenge. This suggests that the management of hamstring injuries is still not effective (Ekstrand et al., 2013 and Mendiguchia et al., 2012). Reasons for this may include a lack of evidence regarding the efficacy of treatment and rehabilitation strategies (Pizzari et al., 2010). Because of the heterogenous nature of the hamstring group it means injury location, types and size of injury make prognosis and rehabilitation a challenge (Askling et al., 2012).

Hamstring exercises intended for rehabilitation and training have received much attention in recent years. Despite this focused effort, first time hamstring injuries and recurrent hamstring injuries remain high (Prior et al., 2009 and Mendiguchia, Alentorn-Geli & Brughelli 2012). Ekstrand et al., (2013) report that hamstring injury rates have not improved over the last 3 decades. Researchers have presented reasons as to why hamstring injuries remain prevalent, including early return to play following hamstring injury, lack of high-quality evidence-based research and a reductionist approach to the current literature (Mendiguchia, et al., 2012). According to Ekstrom, Donatelli & Carp have noted that rehabilitation and training programmes should be based on the principle that “specific imposed demands on the musculoskeletal system will produce specific adaptations” (2007: p.754). Therefore, those involved in the management of hamstring injuries must understand the complex, heterogenous nature of hamstring injury (Askling et al., 2014).

Management of hamstring injuries frequently includes rehabilitation, where prescription of a large variation of hamstring exercises to rehabilitate and return an injured athlete back to sport are included. Rehabilitation of hamstring injuries is complex and Askling et al., (2014) identified a lack of high-quality clinical research regarding the effectiveness of various hamstring rehabilitation programmes. Reurink et al., (2012) shows that there is no agreement as to which exercise is best for rehabilitating hamstrings. A reason for the lack of consensus may be reflected by the small number of published rehabilitation studies (Sherry and Best, 2004, Heiderschiet et al., 2010, Askling et al., 2013, Sherry, Johnston & Heiderschiet 2015, Mendiguchia, Martinez-Ruiz, Edouard et al., 2017 and Macdonald et al., 2019). A systematic review undertaken by Reurink et al., (2012) analysed several interventions used in the management of hamstring injuries, they concluded that there is no consensus on the effectiveness of interventions used for management of hamstring injuries. However, these recommendations should be viewed with caution due to the variations in reporting severity of hamstring injuries, incidence of hamstring injuries and different rehabilitation protocols.

Understanding how practitioners conduct their practice and their player welfare approaches is as important as understanding what they do. However, there are very few actual accounts of how this is done in the literature. One study by Pizzari et al., (2010) show they are managed from a physiotherapist’s perspective in Australian Rules Football and a more recent study by Macdonald et al., (2019) gives an insight in to how hamstring injuries are managed and rehabilitated depending on their classification using the BAMIC within British Athletics. A hamstring injury will usually produce a loss of strength, power, and neuromuscular control. The extent of the impact of a hamstring injury and the subsequent management strategies will be dictated by both the mechanism and the severity of the injury.

Recurrent hamstring injuries are prevalent in sport (Ekstrand et al., 2016). With recurrent hamstring injury rates stated as 23%-30% (Brooks et al., 2006 and (Ekstrand et al., 2016).). Previous research shows that recurrent hamstrings injuries are associated with being more severe, with athletes having to spend a longer time away from both training and competition (Woods et al., 2004 & Brooks et al., 2006). There is no recent data to agree or disagrees with this. It has been suggested that recurrent hamstring injuries are most common within the first month of return to play but can pose a risk for up to 12 months post return (Brukner et al., 2013). Factors often associated with high recurrent hamstring injuries include return to play too soon, (current functional tests do not reveal whether an athlete's previous injury has completely healed), poor rehabilitation (under or over loaded), incorrect diagnosis, pressures from the club or a lack of conditioning once the athlete has returned to play. The presence of one or more of these factors are often associated with recurrent hamstring injuries. Therefore, understanding the complexities of the professional context in which injury management takes place will be addressed within the thesis.

1.4 Thesis Structure

Chapter two presents a critical overview of the role of the practitioner in the management of hamstring injuries and the management strategies and interventions used to treat hamstring injuries. The literature review will focus on the practitioner's role and then move on to how hamstring injuries are currently being treated in the literature. The chapter will identify gaps in the literature to demonstrate the original contribution of knowledge this thesis will bring. Most research focuses on what is done in each stage of the rehabilitation process, but little focuses on understanding the complexities of the processes behind the practice. No studies from the authors knowledge looks at this from a doctor, physiotherapist and strength and conditioning point of view, most focus only one profession. In sports medicine working in a multidisciplinary team is common, and fundamental in elite sport.

A multidisciplinary team (MDT) can be defined as a group of professionals from various disciplines that work collaboratively to provide the best care to an athlete (Breitbach et al., 2017). Multidisciplinary teams will vary depending on the complexity and demands of the sport (Buran et al., 2019). A MDT in elite rugby union may consist of a doctor, physiotherapist, soft tissue therapist and strength and conditioner and in some cases, there will be a Head of Sports Medicine who work alongside a head coach, physiologist, analysist and skills coaches. The chapter will conclude with the research question and an overview of the aims and objectives.

In Chapter three, I describe my research methodology and underpinning philosophy the mixed methods research. I demonstrate my paradigmatic position and discuss why the research methods were chosen. I describe and explore the constructivist philosophical research paradigm, research design and methods that underpin the research. The chapter also details the study methods. Which includes information on how the study was conducted, recruitment methods, data generation methods and information on the qualitative interviews. The chapter concludes with a description of the thematic approach to analysis.

The analysis chapters follow, within these I extrapolate and interrogate some of the complexities of what it means to undertake sports work in a professional setting, how knowledge and ideas are conceptualised and enacted upon in practice, and how ideas related to athlete welfare and duties of care translate into their work. Specifically, in chapter four I analyse the pilot study in terms of data generated and the methodology. The focus of the pilot study was to evaluate the interview structure and methods and for me to gain confidence in the interview process.

Chapters five to seven are where I present the findings of the study. Chapter five disseminates the data and discussions in relation to the technical expertise and scientific knowledge of the practitioners alongside their professional attributes and beliefs surrounding hamstring injuries. The chapter also covers working in a MDT. This chapter focuses on the technical expertise and scientific knowledge the practitioners use to manage hamstring injuries in elite English rugby union. Technical expertise and scientific knowledge underpin successful manage of injury and is guided by evidence-based practice. The chapter shows that all practitioners in the study rely on their technical expertise and scientific knowledge to manage hamstring injuries as it underpins everything they do. This is important as it allows them to management injures to the best of their ability, however there may still be issues with recurrent injures, poor healing and poor progressions. But using a technical expertise and scientific knowledge approach should enhance both what is done but also the level of player welfare and duty of care.

In chapters 6 and 7 I provide a detailed overview of what is implemented and conducted by the practitioners to manage the hamstring injuries. These chapters are included to illustrate the scientific basis of hamstring injuries and offer further insight into some of the specificities of injury management that practitioners are faced with in professional rugby. Chapter 6 explores how hamstring injuries are manged by the medical team – the doctors and the physiotherapist. Chapter 7 outlines how the strength and conditioning staff manage hamstring injuries.

In chapter 8 and 9, the findings of the thesis are considered in their entirety and concluded. An overall discussion and conclusion of the thesis will be drawn that considers all aspects of the practices and the processes involved in the management of hamstring injuries. I will draw together the main findings and highlight the strengths and limitations of the study. I will also recommend future research directions.

Chapter 2

Literature Review

2.1 Chapter outline

The first chapter of the thesis introduced the study by setting the scene and giving a contextual background to the study. In this chapter I will draw on the current literature to support the study, allow arguments and to develop discussions around the management of hamstring injuries in English rugby union. Following the literature review, the thesis will highlight the studies and discuss key themes and results.

2.2 Managing injuries in elite sport

For teams to be successful avoiding injuries is essential (Ekstrand et al., 2021). Injuries cause athletes to miss significant periods of training and competition (Orchard & Seward 2002, Ekstrand et al., 2011 and Brooks et al., 2016). Impact of injury can have multiple effects on the athlete, team, coaches and managers, medical staff, the athlete's family, and anyone involved with the player (Short & Tuttle, 2020). These impacts can range from physical, psychological to psychosocial implications that cause stress, anxiety, and pressure on the injured player. At elite level, added to the implications already mentioned are pressures from fans, the media and social media as injuries are often reported in the news, on websites and on social media where information is instantly available. Everyone is able to give their critique, opinion, offer advice and openly criticise injury timescales, treatment techniques and parts of the injury management process, which can often be detrimental to the athlete's and sometime practitioners physical and mental wellbeing (Hainline et al., 2017 and Reardon et al., 2019). Often these multifaceted effects that impact the management of sports injures are unnoticed and not appreciated (Short & Tuttle, 2020). This has been highlighted in basketball by McLean, Strack & Russell et al., (2014). Therefore, preventing injury is an important aspect of the injury management process (Short & Tuttle 2020). If a medical team can reduce the risk of injuries occurring, they will be reducing time out of sport, maximising playing time of athletes but also protecting the player and the medical team from the pressures that come with elite players getting injured. Specific hamstring injury prevention protocols and literature will be reviewed later in the literature review.

Hamstring injuries are increasing in football (Ekstrand et al., 2016; and Jones et al 2019) and baseball (Ahmad et al., 2014), and remain high in athletics (Pollock et al., 2022) and rugby union (Brooks et al., 2006), although there has been no new published data on hamstring injuries from Brooks and colleagues since their initial study in 2006. The management of these injuries is focused on expediting the return to sport as quickly as possible. Athletes train hard, play hard and expect 'gold' standard medical care as they often want to train and play when injured or unwell. We need to develop our understanding of these highly prevalent injuries in order to ensure athlete welfare and the best possible injury outcomes and to allow more focused future research and education. Most of the current research focuses on what exercises are good for rehabilitation, what should be included in preseason training, in injury prevention programmes, what loading, and volume of training should be implemented. However, there is little research on the efficacy of these (Mason, Dickens & Vail, 2007 and Prior, Guerin & Grimmer 2009) and hamstring rehabilitation protocols have not been directly compared to each other (Macdonald et al., 2019). Future research should take the research that has already been conducted and look at the efficacy of these interventions to develop high quality evidence-based practice that can be easily translated into practice. There is scant research looking at the practitioners working in elite rugby union and how they manage hamstring injuries, this thesis will look to address this and cover how professional sports workers practice in pursuit of Athlete Welfare.

2.3 What is elite sport

There is no consistent definition of what elite sport is. However, the term 'elite' is often used to "describe the standard of athlete in a research or support setting" (Williams, Day, Stebbings & Erskine, 2017). World class and high performance are other terms sometime used instead of elite. For this study elite refers to full time and those in the highest tier of rugby.

2.4 Duty of Care

At the heart of all sport, at all levels is the participants (Grey-Thompson, 2017). Anyone working in sport with athletes has a duty of care towards both their physical and mental and emotional wellbeing and welfare Grey-Thompson (2017). There is an increased awareness that everyone engaged in sport at whatever level need to provide player welfare and duty of care to everyone involved (IOC, 2016).

Duty of care must be considered when managing injuries, practitioners must have duty of care at the forefront of what they do, and ensure the athlete is provided with the correct injury management procedure. This thesis does not cover duty of care and data will not be analysed to consider this however, it is important to understand where it fits in the process of injury management. Understanding how injuries are managed is key to ensuring duty of care. Despite an increase in hamstring literature over the last 20 years hamstring injuries are still prevalent and little is still known about the most effective ways to manage hamstring injuries. Therefore, practitioners are relying on older methods (not always incorrect or unsuitable), generic methods, methods that may not have been tested within their population, sport or their level, and as such may not have the same results as the original study. This study aims to see how hamstring injuries are managed in elite English rugby union. Duty of care can be an umbrella term that includes safeguarding and athlete/player welfare. In a perfect world duty of care should be the responsibility of everyone and should never be questioned. However, some breaches of duty of care in high profile sports such as rugby, football, and cycling (see below in 3.4) it was decided that an independent review of duty of care across all levels of sport should be conducted. Therefore, in 2015, Baroness Tanni Grey-Thompson was commissioned to undertake an independent review and report into the duty of care in sport. The final report can be viewed here: Microsoft Word - 170419 Duty of Care Review - Final version .docx (publishing.service.gov.uk). For the purposes of the report a broad definition of duty of care was adopted. This covered many aspects from grass roots sport all the way to elite sport in the UK. Aspects covered included personal safety, injury, and mental health. As a result of the independent review, The Duty of Care in Sport Report (DoC in Sport Report) was published by the Department of Digital, Media, Culture and Sport (DMCS) in April 2017. The results of the report made seven Priority Recommendations, which can been seen here: Microsoft Word - 170419 Duty of Care Review - Final version .docx (publishing.service.gov.uk). We should no longer be driven to win-at-all-costs. Instead, athlete welfare and safeguarding should be at the forefront of all practitioners' minds during the management of injuries. Closely linked to duty of care and player welfare is ethics.

2.5 Ethics of care

Ethical challenges for the medical teams in elite sport are evident (Malcolm & Scott, 2014). Practitioners will be pulled in many directions to get the player fit and back playing. There will be pressures from the coaches and managers, players themselves, pressures within the multidisciplinary teams and possibly from the media. These stressors were documented by Arnold et al., (2019). Upholding confidentially and other ethical issues can be problematic in elite sports. Sometimes these ethical breeches make public news and are brought to the attention of the media and social media. An incident in 2009 was seen in elite rugby union and was coined by the media as ‘Bloodgate’. The highly publicised incident highlighted unethical practice by a doctor and physiotherapist at one elite rugby club. With this came varying opinions and debate from the medical and sporting worlds on the conduct of the professionals involved. One of the issues that was highlighted in this case was the player who took the blood capsule, he felt he had no choice as there was a ‘win at all costs’ mentality at the club and he followed orders from the club’s Director of Rugby. Like duty of care, this thesis does not cover ethics of care and data will not be analysed to consider this however, it is important to understand where it fits in the process of injury management.

2.6 Scope of practice

Sports medicine for elite athletes is challenging on many fronts and return-to-play (RTP) decision- making is complex (Jacobsson et al., 2013). With many practitioners working in fast paced environments under huge pressures to return the athletes as soon as possible. In an ideal world practitioners aim to use evidence-based protocols for all aspects of management; however, we have seen that there only a few of these and most focus on rehabilitation and treatment protocols are either old or very generic like the new PEACE and LOVE injury management protocol developed by Dubois and Esculier (2020). Perhaps research needs to focus on how we apply generic protocols like this to specific tissues, how do we change aspects of this for different injuries and different injury classification etc. By understanding how practitioners do this as part of the management process may help us to understand if practitioners do stick to a one size fits all process or if they do try and change what they do depending on the injury. If we see that a lot are sticking to a generic method and getting recurrent injuries, it may be a reason to develop more individualised injury specific treatment protocols. However, finding the time to do the research, make the implementations and keep up to date with the is often difficult due to the pressures of working in an elite sporting environment. A recent study by Short & Tuttle (2020) shows that team-based practitioners in the United States have found this particularly challenging when implementing injury prevention strategies that are published. Short & Tuttle (2020) argue that the research side is clear and defined, whereas the implementation of the research is often not as effective in real life as it is compared to the participant groups used within the study. They believe that there is “an inherent difficulty in the application of research to practice in elite sport” (Short & Tuttle 2020, p.1229). Often practitioners need to translate research in to practice by bringing ideas, protocols and recommendations from other sports which obviously is not ideal. This is highlighted with hamstring injuries in basketball and running based sports like rugby and football. The literature shows us that the best practice for hamstring injury prevention should include eccentric training, sports specific preseason training and individualised high-speed running (Buckthorpe et al., 2017). Physiologically basketball is very different from running based sports, but due to the lack of evidence-based hamstring injury prevention protocols for basketball, often medical practitioners and those involved in the management of hamstring injuries will have to draw on the protocols developed for running based sports. As the sports have different demands and mechanisms of injury this can lead to ineffective injury prevention. Fixture congestion is also problematic when using protocols from different sports. Often rugby has one match a week, therefore rest and recovery from both training and matches is possible. In Basketball in the US often teams play more than three time a week, often playing three days out of four, this does not allow for sufficient recovery Caparros, Casals, Solana, et al (2018). Therefore, a hamstring injury prevention protocol adopted from a running based sport would not be possible for a basketball squad as they recommend eccentric exercise like the Nordic Hamstring strength exercise (Wollin, Thorborg & Pizzari, 2018 and Wollin, Thorborg & Welvaert, et al., 2018).

Within The UK, there are several significant professional bodies that set professional standards for practitioners. These statutory bodies include the General Medical Council (GMC) and The Health and Care Professions Council (HPCP), The British Medical Association (BMA) and the Chartered Society of Physiotherapy (CSP). Sports specific bodies include The British Association of Sports Rehabilitators and Trainers (BASRaT), British Association of Sport and Exercise Medicine (BASES) Association of Chartered Physiotherapists in Sports Medicine (APCSM) and The UK Strength and Conditioning Association (UKSCA). McNamee & Philips (2011) states that there are nuanced differences between these professional and regulatory bodies however they do share several common branches relating to duty of care and scope of practice. Therefore, it is imperative that practitioners work within their scope of practice in order to uphold their professional standards and maintain safeguarding of all. As with duty of care and ethics of care this thesis does not cover scope of practice and data will not be analysed to consider this however, it is important to understand where it fits in the process of injury management.

2.7 Multidisplinary teams

Arnold et al., (2017) illustrated that 'the team behind the team' in elite sport typically includes five sports medicine personnel (e.g., doctors, physiotherapists), sport scientists (e.g., physiologists, biomechanists) and various other support staff (e.g., performance lifestyle advisors, performance analysts). This differs from elite rugby as they tend not to have biomechanists, lifestyle advisors and multiple analysers. Within elite English rugby union there will usually be a team doctor, lead physio and lead S&C, with less experienced and junior members below the lead roles. In some clubs there are soft tissue specialists' rehabilitation S&C personal, sprint coaches, so there are no set criteria that clubs must follow.

As a practitioner whether it be a doctor, physiotherapist or S&C they need to be able to understand the scientific principles that underpin their practices. This will enable them to plan and implement management strategies that can be implemented by the MDT. To enhance the management strategy of injuries, a sound knowledge and understanding the demands of the sport is also a key factor in the management of injury, understanding the demands of rugby union, positional demands, physiology of the sport, understanding the specific nuances between positions is key (Duthie, Payne & Cooper, 2003 and Till et al., 2019).

2.8 Methodologies

Research allows us to answer questions, acquire new knowledge and develop our understanding in a systematic manner, (Garg, 2016). Mixed Methods Research (MMR) is often seen as the third research paradigm. It encompasses and utilises both qualitative and quantitative deigns to answer research questions. Understanding the research methodology is fundamental to a researcher (Garg, 2016). If a researcher understands the methods utilised in their study the research is more likely to be reliable, robust, reproducible with acceptable outcomes (Garg, 2016). Increasing our research rigour can only be a positive step as this will ultimately reflect the quality of the researcher. This is often forgotten in qualitative research, despite it becoming more popular amongst researchers (Krefting, 1991). As a researcher it is up to us to understand, formulate and articulate beliefs, questions about our research areas so that we can set about it using the correct methods to attain knowledge and understanding (Rehman & Alharthi, 2016). We do this through research paradigms – a belief system with a theoretical framework (Rehman & Alharthi 2016). Simply, a research paradigm is the way in which we go about understanding our research questions and understand reality. These methodologies will be applied to the current thesis in order to see how hamstring injuries are manged from the perspective of lead doctors, physiotherapists and strength and conditioner.

2.9 Why the hamstrings?

Hamstring injuries are highly prevalent in elite rugby union and many running based sports (Ekstrand et al., 2011, Brooks et al., 2006, Ekstrand et al., 2016 and Kerin et al., 2022). Hamstring injuries have been the focus of a lot of research over the last decade, which includes MOI, assessment, diagnosis, treatment, rehabilitation, injury prevention and return to play. Despite the increase in hamstring research, hamstring injuries still remain high (Ekstrand et al., 2016). However, they are potentially more amenable to injury reduction/prevention strategies than other injuries. Research focused on optimising rehabilitation following a hamstring injury is progressing (Ishoi et al., 2020). However, a lot of research is still focused on team sports and multiple classifications of injury. This section of the literature review explores the research and literature surrounding hamstring injuries.

Due to their anatomy, function, and physiology they are a complex heterogeneous group of muscles consisting laterally of the biceps femoris and medially the semitendinosis and the semimembranosus (Askling et al., 2000). The biceps femoris has two heads, the long head of biceps femoris and the short head of biceps femoris. The semitendinosis, semimembranosus and the long head of biceps femoris are biarticular muscles that cross the hip joint proximally and the knee joint distally (Mendiguchia, et al., 2012). The short head of biceps femoris is uniarticular and works only at the knee joint. For a more comprehensive overview of the anatomy see Appendix 1. Contraction of the hamstrings is complex and needs to be understood prior to managing hamstring injuries. Due to the biarticular nature of the hamstrings they allow simultaneous hip extension, and knee flexion when they contract concentrically, similarly, they will lengthen during hip flexion and knee extension (Opar, Williams & Shield, 2012). Anatomy combined with function and physiology make the hamstrings a complex group for injury management and reduction/prevention.

Acute first-time hamstring injuries are prevalent, complex and a multifactorial problem within field-based sports (Woods et al., 2004, Brooks et al., 2006, Ekstrand et al., 2011, Ekstrand et al., 2016 and Danielsson et al., 2020). Hamstring injuries are the most prevalent injury in sports that require high speed running, sprinting, acceleration, deceleration and kicking (Devlin, 2000, Drenzer, 2003, Askling et al., 2006; Brooks et al., 2006, Ekstrand et al., 2011; Askling et al., 2014, Ekstrand et al., 2016 and Danielsson et al., 2020). With recurrent injury rates reported of 23%-30% reported by (Brooks et al., 2006 and Ekstrand et al., 2019). Classifying these injuries is important for practitioners who are involved in the diagnosis, decision making and prognosis of injuries (Pollock et al., 2014). There is inconsistency surrounding the classification of hamstring injuries and reporting injury severity as there is no universal classification system. This may be due to the complex heterogenous nature of muscle injuries (Mueller-Wolfhart et al., 2013). Various methods cited in the literature are employed by practitioners to classify muscle injuries, these include methods proposed by O'Donoghue, (1962), Peetrons, (2002), Stoller et al., (2007), Mueller-Wolfhart et al., (2013) and more recently Pollock et al., (2017). Due to inconsistent methods in which muscle injuries are classified, it is difficult to make comparisons between studies, sports, and positions. Similarly, this variation could potentially make a practitioner's job more challenging when recording medical notes and documenting the details relating to the hamstring injury. It may be an even greater challenge for those working in multidisciplinary settings where medical notes are shared between a multidisciplinary team and where each member could potentially use a different classification system from the literature. Previous muscle classification systems have been based on the amount of tissue damaged and the amount of functional loss (O'Donoghue, 1962). However, Peetrons, (2002) and

Stoller et al., (2007) developed muscle classification further and introduced radiological imaging to assist with grading muscle injuries. Despite these advances, Mueller-Wolfhart et al., (2013) noted limitations within the previous classification systems and implemented a more robust muscle classification system to standardise muscle classification and injury reporting. The classification of injuries using the consensus guidelines proposed by Mueller-Wolfhart et al., (2013) is comprehensive but very detailed. The injury classification set out by Pollock et al., (2014) known as the British Athletics Muscle injury Classification (BAMIAC) could potentially be more “user friendly” for practitioners as it is not as detailed as the classification system proposed by Mueller-Wolfhart et al., (2013). However, the BAMIAC has been validated showing high intra-rater and inter-rater reliability (Patel et al., 2015 and Wagnesteen et al., 2017). This could potentially have positive practical implications for practitioners when reporting hamstring injuries, but also managing them. If practitioners use different classification systems inaccuracies and discrepancies may develop within the medical teams and those involved in the management of injuries. All practitioners involved in the management of injuries should ideally be following the same guidelines to avoid tensions and mismanagement within the multidisciplinary team. In order to do this, more studies need to be carried out that focus on what is being done to manage them, the studies would then need to be compared and contrasted to look for any areas of management that show a consensus and where there are outliers and anomalies.

2.10 Hamstring injury incidence rates

Epidemiological studies have reported that hamstring injuries account for between 6 and 29% of all injuries in; Australian Rules Football (AFL) (Garrett, 1996 and

Orchard & Seward, 2002); sprinters (Malliaropoulos et al., 2010 and Edouard et al., 2016); football, (Woods et al., 2004; Ekstrand et al., 2008 and Ekstrand et al., 2016) and in rugby union (Brooks et al., 2005a; Brooks et al., 2005b and Brooks et al., 2006) For injury definitions see Appendix 6. Brooks et al., (2005a; 2005b & 2006) have reported they are the most prevalent injury in elite rugby union. Brooks et al., (2006) reported 164 hamstring injuries over 2 consecutive seasons. Due to the inconsistent methods in which muscle injuries are classified and incidence rates reported, it is difficult to compare studies, sports and positions. Previous research from rugby union and football largely confirms that match play is more high risk for acute first-time hamstring injuries than training, (Brooks et al., 2006 and Hagglund et al., 2006). In rugby union, Brooks et al., (2006) have documented hamstring injury rates over 2 seasons and reported a significant (P =0.001) difference between training (0.27/1000 hours) and match injuries (5.6/1000 hours). In football, Hagglund et al., (2006) report slightly higher incidence rates over 2 seasons 5.1 and 5.3 hamstring injuries per 1000 training hours compared to 25.9 and 22.7 hamstring injuries per 1000 match hours. Despite the variation in injury incidence reporting, hamstring injuries are extremely prevalent in all sports (Mendiguchia et al., 2012) at both recreational and professional level. It may also complicate management approaches and cause inconsistent approaches between practitioners in a multidisciplinary team Ensuring that injury incidence rates can be compared may allow got more successful management of hamstring injuries. Acute first-time hamstring injury rates have not really reduced over the last 3 decades despite more research and more focus on rehabilitation and prevention Ekstrand et al., (2013). Ekstrand et al., (2013) showed that there had been no change in hamstring injury rates (training and match) over 7-year period within 23 European soccer clubs, and this indicates that the management of hamstring injuries has not been effective to date. In fact, a recent study by Ekstrand et al., (2016) has shown that hamstring injuries have increased by 4% each year in football in 12 European countries since 2001. To support this notion that hamstring injuries are not reducing, a retrospective study by Pollock et al., (2016) reported that time to return to training was delayed and more recurrent injuries occurred. Though, we must use this data wisely as it was a retrospective study. Hamstring injuries may still be prevalent due to due to poor quality research studies, a reductionist approach to current literature and practitioners not translating research in to practice (Buckthorpe et al., 2018). This indicates that more attention and emphasis should be placed on correct rehabilitation that follows healing timescales, safe return to play criteria, testing, and post return monitoring. However, we know from the literature there is no consensus on the best way to rehabilitate hamstring strains.

Hamstring injuries can result in a lot of time lost from sport (Freckelton & Pizzari, 2013 and Pollock et al., 2022) this places the medical staff who are involved in the management of hamstring injuries under a lot of pressure to return the player to sport as soon as possible (Koulouris, Connell & Brukner et al., 2007). Often there are performance and financial implications for all involved (Edouard et al., 2015). High prevalence, poor healing, long duration, and high risk of re-injury within the first month following return mean increased pressures on medical staff and all involved in the management of hamstring injuries (Brukner et al., 2013). Previous research confirms that hamstring injuries have a high risk of recurrence (Brooks et al., 2006; Mendiguchia et al., 2012 and Woods et al., 2004), and are a challenge in sport (Brukner et al., 2013).

Recurrent hamstring injury rates have been reported to be between 12 and 30% in rugby union (Brooks et al., 2006), football, (Woods et al., 2004) and in sprinters (Malliaropoulos et al., 2010 and Pollock et al., 2016). Recurrent hamstring injuries are known to be more severe and require more time to return to sport (Brooks et al., 2006 and Kerkhoffs et al., 2013). Brooks et al., (2006) show that recurrent hamstring injuries require 1.9-11 days longer to return than first time hamstring injuries. More than 50% of recurrent hamstring injuries occur within one month of retuning to play (Brooks et al., 2006; Orchard et al., 2002 and Brukner et al., 2013), however, some authors note that the risk remains high for 12 months following return (Hagglund et al., 2006; Gabbe et al., 2006 and Malliaropoulos et al., 2010) and report up to 30% of recurring hamstring injuries occur within 1 year following the initial injury, Petersen et al., (2010) found similar recurrence rates, they reported 25% recurrent hamstring injuries one year after their initial study. High recurrent hamstring injuries may indicate insufficient rehabilitation and returning to sport too early (Heiderschiet et al., 2010).

2.11 Mechanism of injury

Understanding how injuries occur is key to the management of hamstring injuries. Ekstrand et al., (2011) have shown that as much as 92% of hamstring injuries are caused though non-contact mechanisms, and therefore could be more amenable to injury reduction. Common hamstring mechanism of injury (MOI) reported in the literature include kicking and cutting (change of direction) (Brooks et al., 2006, Woods et al., 2004 and Kerin et al., 2022), stretching at end of range and running Askling et al., 2002 and Kerin et al., 2022). Running has been reported as the most common MOI for hamstring injury in RU (Brooks et al., 2006) and football (Woods et al., 2004), this suggests that high-speed running and sprinting places the hamstrings under the most load and therefore when they are most susceptible to injury. Askling and colleagues in 2002 were one of the first authors to look at MOI of hamstring injuries and this work is still used and cited in the most recent literature. Their work identified two main types of hamstring injury, explosive, and slow stretch. Work undertaken by Woods et al., (2004), Brooks et al., (2006) and Malliaropoulos et al., (2010) support this and have noted that most hamstring injuries are caused by running, explosive movements or over stretching. However, Recent work by Kerin et al (2022) retrospectively analysed videos that showed the mechanisms of hamstring injury in one rugby union team. The study concluded that sprinting was not the only MOI, and hamstring injuries occurred as a result of tackling, rucking and direct trauma. This new information regarding MOI for hamstring injuries should therefore be considered alongside the previous mechanisms noted in the literature. Caution must be applied however, as this was a retrospective study and only covers one club therefore a bigger scale study should be performed across different rugby setting (male, female, semi-professional, amateur) to see if these MOI are common in a bigger sample. The study only used match-based injuries as well and we know for the literature many hamstring injuries occur in training, extending the study to cover both match play and training-based injuries would be beneficial. Adding to the more recent research and detail surrounding MOI is a systematic review by Danielsson et al., (2020) shows stretch based hamstring injuries occur as a result of knee extension or hyperextension with extensive hip flexion whereas those that occur during sprinting are due to excessive eccentric strain on the muscle during the late swing phase of the gait cycle.

By understanding the different types of hamstring injuries, it may assist practitioners when formulating rehabilitation protocols and establishing return to sport criteria and importantly, help manage athletes' expectations about time away from sport. The study by Askling et al., (2002) shows that there is a link between the type of hamstring injury (high speed or slow stretch) and symptoms/function, as well as return to pre-injury levels. This is supported more recently by Macdonald et al., (2019) who used the British Athletics Muscle Injury Classification system to guide hamstring injury management and created specific management strategies for three types of hamstring injury. The results reported by Pollock et al., (2022) showed lower reinjury rates and less time was taken for the athlete to return to training and advocates that a rehabilitation programme that is formulated based on the specific injury classification is sensible. Ensuring athlete care and welfare is an important step towards successful management of injuries especially as we should be working in an environment that is not win at all costs. Practitioners involved in the management of hamstring injuries can use this information on MOI and target rehabilitation programmes to build on their knowledge and expertise.

2.12 Risk factors

A systematic review by Freckelton & Pizzari, (2013) shows that there are many risk factors for hamstring muscle injury. Understanding factors that may predispose a player to hamstring injury is important, however, a full overview of the plethora of risk factors relating to hamstring injury is not the focus of the thesis. Previous hamstring injury has been agreed in literature to be the greatest risk factor for recurrent hamstring injury (Arnason et al., 2004; Gabbe et al., 2006 and Warren et al., 2010). There are conflicting results in the literature surrounding hamstring weakness and risk of injury following hamstring injuries. The importance of understanding risk factors in the management of hamstring injuries is discussed in chapters technical expertise and scientific knowledge and duty of care as it is not just the conflicting literature, but also the conflicting translation of the research into practice, which are then further compounded by the entrenched cultures and ways of working that are a part of professional sport and often hard to counter.

Studies by Woods et al., (2004) and Verrall et al., (2005) demonstrate that the higher the level of sport the more likely hamstring injury is to occur. Therefore, practitioners working in elite sport need to be highly trained with exceptional levels of scientific knowledge and technical expertise. Fatigue is another area of risk factors that has been focused on a lot recently with regards to hamstring injuries and requires consideration form those involved in the management of hamstring injuries. However, there is conflicting evidence and opinion which makes translating research in to practice more complex.

2.13 Management of hamstring injuries

There is a plethora of literature on the management of hamstring injuries across different populations. An old Cochrane review on the management of hamstring injuries by Mason, Dickens & Vail, (2007) and a systematic review by Prior, Guerin & Grimmer, (2009) have highlighted a variety of interventions are used by practitioners to manage hamstring injuries, but there is scant evidence to support their efficacy. More recently the focus of studies had been on rehabilitation exercises, high speed running, eccentric exercises, and injury prevention programmes for hamstring injuries however, with little consensus as to what is the best way to manage these complex injuries (Buckthorpe et al., 2018). Despite this increased focus in the research of hamstring injuries, they remain prevalent across running based sports Ekstrand et al., 2016 and Pollock et al.,2022). Pizzari et al., (2010) conducted a study that looked at the management of hamstring injuries in the Australian football league. Pizzari, et al., (2010) found that assessment, diagnosis, and treatment showed some consistency between the respondents, however there was more variation in the rehabilitation, injury prevention and return to play. The current thesis will expand the original work of Pizzari, et al., (2010) by looking at more than just what is implemented, but the processes behind what is implemented. This thesis will explore the Professional Sports Workers Practice in pursuit of Athlete Welfare and will interrogate some of the complexities of what it means to undertake sports work in a professional setting, how knowledge and ideas are conceptualised and enacted upon in elite practice. The following sections highlight the key research for the management of hamstring injuries.

2.14 Diagnosis of hamstring injuries

We have seen that making an accurate diagnosis of injury is vital to the successful management and allows practitioners to put the athlete’s welfare at the forefront of the care they give. However, because the hamstrings are heterogeneous group of muscles, Askling et al., (2012) feel this makes diagnosis of injury complex and often problematic. The complicated biomechanics of the biarticular muscle group also means management of hamstring injuries will be challenging (Orchard, Best & Verrall, 2005). The need for a quick, accurate assessment and prognosis of a hamstring injury is vital in sport (Kerkhoffs et al., 2013). Malliaropoulos et al., (2010) and Ericksen & Sherry (2017) state it is important to establish the exact cause of the injury, assess the severity of an injury in elite athletes as soon as possible and to recognise and establish the severity and avoid early return to sport and the risk of re injury. These factors may be why, there is no real consensus in the research regarding the most optimal methods to assess a hamstring injury. However, to ensure athlete welfare and the highest standards injury management it is imperative that we assess injuries with consistency using the best possible evidence-based guidelines. Issues regarding development of assessment and diagnosis from a technical expertise and scientific knowledge point of view will be discussed in Chapter 5. An overview of what is implemented in terms of clinical assessment and diagnosis of hamstring injuries will be discussed in Chapter 6. Diagnosis and prognosis of hamstring injury (and other injury) is usually performed manually by a well-qualified physiotherapist or sports physiotherapist (Malcolm et al., 2006). Manual assessment often includes palpation, evaluation of pain, strength through manual strength tests, range of motion, movement patterns and functional tests (Whiteley et al., 2018). However, validity of these assessment methods is still unknown (Whiteley et al., 2018) and many still use diagnostic imaging to assist with diagnosis and prognosis (Kerkhoffs et al., 2013) despite the best imaging option is still not clear.

Diagnostic imaging was popular in the early 2000's with more clinicians turning to magnetic resonance imaging (MRI) to assist diagnosis (Schneider-Kolsky et al., 2006). However, there is no consensus as when the best time to image is, with Ekstrand et al., (2012) suggesting for correct diagnosis the hamstring should be imaged with 24-48 hours of the initial injury.

Inconsistencies are evident when looking at the timing of examination and when to perform a clinical assessment or to use diagnostic imaging following a hamstring injury. Kirkhoffs et al., (2013) state that the initial objective assessment of an acute first-time hamstring injury should be performed between 1hr to 48hours post injury. Advantages of early assessment advocated by Kirkhoffs et al., (2013) and Malliaropoulos et al., (2010) may mean quicker diagnosis and prognosis, however, some symptoms like swelling and ecchymosis will not appear until a few days post injury, therefore so some argue the initial assessment should be delayed or, reviewed again after the initial assessment has taken place (Askling et al., 2008). An early assessment may also be influenced by pain and therefore should be taken into consideration when making a prognosis (Kirkhoffs et al., 2013). Various clinical tests and methods of assessment can be used when assessing a hamstring injury Erikson & Sherry, (2017). Clinical testing has been shown to provide a useful tool for predicting time to return however there is no consensus or agreements as to what the best way is to assess a hamstring injury to guide diagnosis, rehabilitation or return to play. Malliaropoulos et al., (2010) suggest testing active knee range of motion deficit 48 hour post initial injury as an objective and accurate measurement to assist in predicting time to return. Testing outer range strength, maximal hip flexion, active knee extension (MHFAKE), recording pain and palpation outcomes should be conducted daily as these are useful outcome measures that can inform and assist with the progression of rehabilitation (Whiteley et al., 2018).

There are times diagnostic imaging in needed to support an objective hands-on clinical assessment. Magnetic Resonance Imaging (MRI) and Ultrasound (US) are the most used imaging techniques for hamstring injury (Kirkhoffs et al., (2013). Each have their own advantages and disadvantages see Kerkhoffs et al., (2013) for a more detailed overview as this is beyond the scope of the thesis. However, in summary, Kerkhoffs et al., (2013) recommend based on the literature they reviewed the physical assessment should take place within 48 hours of the injury and should involve assessment of posture, gait, palpation, flexibility, strength and referred pain. In terms of diagnostic imaging, Kerkhoffs et al., (2013) show from the literature that MRI is preferred to US as they believe it has a greater sensitivity for more minor injuries and it is easier to give an accurate diagnosis.

MRI is often used if there are complications or if rehabilitation is not going to plan (Blankenbaker & DeSmet, 2004) and US is often chosen as it is cheaper (Connell Schneider-Kolsky, Hoving et al., 2004). Like with clinical assessment, the literature shows that there is no consensus as to when the best time to image an acute hamstring injury (Kerkhoffs et al., 2013). Ekstrand et al., (2012) state that imaging should occur within 24 -48 hours post injury as this will give you more information regarding time to return to play. In terms of healing response, studies show that maximal swelling will occur at approximately 24 hours post injury and begin to decrease after 48 hours. Therefore, based on this, imaging should ideally be carried out 24-48 hours post injury and supports the thoughts of Ekstrand et al., (2012).

2.15 Treatment of hamstring injuries

Treatment and rehabilitation interventions should follow a fully and accurate clinical assessment and be based on the type, severity, and location of the injury (Askling et al., 2006; 2007a; 2007b & 2008). Interventions used for treatment and rehabilitation should be individualised and based on the best evidence-based practice (Brukner et al., 2013). However, according to Petersen & Holmich, (2005b) and Whiteley et al (2018) there is lack of evidence for assessment, treatment and rehabilitation, and no consensus of best practice.

Initial treatment should focus on controlling the inflammatory response and reducing the intermuscular bleeding and pain associated with injury, according to Hamilton (2015) this aim has not changed a great deal over the last 60 years. Reasons as to why there have been little change and development are unclear, but it may be due to practitioners using tired and tested methods that have “withstood the test of time” (Hamilton, 2012 p900). Surprisingly, popular treatment methods used by practitioners have little evidence and are often controversial (Orchard et al., 2008, Cook, 2010 and Franklyn-Miller et al., 2011). Practitioners will use popular methods and techniques that often have little evidence base (Hamilton, 2012). More recent support of this some from Whiteley et al., (2018) who state we still do not know enough about clinical tests used to assess hamstring injuries, if a clinician was to perform two tests with contradictory outcomes it is not know which test is the ‘better’ or more valid test. Adding to this Whiteley et al., (2018) states that it is still not evident if any of our clinical assessment methods have any useful relation to rehabilitation.

However, the pressures and stressors facing practitioners working in elite sport are high (Arnold et al., 2019). Researching and learning new interventions and protocols often require practitioners to go on long and expensive training courses, take time out to read the most up to date literature and evidence which according to Arnold et al., (2019) is a stressor which often takes the practitioner away from their day-to-day role. This would take them away from the club and multidisciplinary team and injured athletes for a period and could affect the management of injuries, ultimately the practitioners are contracted and paid to return athletes from injury as quickly as possible. Practitioners work in high pressured, fast paced environment, and have little room for error and minimal time to anything other than assess, treat, rehabilitate, and manage their injured players Coutts (2016). These pressures and issues surrounding this are discussed in chapters 5.

2.16 Rehabilitation of hamstring injuries

Rehabilitation is a process used to restore function within a muscle following injury (Mason et al., 2012). Rehabilitation of hamstring injuries can be lengthy, especially if an athlete sustains a stretch type injury (Askling et al., 2007 and Brukner et al., 2016). For rehabilitation to be successful, rehabilitation needs to be planned and based on the best evidence available and utilising the most suitable interventions (Mason et al., 2012). Interventions used to treat according to a systematic review carried out by Mason et al., (2012) include: PRICE, electrotherapy modalities, manual therapy, and soft tissue massage. Interventions implemented by practitioners to rehabilitate hamstring injuries according to Mason et al., (2012) include: stretching (flexibility) and mobilising (ROM) exercises, strength-based exercises, and movement dysfunction exercises to correct movement dysfunction. However, the optimal way to rehabilitation and an acute first-time hamstring injury is still not fully understood (Petersen & Holmich, 2005; Goldman & Jones, 2007 and Hamilton 2012). Choosing the correct rehabilitation exercises can be a difficult task for practitioners as “there is a lack of clinical research and consensus based on prospective, randomised studies regarding the effectiveness of various rehabilitation protocols for acute hamstring injuries in elite sprinters and jumpers" Askling, et al., (2014, p.532) and many other athletes and sports. There have been several studies that have looked at the effectiveness of different rehabilitation protocols for hamstring injuries for various sports (Sherry & Best, 2004 and Silder et al., 2013). Another problem surrounding the rehabilitation is the differences in technical expertise and scientific knowledge of practitioners, this varies within the multidisciplinary team and is discussed in chapter 5. Linked to this, is the length of time research takes to be implemented and translated into practice developing high quality approaches to athlete care is lengthy and reflected in the work by Coutts (2016). Rehabilitation should be individualised and depend on many factors including type of hamstring injury, location of the hamstring injury within the muscle, severity of the injury, first time vs. recurring (Askling et al., 2006, Whitely et al., 2018 and Macdonald et al., 2019). This is discussed in chapter 5. Exercises must also be analysed and critiqued prior to be using as part of rehabilitation and most practitioners will try and use evidence based best practice (Fanchini et al., 2020). However, some practitioners will base their rehabilitation exercises on anecdotal evidence rather than empirical evidence as it has been noted that it takes 17 years for research to be used and applied in practice (Leon, 2011 and Bolling et al., 2018). Other barriers to translating research into practice have been noted by Murphy et al., (2021) who state that often research can be lost in translation and implementation as practitioners are not able to determine if their patients are similar to the research patients and therefore actually able to implement the research. Murphy et al., (2021) also note that some practitioners feel they may not get the same outcome as the practitioner used within studies, and therefore will not adopt the approach(es) from the research.

Despite the growing body of literature surrounding hamstring injury rehabilitation, there are still gaps in the research. These include:

1. Rehabilitation programmes - What is the best way to rehabilitate a hamstring injury?
2. Exercise selection - What is the best exercises for each stage of healing?
3. Progressing rehabilitation - When to progress rehabilitation from one stage to the next
4. Running - How and when to introduce running, high-speed running and sprinting to the rehabilitation programme. This includes loading, exposure and prescription.
5. Fatigue - How fatigue affects muscle output during rehabilitation programmes and the rehabilitation process.

Although these may be difficult as healing is not linear (Whitely et al., 2018).

Recurrent hamstring injuries are high and pose significant problems for practitioners involved in the management of them, although this thesis focuses on first time hamstring injuries, trying to reduce recurrent injuries is important. An early study by Sherry & Best (2004) looked at the effects of two types of rehabilitation programmes on risk of re injury. They found that the group that performed core stability exercises as part of their rehabilitation suffered significantly less hamstring recurrent injuries compared to the group that completed conventional isolated hamstring strength and flexibility exercises at 2 weeks and 12 months post return to sport.

2.17 Hamstrings and eccentric strength

We have previously highlighted that rehabilitation should focus on the MOI, and that running based activities and eccentric contractions cause most of the hamstring injuries reported. Therefore, if we are basing rehabilitation (and injury prevention) on the MOI we must employ lengthening eccentric contractions within the programme

(Macdonald et al., 2019 and Danielsson et al 2020). The use of eccentric strength exercises to reduce hamstring injury has been widely researched, with a lot of focus on the Nordic hamstring strength exercise developed by Brockett et al., (2001). Brockett et al., (2001) were the first to show the long-lasting effects following the Nordic Hamstring Strength Exercise (NHSE). In their study, they found that following a programme that utilised the NHSE, there was a shift in optimum length meaning that the fascicle length increased of the hamstring muscles that may protect the hamstrings against injury. However, more recent research is divided

Patricio et al. (2022) show fascicle length in the distal portion of long head of biceps femoris increased after 3 weeks of the NHSE. Presland et al., (2018) however showed only short-term temporary fascicle lengthening following a 2-week NHSE training programme, the study showed fascicle length was lost after 2 weeks. As well as increasing fascicle length, eccentric strength exercise programmes have been shown to increase eccentric hamstring strength and reduce hamstring injury (Askling et al., 2003, Mjolsnes et al., 2004, Proske & Morgan 2004, Brooks et al., 2006; Gabbe et al., 2006; Arnasen et al., 2007; Arnason et al., 2008 and Petersen et al., 2011). However, Goldman's 2007 Cochrane systematic review concluded that there was not enough evidence to support the use of eccentric exercise interventions. As risk of re injury is so high and the fact that eccentric benefits are only temporary (Brockett, Morgan & Proske 2001) it is imperative that maintenance work is continued beyond return to play. Maintenance work is often implemented by strength and conditioning staff, this is highlighted in chapters 5.

2.18 Hamstring injuries and running

Running is an important part of rugby union and team sports (Sheehan et al., 2022). We have already seen that high-speed running causes most hamstring injuries (Daniellson et al., 2020 and Kerin et al., 2022). Therefore, if we are taking note of the research, we should base rehabilitation on the MOI (Askling et al., 2006, Whitely et al., 2018 and Macdonald et al., 2019). Consequently, running must be addressed during the rehabilitation period following a hamstring injury. Duhig, et al., (2016) have shown that optimal loads concerning running must be established to reduce the risk of hamstring injuries. Duhig, et al., (2016) has advocated that athlete should be exposed to weekly sprint distances of approximately 90-120m and these should be carried out at 95% or more of their maximum speed, with no more than 6-10 repetitions. However, this does not reflect match distances in rugby union and the prescription stated by Duhig et al., (2016) should be adjusted to reflect match distances and demands for elite rugby union players. Chapters 5 shows how contentious running is for practitioners and how little consistency there is. A fine balance of introducing it early and doing ‘enough’ against athlete welfare and duty of care is difficult.

2.19 Hamstring injuries and return to play

Returning athletes to sport and prior levels of fitness with minimal risk of recurrent injury is imperative. Return to play testing is varied and there is no consensus within the literature as to what the bests tests are or should be performed as part of an RTP test. Whilst recent studies by Whitely et al., (2018) and Macdonald et al., (2019) agree that rehabilitation should be progressive and based upon the injury severity, location and MOI there is little consensus as to the most effective methods to implement for running based hamstring injuries. There are several factors that will need to be considered when looking at time to RTP, and making sure practitioners return the athlete when it is ethically right to and are not swayed by coaches, managers, and the pressures of the elite sport environment. Even though the athlete fully rehabilitated they may not be ready to return, ensuring the athletes welfare is prioritised should be down to the lead staff involved in the management of the injury. Factors that influence return to play decision making include the type of injury, location of the injury and the location of pain (Askling et al., 2014). Askling et al., (2006) show that the slow stretch injuries require longer time to return to play compared to the high-speed sprint-based hamstring injuries, slow stretch median 50 weeks to return (range 30-76 weeks) compared to high speed 16 weeks to return (range 6-50 weeks however, they did not identify how these times differed for different grades of hamstring injury. This must be considered when managing athletes' expectations of time to return to play and ensure athlete welfare is at the front of any return to play decision and should only be considered when the athlete is ready both physically and psychologically. Askling, et al., (2010) and Orchard et al. (2005) state, before athletes return to sport, they should undertake a series of hamstring specific tests with no remaining sign or symptoms of injury, however, Askling et al., (2006) believe that an athlete can return if they are at 90-95% of the pre injury levels and compared to the uninjured however, if apprehension and fear of over exerting, this could lead to a delay in return to play even though physiological healing has taken place. Alongside the decisions being made regarding the physical outcomes of return to play, the psychological aspect of rehabilitation also needs to be considered, Askling et al., (2014). Askling et al., (2014) showed that 27 sprinters and jumpers felt insecurity when performing the H-test, because of this their rehabilitation was extended by 8-10 days. This shows the importance of taking RTP decisions individually, which is highlighted in chapters 5 and 6. Practitioners need to be aware that when looking at RTP timescales most studies only take into consideration one sport and one injury and therefore it is hard to make comparisons across different injuries and sports. These issues are complex and require technical expertise and scientific knowledge but should be based on the athlete's welfare and be made with the duty of care to the athlete at the forefront. These complexities are discussed in chapters 5. Adding to the complex nature of return to play testing, Brukner et al., (2013) emphasise the importance of player returning to training and playing in a non-fatigued state. They also state the importance of the athlete having sufficient recovery time between sessions to reduce the effects of fatigue. Brukner et al., (2013) advise that if a player is likely to return 3 weeks post injury, this may mean only 5-7 intense sessions (1 session every other day). Duhig et al., (2016) agree with this as they state the importance of optimal loading during rehabilitation and training to reduce the risk of subsequent hamstring injuries.

2.20 Hamstring injuries and injury prevention

Injury prevention is a high priority to practitioners and staff working in elite sport. As discussed in chapter 5 practitioners working in elite English rugby union, they feel they can reduce hamstring injuries. However, Brukner et al., (2013) show that there is low uptake between evidence-based recommendations and the hamstring injury prevention programmes implemented by clubs. Only 11% of elite football clubs surveyed by Bahr et al., (2015) are implementing the Nordic hamstring programme, despite the evidence showing it can help reduce the number of hamstring injuries (van der Horst et al., (2014). This shows a distinct gap between evidence-based practice and its utilisation within sport and researchers are now asking why elite sports teams do not adopt the research and evidence-based practice (McCall et al., 2015). Researchers need to ensure that results are disseminated to practitioners to ensure that evidence-based practice is penetrating through to all levels, not just elite sport and that the knowledge translation gap is reduced. Models of injury prevention have been developed to assist this, and include work from van Mechelen et al (1992), Finch (2006), Meeuwisse et al., (2007), Bittencourt et al., (2016), Roe et al., (2017) and Windt & Gabbett (2017)

The Translating Research into Injury Prevention Practice (TRIPP) model proposed by Finch (2006) is model that can help with this knowledge translation. The TRIPP model can help understand the context of the implementation as well as evaluate the context of the implementation, not just the efficacy of the intervention. Therefore, it is looking at the behaviour of those implementing the intervention. Since this work by Finch in 2006, several other injury prevention models have been developed, however, most still include the steps set out by the TRIPP model. However, most are still very linear Meeuwisse et al., (2007), have a generic approach (Roe et al., 2017) a reductionist approach Bittencourt et al., (2016) or do not take into consideration the players workloads and work rates Windt & Gabbett (2017). To help bridge these gaps the TIP model was developed specifically for team sports by O'Brien, Finch, Pruna & MaCall (2018). The continuous cyclical model has three stages, stage 1, (Re) evaluate, stage, identify stage 3, intervene. All three stages incorporate ethe main aspects of both the van Mechelen model from 1992 and Finches TRIPP model from 2006. The model also utilises the risk management approach advocated by Fuller et al., (2004) and Dvorak (2012). It is proposed that as practitioners move through each stage of the model, they can develop context specific and dynamic injury prevention strategies for their team. For an overview of the TIP model see O'Brien, Finch, Pruna & MaCall (2018). Buckthorpe et al., (2018) looked at reasons why research is not being translated into practice, they consider 3 factors that should also be taken into account when trying to provide a more holistic hamstring injury prevention programme, they are as follows:

1. Consider functional not just isolated strength
2. Players should be conditioned to meet the increasing demands placed upon them
3. Consider the effect of fatigue

Brukner et al., (2013), advocated, the best way to reduce hamstring injuries is by having a holistic approach to rehabilitation, training, and prevention. By including the 3 factors outlined by Buckthorpe et al., (2018) and translating more research and evidence- based work in to practice, it may be possible to reduce the number of hamstring injuries in both elite and non-elite sport. When strengthening the hamstrings as part of rehabilitation or as part of an injury prevention programme, the practitioner should focus on both isolated strength (like the Nordic Strength Hamstring Exercise - NHSE), but they should also focus on developing functional strength. Functional strength according to Buckthorpe et al., (2018) is the ability of the hamstrings to produce force in settings and positions in which they are used (running based). This links to MOI and shows that any rehabilitation, conditioning, or injury prevention work with the hamstrings should be performed according to MOI, sport, position and level which is consistent with the imposed demands.

Conditioning players for the demand placed upon them requires knowledge and application of training and rehabilitation science, as discussed in chapter 5. Athletes returning from injury or breaks need to be conditioned to perform optimally, being underprepared can increase the risk or injury. In this context, a lack of running and sprinting in rehabilitation or training can be a major risk for hamstring injury (Soligard et al., 2016). Optimal loading is essential for athletes, many elite clubs use global positioning systems (GPS) to monitor training load, running and sprint distances and speeds to optimally load athletes during training and rehabilitation. As workload is now seen to be a key factor in hamstring injury prevention (Soligard et al., 2016 and Duhig et al., 2016) but understanding and implementing knowledge about this is difficult within the context of elite sport and working in professional environments.

2.21 Conclusions and gaps

Despite a plethora of research surrounding the treatment and management of hamstring injuries very little is known about how they are managed within elite rugby union. Therefore, the aim of this study was to identify current practice in the diagnosis, treatment, rehabilitation, and prevention of hamstring injuries in elite rugby union clubs and the National senior squad. This qualitative approach will enhance applied practice and allow other practitioners to gain a deeper understanding of the treatment and management of hamstring injuries in English rugby union. Knowledge gained from the study may also be used to inform future studies which will make them more ecologically valid and applicable to the applied practitioners working in the fast environment (Harper & McCunn, 2017). Based on the literature we can see there is a lot on the management of hamstring injuries. However, the majority of this is based on a quantitative methodology, statistical analysis, and viewpoints. Very few are from a qualitative point of view. A small number of studies look at whole management process of hamstring injuries, often research focused on one area for example rehabilitation or injury prevention. Most studies focus on the physiotherapy perspective with more recent focus on the role of the strength and conditioner. To the authors current knowledge there are no studies that look at the management of hamstrings from the perspective of Professional Sports Workers Practice in their pursuit of Athlete Welfare.

Therefore, this thesis will look at addressing these gaps and cover the entire management process and explore the management of hamstring injuries from three practitioner perspectives (doctor, physiotherapist and strength and conditioner) using well established qualitative mixed methods research (MMR) methods. We need to establish why hamstring injuries are still prevalent, we have seen in the previous sections that research focuses on looking at the efficacy of rehabilitation, return to play and injury prevention following hamstring injury. However, little is known about how we management hamstring injuries and to our current knowledge no previous studies have looked at the management of hamstrings in elite English rugby union from the perspective we are.

2.22 Research question

The focus of the thesis is to explore and analyse professional sports workers practice in pursuit of Athlete Welfare. Within the thesis we explored the complexities of the professional context in which injury management takes place. I have also explored the wider related issues of technical expertise and scientific knowledge and working within a multidisciplinary team (MDT). The second aim of the thesis was to identify current practice in the diagnosis, treatment, rehabilitation, and prevention of hamstring injuries in elite English rugby union clubs and the National senior squad.

The research question is:

Professional Sports Workers Practice in pursuit of Athlete Welfare: How are hamstring injuries managed within elite English rugby union?

2.23 Aims of the study

1. To explore the complexities of what it means to undertake sports work in a professional setting with reference to the application of technical expertise and scientific knowledge and working in a MDT team.

2. To understand how lead doctors manage hamstring injuries.

3. To understand how lead physiotherapists manage hamstring injuries.

4. To understand how lead strength and conditioners manage hamstring injuries.

5. To give other practitioners an insight into how hamstring injuries are managed within elite English rugby union.

6. To use the results of the study to help educate future practitioners in the management of hamstring injuries.

2.24 Objectives of the study

1. To understand how medical practitioner and strength and conditioning staff manage hamstring injuries in elite English rugby union.

2. To conduct semi structured interviews to gain an understanding of how hamstring injuries are managed within elite English rugby union.

3. Include practitioner perspectives from the interview narratives within the analysis.

2.25 Summary

Within this chapter I have presented an overview of the literature covering all aspects of the management of hamstring injuries. It has drawn upon and covered evidence-based studies to show global perspectives of how hamstring injuries are managed within different sports and with different populations. However only one study by Pizzari, et al., (2010) show how hamstring injuries are managed. There are gaps in the literature that will be addressed by this thesis.

Chapter 3

Methodology

3.1 Chapter outline

In this chapter I set out, explain and justify the thesis methodology. Prior to doing so, it is necessary to acknowledge epistemological underpinnings of my research approach and subsequent methods (Bleiker et al., 2019). For the thesis to be meaningful and coherent my ontological viewpoint must tie into my epistemological approach as this informs the research approach, methodological decisions I make, and the analytical and critical conclusions I draw from the data (Bleiker et al., 2019). Research is a process that allows us to acquire new knowledge and deepen and build on what we already know. The research process involves a systematic approach, meticulous and conscious planning to ensure it is robust and gives practitioners within the field the best information possible (Garg, 2016). Accordingly, this chapter will explore the constructivist philosophical research paradigm, research design and methods that underpin the research. A Constructivist approach was utilised as it will draw upon the participants views and their views on reality (Bergman et al., 2012). It will help us understand what is happening in the real world (for the purpose of this thesis the real world is elite English rugby union) and will connect professional knowledge within the context of work and the wider issues surrounding elite sport. As discussed below, the approaches set out and employed in this chapter are consistent with the intentions of constructing an in depth understanding of how acute first-time hamstring injuries are manged within elite English Rugby Union and to ensure that the thesis is of high quality, consistent with the philosophical approach to MMR. Within this chapter I will also discuss ethical considerations and limitations to this approach.

3.2 Paradigmatic approach

The aim of a researcher is to understand and gather coherent information and beliefs surrounding the nature of reality, what we can be identified about it and how we go about obtaining this information and beliefs. These practices and processes form a researcher’s ontology; the philosophical starting point for inquiry which aims to find explanations and develop understanding of theories, beliefs and concepts (Bleiker et al., 2019). In addition, a researcher’s ontological position may also influence and dictate their subsequent research paradigm/framework of inquiry that governs how they go approach and understand their research context and subject therein. In short, a paradigm is comprising a theoretical framework (or set of frameworks), beliefs and practices shared by scientists and researchers which standardise investigations within disciplines about how problems should be understood and tackled (Kuhn, 1970, Scott & Malcolm, 2015, Arnold et al., 2019 and Kerai, Wadey & Salim, 2019). Simply, a paradigm is “a basic theoretical framework and set of beliefs” (Rehman & Alharthi, 2016, p.51). In this research, I adopt a Constructivist-Interpretivist approach, similar to (Scott & Malcolm, 2015, Arnold et al., 2019 and Kerai, Wadey & Salim 2019) to unearth how practitioners in elite English Rugby Union treat and manage first time acute hamstring injuries. Constructivism-Interpretivism fosters the idea that individuals are methodical and original in their actions and through this, they build their social world and consider the dynamic and evolving nature of society (Cohen, Manion & Morrison, 2011). Accordingly, the paradigm encourages assessment social realities and situations through the eyes of the participants in the study rather than the researcher (Cohen, Manion & Morrison, 2011). The participants construct a subjective account of their role in the treatment and management of hamstring injuries. The interpretivist dimension of the paradigm comprises two central elements: firstly, it uses subjective epistemology which anticipates multiple, diverse interpretations of reality i.e. what actually happens (Bunniss & Kelly, 2010) and it is associated with an explanatory effort to assemble a series of in depth accounts with the aim of constructing a comprehensive depiction of how a certain experience or value is comprehended by individuals who have personal and first-hand experience of it (Bunniss & Kelly, 2010). Constructivist research utilises methods that generate both qualitative and quantitative data. Generally speaking, under the paradigm qualitative research is utilised to aid interpretation and to uncover processes, systems, meanings and ideas that constitute human worlds, experiences and the interactions within them (Blekier et al., 2019 & Rehman & Alharthi, 2016). In this thesis, qualitative analysis is utilised to aid interpretations of practitioners' professional worlds and experiences and to unravel the complexities regarding treatment and care approaches.

3.3 Research design

This thesis adopts a qualitative Mixed Methods Research (MMR) approach for the pilot study and main study. The qualitative MMR research approach is centred around researchers collecting and analysing both qualitative and quantitative data within one study (Shorten & Smith, 2017). A qualitative MMR approach will give us a much more complete, in depth and comprehensive understanding of what is done (see chapters 8 and 9) but also the context of how and why. MMR has been described as the third research paradigm (Johnson & Onwuegbuzie, 2004) which is placed in the middle of the hypothetical research methods quantitative – qualitative continuum (Leech et al., 2010). Quantitative methods focus on the measurement and evaluation of scientific ‘truths’, whereas qualitative research focuses more on naturalistic and contextually framed analysis to gather information to aid understanding and knowledge. In the case of this study, a qualitative MMR approach will aid the knowledge and translation in to practice with regards to how acute first hamstring injuries are managed in elite English rugby union. For example, by utilising a qualitative MMR design with open ended semi structured interview questions and questionnaire based questions it is possible to understand not only the extents to which practitioners undertake a full assessment of the hamstring strain but, also, there is potential to delve deeper and gain more understanding of what assessments methods, what tests are used and when they used to assist in the diagnose a first-time grade 2 hamstring strain. Using the qualitative MMR approach, we can delve into what they do, and how they do it in order to deepen our knowledge. Within the context of MMR, “Purposeful data integration enables researchers to seek a more panoramic view of their research landscape, viewing phenomena from different viewpoints and through diverse research lenses” Shorten & Smith (2017, p.74). Harper & McCunn (2017) explain how critical it is that when using MMR researchers must “be aware of the ontological (nature of reality) and epistemological (theory of knowledge) differences between quantitative and qualitative paradigms” Harper & McCunn (2017, p.990). However, it must be appreciated that this does add complexity to the research process (Shorten & Smith, 2017). Epistemologically, quantitative driven research detaches the investigator from the investigated Harper & McCunn (2017, p.990) so that they do not influence the outcomes of the study. MMR can be used to broaden and increase our understanding of connections or inconsistencies between qualitative and quantitative data; it can give participants opportunities to develop a strong qualitative narrative in order to voice a strong opinion or share their experiences, therefore, MMR enables deeper analysis that will ultimately enrich the research. In this instance the qualitative narrative analysed will give us a greater understanding of how practitioners manage acute first-time hamstring injuries in elite English rugby union and how this can be used in applied practice by others. For example, how do practitioners treat a hamstring injury in the acute stages of healing? What progressions do they use when introducing running in to rehabilitation? How do they manage load and volume towards the end of rehabilitation? Translating knowledge in to practice in the field of management of hamstring injuries has been explored with similar approaches previously by Pizzari, et al., (2010) injury prevention, Bekker et al., (2017) and McCall et al., (2016). Coutts (2016) recently spoke of the importance to work fast and work slow in high performance settings, with practitioners working at a fast paced to manage the injuries and a researcher employed to look at the efficacy of the interventions used. This is supported by Bandholm, Henriksen & Thorborg, (2017) who feel the need to slow down the pace in order to strength sports medicine research. Fast paced practitioners are those working and leading on the frontline within high performance environments. In this thesis, the fast-paced environment is elite English rugby union, and the practitioners are lead doctors, physiotherapists and strength and conditioners. Working slow refers to the researcher “a researcher embedded in the environment” who is responsible for investigating new methods (McCall et al., 2016, p.990). Working alongside each other is thought to enrich applied practice within these high-performance settings (McCall et al., 2016). It is usual to find the slow-paced researchers within the fast-paced nature of professional sport, however, it is unusual for them to be present within amateur, semi-professional level sport. Accordingly, this thesis covers both professional and semi-professional environments which will enrich and broaden the applied practice surrounding the management of acute first-time hamstring injuries in rugby union at both professional and semi-professional levels. Qualitative research is becoming more ubiquitous within sport and exercise and aims to influence applied practice by allowing research to be translated into practice (Curtis et al., 2017). One to one interviews and questionnaire are two methods used within these applied environments where the researcher uses their own knowledge of the sport and the science that underpins it but will also include practitioners, coaches, athletes and other staff to assemble thoughts, beliefs, opinions and ideas (Bishop, 2004). Evidence-based practice is regarded as key to enhancing and improving patient care and outcomes Blekier et al., (2019). Qualitative research does allow the interaction of both, forming a more rounded and joint approach. Despite the differences in the two methods, they can be used concurrently within a study Harper & McCunn, (2017). There is an array of MMR methods used by researchers, this study utilises an exploratory Qualitative-Quantitative experimental design. This is characterised by the collection and analysis of the qualitative data first followed by the collection analysis of the quantitative data to support and enrich the qualitative data (Shorten & Smith, 2017). With regards to this study, the qualitative data and the quantitative data were collected concurrently, with the interviews taking place before the questionnaire questions completed. In keeping with MMR, this thesis consists of six studies, the pilot study, technical expertise and Scientific knowledge, duty of care, scope of practice and autonomy, the medical study and the strength and conditioning study. The thesis involved a mixed methods approach to explore current practice in the diagnosis, treatment, rehabilitation and prevention of hamstring injuries in English Rugby union within Championship Rugby union clubs and the National senior squad from a medical perspective (doctors and physiotherapists) and a strength and conditioning perspective. Using quantitative (questionnaire-based questions) and qualitative (face-to-face interviews) to gather data on beliefs and professional attributes, assessment, diagnosis, treatment, rehabilitation, return to sport and prevention. Pizzari, et al., (2010) used a similar approach to good effect in the Australian Football League (AFL). However, their analysis was more focused on what is implemented and the scientific aspects of the management of hamstring injuries and only included physiotherapists perspectives. The thesis study design is based on constructivist paradigm. Constructivism fosters the idea that individuals are methodical and original in their actions and through this, they build their social world and consider the dynamic and evolving nature of society. This theory assesses a situation through the eyes of the participants in the study rather than the researcher (Cohen, Manion & Morrison, 2011).

3.4 Question development

Congruent with the research design, and similar approaches by Pizzari, et al., (2010), Bekker et al., (2017) and McCall et al., (2016) the data collection was undertaken using two key methods: semi-structured interviews and questionnaires. The study explored participant beliefs and professional attributes, assessment, diagnosis, treatment, rehabilitation, return to sport and prevention and were based on previous work by Pizzari et al., (2010) who looked at the management of hamstring injuries in Australian Rules Football. The areas explored and questions asked were developed and chosen in order to gain information on the current management and practice of hamstring injuries and to address gaps within the literature see table 1 below.

Table 1: Areas explored through the questions.

Area to be investigated	Includes	Question numbers
Beliefs	Beliefs on cause of hamstring injuries and whether hamstring injuries could be reduced in elite English Rugby Union.	1-5
Clinical assessment	How hamstring injuries are assessed and diagnosed	6-11
Treatment and rehabilitation	How hamstring injuries are treated and rehabilitated. Other questions explored the use of different treatment and rehabilitation protocols and progression criteria.	Doctors 12,13, 18 Physiotherapists 12, 13, 14, 15, 16, 17, 18 19
Return to sport	How they determine whether a player is ready to return to sport. Questions also focused on the hamstring specific tests used and the volume and loading of exercises.	Doctors 28 Physiotherapists 20, 27, 28
Injury prevention	How they screen players to reduce the incidence of hamstring injuries. Questions also explored hamstring specific prevention programmes used by participants.	Doctors 29 Physiotherapists 29, 30
Professional attributes	Asked about the resources available to them and their personal knowledge in the treatment, rehabilitation and prevention of hamstring injuries.	34-36

Note: Answers to the interview questions will be based on a grade 1-2 acute hamstring injury. The injury definitions utilised in this study are consistent with the

International Rugby Board (IRB) consensus statement on injury definitions (see appendix 2) for a full overview of injury definitions. The importance of clear language is discussed further down in this chapter within the pilot study section. Key terms were given set definitions to standardise response and allow comparisons to be made. These were set out in the respondent's pack as see in Appendix 4. Some of the key definitions are see in table 2 below.

Table 2: Key term definitions.

Term	Injury	Reference
Injury	An injury was defined as 'any injury that prevents a player from taking a full part in all training activities typically planned for that day and/or match play for more than 24 hours from midnight at the end of the day the injury was sustained'.	Fuller, et al. (2007)
Injury severity	Injury severity was measured as time (days) lost from competition and practice. It was recorded as the number of days from the date of the injury to the date that the player was deemed to have regained full fitness not including the day of injury or the day of return. A player was deemed to have regained full fitness when he was 'able to take a part in training activities (typically planned for that day) and was available for match selection.'	Fuller et al. (2007).
Recurrent injury	An injury of the same type and at the same site as an index injury and which occurs after	Fuller et al. (2007).

	a player's return to full participation from the index injury.	
Injury incidence	The likelihood of sustaining an injury during match play or training is reported as the injury incidence. The injury incidence is the number of injuries expressed per 1000 player-hours of match exposure (or training exposure).	Fuller et al. (2007).
Days absence	Equally important to the player and/or his club is how long players are absent. This is known as the days absence and is also expressed per 1000 player-hours of match exposure (or training exposure).	Fuller et al. (2007).

The interview structure and question and questionnaire questions were developed independently by me and then presented to a project advisory group, and stakeholders for comment and approval. The advisory group consisted of medical practitioners and a strength and conditioning coach all of whom work with elite rugby teams. The project advisory group reviewed, commented and gave feedback on the questions and signed off the questions prior to the pilot and main studies commencing. The S&C questions were approved by the S&C specialist on the panel to ensure they were correct and relevant as this is an area of specialism within the management of hamstring injuries.

3.5 Interview design and protocol.

In this study, semi structured interviews were conducted. Qualitative semi-structured interviews are widely used in social sciences to gather (Bradford & Cullen, 2012 and (McGannon & Schinke, 2013). They can be used to consider experience, meanings and the ‘reality’ of practitioner experiences (Braun & Clarke, 2006). Semi structured interviews should consist of more open-ended questions to allow participants to elaborate and broaden their answers to ultimately deepen the analysis to enrich applied practice Evan & Lewis (2018). In this study, all interviews were conducted by one researcher, with one practitioner to keep the structure and delivery consistent (Blekier et al., 2019). Interviews lasted up to 60 minutes in duration (as requested by the Gatekeeper). Deviating from the semi structured questions and probing further was not permitted by the Gatekeeper. The participants were able the participants to talk widely and freely on the 6 topic areas - beliefs regarding hamstring injuries, clinical assessment, treatment and rehabilitation, return to sport, injury prevention and personal attributes. A bespoke set of questions (see Appendix 6) were developed for the interviews, with the aim of deepening our knowledge of how acute first-time hamstring injuries are manged in elite English rugby union. In the context of this research and a qualitative MMR research, these questions will allow us to analyse the context of the process, what happens in the real world, they will give use greater understanding of the complexities involved in the management of hamstring injuries. The qualitative questions were more open ended and allowed the practitioner to explain, expand and give opinions. The full set of questions can be seen in Appendix 6, some examples are shown below:

What do you think is the most common mechanism of injury for a hamstring injury in Elite (England Rep and Premiership) English Rugby Union?

When you carry out the initial assessment (< 72 hrs) of a hamstring injury, what are the critical clinical assessment tests (subjective and/or objective) that you use to make your diagnosis?

These questions were asked to help understand what the practitioners think the common MOI for hamstring injuries is. Research shows 2 types, slow stretch and running based mechanisms Askling et al., (2002) therefore we can see if the hamstring injuries in rugby union are consistent with the research and comparable to other sports.

What are your (hamstring specific) progression criteria for moving between the following stages of rehabilitation?

Early to mid-stage

Mid to late stage

Late to after discharge from physiotherapy treatment (modalities)/pre return to competition

Discharge from Physio to return to competition

This was asked to get an idea and broaden our understanding of how and when practitioners are progressing hamstring rehabilitation, there is little evidence in the literature surrounding rehabilitation and more so progression criteria.

When do you introduce running to the rehabilitation programme?

How? – What running progressions do you use and how do you determine when a player is ready to progress?

This question was developed from the literature. Running is seen as a vital part of rehabilitation, but little is known about volume, prescription and progressions. Answers from this question were of value in showing what running is performed in the rehabilitation of a grade 2 hamstring tear and how it is progressed.

3.6 Questionnaire design and protocol

Alongside the interview questions, data was collected using short questionnaires. The aim of these questions was to give a general overview of what is done and to gather basic opinions and to help us gain a richer understanding surrounding decision-making processes and professional values. They required participants to provide short yes, no answers, or to rank items in a table. They also asked participants to give a strength of opinion. Questionnaires are commonly used in health and sport research. A good questionnaire will allow efficient collection of data if it does not have too many questions and not take too long to complete (McCall et al., 2016 and Harper & McCunn, 2017). The design, aesthetics and language used is also important when developing questionnaires (Harper & McCunn, 2017). Questionnaires should be tried and tested prior to being used in the main study (Blekier et al., 2019). In this research project this was done in the pilot study see Chapter 4 for a more detailed overview of the pilot study. To recall, the aim of this was study was to identify current practice in the diagnosis, treatment, rehabilitation and prevention of hamstring injuries in elite rugby union clubs and the National senior squad. These questionnaire-based questions will enhance applied practice and allow other practitioners to gain a deeper understanding of the treatment and management of hamstring injuries in English rugby union. Knowledge gained from the study may also be used to inform future studies which will make them more ecologically valid and applicable to the applied practitioners working in the fast environment (Harper & McCunn, 2017). As with the semi structured interview questions, I was unable to deviate from the questionnaire questions and probing further was not permitted by the Gatekeeper. The full set of questions can be seen in Appendix 6; however, some examples are shown below:

Do you think it is possible to prevent first time hamstring injuries in Elite English Rugby Union?
Do you think it is possible to prevent recurrent hamstring injuries?

These two questions required the participant to give a simple yes, no answers and then give a strength of opinion. The two questions were asked as the incidence of hamstring injuries occurring in rugby had risen (Brooks et al., 2006). The data was taken from the one word yes, no or no opinion answer and then the strength of opinion.

What would you consider to be the most important components of a hamstring injury prevention programme? Why?

This question was included as there is currently no consensus in the literature as to how hamstring injuries should be rehabilitated Heiderschiet et al., (2010) They give a quick overview of what is done and how important each component of rehabilitation is for the participant. Here we can quickly gather data that will show us if there is agreement within the participants or not.

Do you typically use diagnostic investigations like diagnostic US and/or MRI, in your assessment of acute hamstring injuries?

If yes, which tests, when (for which conditions and at what time after injury) and why

If no, why?

This question will tell us how many clubs use diagnostic investigations. It will also give us more detail into what diagnostic investigations are used and why. This question was asked as there is debate in the literature surrounding the use of diagnostic tools for hamstring injuries and not all clubs have access to MRI and US.

What rehabilitation exercises do you do in each of the following stages of rehabilitation?

Early (> 3days after injury)

Mid (>10 days after injury)

Late (>21 days after injury)

After discharge from physiotherapy treatment (modalities)/pre-return to competition

Post return to competition

This question will give us quantitative data on what rehabilitation components are used during hamstring rehabilitation. This is important as it allows a quick snapshot into what is done by the practitioners.

3.7 Participant recruitment

The thesis involved elite English rugby union clubs; therefore, a criterion sampling method was utilised (Cresswell & Plano, 2011 and Renfree & Kohe, 2019). The gatekeeper gave access to the two Championship Clubs and England Saxons squad. Following the success of the Pilot study, the Gatekeeper granted me access to the England team and the fourteen Premiership clubs. The interview structure and format were designed to guide the interview to ensure that all the above aspects are covered and were used in the pilot study to great effect. All clubs and participants were emailed a letter outlining the study (see Appendix 3) and to see if they were willing to take part. Interviews were arranged at a time that was convenient for the participants and a study guidance pack sent (see Appendix 4) prior to the interviews taking place. All participants in the study signed a written informed consent form prior to taking part in the interviews (see Appendix 5). All participants completed an individual semi-structured interview and concurrently completed the questionnaire-based questions.

3.8 Data analysis

Due to the interpretive nature of analysis with this work and the data, transcripts were analysed using established qualitative thematic content analysis, inductive analysis was adopted (Bowen, 2009, Fereday & Muir-Cochrane, 2006, and Kohe & Purdy, 2016) to identify themes and categories, Braun & Clarke (2006). Initially the data gained from the interviews was coded, with a descriptive label with a meaningful word, clause, or incident (Kohe & Purdy, 2016). The principal researcher coded all transcripts and thesis supervisor coded a selection to ensure consistency. Codes and themes were then discussed and finalised. The themes from the structure of the analysis and discussion in this chapter (Kohe & Purdy, 2016) and are technical expertise and scientific knowledge (TESK) and multidisciplinary teams (MDT). Data from the questionnaires and the qualitative narrative was triangulated to give a more in-depth analysis (Renfree & Kohe, 2019). Thematic content analysis is a well-established technique used to analyse qualitative narrative. A key feature of thematic content analysis involves the systematic process of grouping and coding of data followed but the identification of specific themes within the data. All themes originated from the analysis of all data obtained by the clubs. It is imperative that robust and valid methods of analysis are utilised following interviews. Typically, this involves verbatim transcription of the qualitative narrative, coding, sorting of themes and then verification of the themes (Braun & Clarke, 2006). In the case of this study, thematic content analysis was adopted to analyse the qualitative narrative. Member checking was also utilised to increase validity and make the study more robust and trustworthy (Bowen, 2009 and Kohe & Purdy, 2016). Akin to the approach used by Bekker et al., (2017) thematic content analysis was used to reveal some key aspects of how doctors, physiotherapists and strength and conditioners treat and manage acute first-time hamstring injuries in elite English Rugby Union. Ultimately, this analytical approach will assist us with a broader and deeper understanding of the nature of the work the practitioners undertake whilst treating and managing hamstring injuries.

Thematic content analysis refers to the process of analysing the qualitative narrative using a systematic approach to develop codes and then themes (Vaismoradi et al., and Castleberry & Nolen, 2018) and is described as a "method used to identify, analyse and report patterns (themes) within data" (Braun & Clarke, 2006, p.79). Thematic analysis is a popular analytic method, used to analyse qualitative data and is useful for either realist or constructionist paradigms within the social sciences research (Braun & Clarke, 2006). Thematic content analysis requires methodical and systematic analysis and coding of the qualitative narrative. By following the steps of thematic analysis Castleberry & Nolen (2018, p.814) believe "researchers can present work that is trustworthy and credible". Coding is the collecting of themes and sub themes that are derived from the data (Braun & Clarke, 2006). Once all codes have been collected and assigned a theme the researchers can create a narrative and story to present the research findings (Vaismoradi et al., 2016). Themes can be known as topics and are the outcome of the analysis and are collections of codes and sub themes that are unified by the theme (Vaismoradi et al., 2016 and Castleberry & Nolen, 2018). Thematic content analysis is a craft that requires the researcher to be aware of the language used and the assumptions of language to be transferred into the analysis (Hughes, Kohe & Purdy, 2019). In order to reduce inference and bias participants were given a respondent's pack (see Appendix 5) outlining key definitions and terminology. For example, treatment is the use of modalities to treat an injury and rehabilitation is the use of exercises to return an athlete to full function. However, some practitioners use the term treatment to cover both. In this thesis the terms are used separately. Vaismoradi et al., (2016) proposes 4 stages to developing themes, initialisation, construction, rectification and then finalisation. Initialisation consists of three stages that gathers the data into a useable and easy to see (Castleberry & Nolen, 2018). It has been advocated by Sutton & Auston, (2015) that the researcher does this themselves so that they can fully immerse themselves in the data in order to select repeated ideas, meaningful data and significant issues. The researcher must ensure that they remain impartial and impart no bias when doing this. Following this the researcher will organise and reduce the data in order to initiate coding. The last stage of the initialisation phase requires the researcher to write reflective notes; essentially an audit trail to ensure all important data is captured that is needed to answer the research question (Vaismoradi et al., 2016). The second phase of thematic content analysis is the construction phases. Here, according to Vaismoradi et al., (2016) phase one codes are then reviewed and then similar codes are clustered together. For example, in this thesis: technical, multidisciplinary and knowledge. With Braun & Clarke, (2006) cited in Castleberry & Nolen, (2018) using the analogy codes are the bricks, themes are the walls containing the bricks, therefore themes contain the codes established earlier in the process. Each cluster of codes is then labelled with an overarching term to cover all content. Examples include technical expertise and scientific knowledge and multidisciplinary teams. Following this, Vaismoradi et al., (2016) explains that the third phase is known as the rectification phase. An important part here requires the researcher to re-evaluate and immerse themselves in the data but at the same time and ensure they have distanced themselves from the data and removed any bias or preconceived ideas. Codes are verified and form this themes and sub themes emerge. The final phase sees the development of a story line ready for the researcher to present and disseminate the data (Vaismoradi et al., 2016). From thematic content analysis three primary order themes emerged, these are: Technical expertise and scientific knowledge (TESK) and multidisciplinary teams, secondary order themes and tertiary order themes are seen in table 3.

Technical expertise and scientific knowledge (TESK) this relate to practitioner knowledge and understanding and includes professional attributes and beliefs. Multidisciplinary teams covers role delineation, communication and autonomy.

Table 3: primary, secondary and tertiary themes.

Primary theme	TESK	MDT
Secondary theme	MOI	Autonomy
	Beliefs	Communication
	Professional Attributes	
Tertiary themes	Assessment	Role delineation
	Diagnosis	Hierarchy
	Treatment	
	Rehabilitation	
	Return to Play	
	Injury Prevention	
	S&C	
	Beliefs	
	Professional Attributes	
	Qualifications	
	Knowledge, training and CPD	
	Resources	

Response rates are one of the criteria used to judge the strength of a qualitative research study. In this thesis the pilot study emails to take part in the study were sent to 9 practitioners, the lead doctor, lead physiotherapist and lead strength and conditioner from 2 pre-selected championship clubs and the England Saxons squad. The response rate to the pilot study was 100% with all 9 participants (3 lead doctors, 3 lead physiotherapists and 3 lead S&C staff) completing the face to face semi structured interviews. In the main study, emails to take part in the study were sent to 39 practitioners, the lead doctor, lead physiotherapist and lead strength and conditioner from all 15 clubs (14 premiership clubs and the England squad). The participant response rate was 25/39 64% with practitioners from 11 clubs (10 elite rugby union clubs and the National senior squad) took part in the study (8 lead doctors, 10 head physiotherapists and 8 S&C leads). Three clubs did not take part in the study. This means the club response rate for the current study was 73%, this was deemed sufficient for analysis and compares to other studies. Previous studies in rugby union have shown response rates of between 69% and 87% (Jones et al., 2016). See table 4 for responses rates. However, these studies have used more questionnaire-based formats, rather than face-to face-interviews.

Table 4: response rates of previous sports and strength and conditioning practice studies.

Study	Response rate
Current study	73% (11/15)
Jones, Smith Macnaughton and French (2017)	77%
Jones, Smith Macnaughton and French (2016)	83%
Gee, Olsen, Berger, Golby and Thompson (2011)	59.3%
Ebben, Hintz, Simnez (2005)	70% (21/30)
Simnez, Dugan and Ebben (2005)	68.9% (20/30)
Ebben, Carroll and Simnez (2004)	76.6% (23/30)
Ackenhead and Nassis (2016)	59%

3.9 The pilot study overview

The aim of a pilot study was to evaluate the feasibility of the methods that were intended to be used on a larger scale for the main study and to ensure questions were robust. The pilot study also allowed the researcher to ensure questions were clear, unbiased, unambiguous, and clear. This is vital as language is seen as a limitation of language-based data acquisition, (Hughes, Kohe & Purdy, 2019). The pilot study afforded the chance to consider the use of language within the questions and the best way to ask each question to reduce ambiguity and confusion. Pilot studies are also conducted to allow results from a pilot study to be used to inform and refine future studies, larger scale studies and to generate hypothesis (Leon et al., 2010). The pilot study also allowed the researcher to gain confidence whilst working in a fast-paced environment within the clubs. Three clubs were chosen by the head of Sports Medicine at the Rugby Football Union (RFU). The England Saxons and two championship rugby union clubs took part in the pilot study, prior to the main study commencing. For the pilot study, questionnaire-based questions and semi structured face-to-face interviews data on beliefs and professional attributes, assessment, diagnosis, treatment, rehabilitation, return to sport and prevention were collected from two Championship rugby union clubs and the England Saxon's squad. The semi structured interviews and questionnaires were carried out with the clubs' lead doctors, physiotherapists and strength and conditioning (S&C) staff. Face to face interviews were conducted with nine participants - three lead doctors, three lead physiotherapists and three lead S&C staff. The semi structured interviews lasted approximately 60 minutes. All interviews explored the following six key areas, beliefs regarding hamstring injuries, clinical assessment, treatment, and rehabilitation, return to sport, injury prevention and personal attributes. These were determined by previous research by Pizzari, et al., (2010). Answers given were based on a grade 1-2 acute hamstring injury. The principal investigator conducted all semi-structured interviews during the 2010-11 season. Interviews were recorded using a digital voice recorder (Olympus VN-713PC), anonymised, and transcribed verbatim. The transcripts were then sent by email to participants for verification. Participants were asked to make ensure they were happy with their answers. None of the participants requested to amend their transcripts. Due to the interpretive nature of analysis with this work and the data, transcripts were analysed using established qualitative thematic content analysis, and an inductive approach was adopted to identify themes and categories, (Braun & Clarke, 2006, Fereday & Muir-Cochrane, 2006, Bowen, 2009 and Kohe & Purdy, 2016). The pilot study was deemed successful by the Gatekeeper and Head of Sports Medicine at the RFU. Only two questions were slightly reworded to make them clearer, and one question was split in to four smaller more concise questions to make it clearer for the participant. A report was written for the RFU to highlight key findings and disseminated to Championship clubs.

3.10 The main study

The main study followed the same approach as the pilot study and used the same qualitative mixed methods approach as the pilot study. Questionnaire-based questions and face-to-face interviews that covered beliefs and professional attributes, assessment, diagnosis, treatment, rehabilitation, return to sport and prevention was collected from premiership rugby union clubs and the National senior squad from a medical perspective (doctors and physiotherapists) and a strength and conditioning perspective. The questions used in the pilot study were used in the main study. The three sets of questions were developed by the lead researcher and approved by a project advisory group, one for each profession (doctor, physiotherapist and strength and conditioners) to allow specific questions to be asked to the different participants. Semi structured interviews were conducted with the clubs' lead doctors, physiotherapists for the results see Chapter 8 and strength and conditioning (S&C) staff in Chapter 9. Ethical approval was granted by the local ethics committee prior to the study commencing. A gatekeeper between the RFU and Premiership Clubs also gave the study approval prior to the start. All information was stored according to the data protection act (1998) and conducted in relation to the University of Kent's GDPR and Health and Safety regulations, see hyperlinks. Research-Integrity-Code-of-Ethical-Practice-in-Research.pdf (kent.ac.uk) GDPR-Privacy-Notice-Research.pdf (kent.ac.uk)

All 12 premiership clubs and the England Senior squad were contacted via email to participate in the study. Practitioners from 10 elite rugby union clubs and the National senior squad took part in the study (8 lead doctors, 10 head physiotherapists) 5 clubs did not take part in the study. Written informed consent was gained from all participants prior to the interviews commencing (see Appendix 5). Prior to the interviews, participants were emailed (see Appendix 3) to see if they would participate in the study, if they were, they were then sent an interview guidance pack (see Appendix 4). Individual face to face interviews were conducted with 15 participants and 3 interviews were conducted by telephone with the lead researcher. The semi structured interviews lasted approximately 60 minutes were carried out on an individual basis by the principal investigator. All interviews explored the following six key areas, beliefs regarding hamstring injuries, clinical assessment, treatment and rehabilitation, return to sport, injury prevention and personal attributes (questions are in Appendix 6). Each section was designed to give specific information on how hamstring injuries are managed in elite English rugby union from initial injury through to return to play and injury prevention. From these sections we were able to build a narrative on the practitioner's experiences and gain an insight in to how they manage acute first-time grade 2 hamstring injuries. All answers given were based on a grade 1-2 acute hamstring injury, this was outlined to participants at the start of the interview and highlighted in all pre interview material. All interviews were recorded, then immediately anonymised, and then typed verbatim by an independent medical secretary. Interview transcripts were then sent via email to the participants for verification. Participants had one week to make changes or amend the transcript if the answer they had provided was not clear. Only one participant made amendments in order to make an answer less ambiguous.

3.10.1 Main study analysis

All interviews were recorded and analysed using established qualitative analysis methodologies (see data analysis section above). Due to the interpretive nature of analysis with this work and the data, inductive analysis was adopted (Bowen, 2009, Fereday and Muir-Cochrane, 2006) to analyse interview transcripts and identify themes and categories, (Braun & Clarke, 2006). Each question and transcript were analysed line by line and all answers categorised under each code and theme (Pizzari et al., 2010). Thematic content analysis was used to identify codes and themes from interview transcripts. These were then discussed with my supervisor, coded and analysed further to develop themes as described in 3.8 above. To increase rigour and trustworthiness peer evaluation was used to (Krefting, 1991). Impartial medical practitioners known to the principal investigator analysed responses to ensure data was accurate and answers had not been misinterpreted or misunderstood.

3.11 Ethical considerations

The research was designed and ethically conducted in accordance with the University of Kent's ethics procedures. Recruitment was done using a gatekeeper who gave access to the clubs and participants. Prior to the interviews taking place, participants were emailed (see Appendix 3) to see if they would be interested in participating in the study. Once they had expressed an interest, they were then sent an interview guidance pack (see Appendix 4). Written informed consent was gained from all participants prior to the interviews commencing (see Appendix 5). The participants that had phone interviews were emailed the informed consent for prior to the interview, it was signed electronically and retuned to me. Before the interviews participants were reminded that answers should be based on an acute firs time hamstring injury. All participant transcripts were anonymised and remain confidential. All verbatim quotes were carefully reviewed so as to not make the participant identity apparent.

3.12 Conclusion

Within this chapter I have documented and outlined my philosophical and methodological approach to the research using an qualitative MMR approach to data generation. I have explained my research paradigm and recognised the theoretical and ethical principles that shaped the research design. Lastly, I have demonstrated the rationale that underpins my methodology and shown how to produce a high quality, reliable and valid study that will enhance applied practice within elite English rugby union. The thesis has adopted a qualitative MMR approach and has been diligently planned in a systematic manner to provide high quality results that explore Professional Sports Workers Practice in pursuit of Athlete Welfare and investigates how hamstring injuries are managed within elite English rugby union. MMR has been used effectively in sports science and sports rehabilitation over recent years (McGannon et al., 2021; McCall et al., 2016 and Arnold et al., 2019). Future chapters interrogate some of the complexities of what it means to undertake sports work in a professional setting, how knowledge and ideas are conceptualised and enacted upon in elite practice, and, in particular, how ideas related to athlete welfare and duties of care translate into their work. The study should be both reliable and valid, in order to achieve this the study should include objective, reliable and repeatable methodology, appropriate data collection methods, correct analysis and logical interpretation (Garg, 2016). The constructivist study design has allowed me to immerse myself into the world of elite sport in order to engage with the practitioners and gain an insight into their experiences and real-world complexities. Through well-established qualitative MMR approaches to data generation and analysis the study sought to answer the research questions in a consistent and efficient way.

This chapter has provided a visible record of the professional methodical rigour in which the study was carried out. The following chapter will go on to analyse and discus the findings of the study so that we can gain a greater depth of knowledge and understanding into the management of acute first-time hamstring injuries in elite rugby union which can be used to inform applied practice by translating research in to practice.

Chapter 4

Management of hamstring injuries in elite English Rugby Union: A survey of practice. A pilot study.

4.1 Introduction

Hamstring injuries are a problem in elite English rugby union (Brooks et al., 2006) football (Woods et al., 2004). They have been associated with high levels of player absence as a result of both match and training injuries. Brooks and colleagues have been at the forefront of research to highlight the prevalence of hamstring injuries in elite English rugby union (Brooks et al., 2005a, Brooks et al., 2005b, Brooks et al., 2005c and Brooks et al., 2006). So far, Brooks and his team have yet to publish hamstring injury incidence levels for lower levels of the game. Therefore, we are only getting an insight in to what happens in elite clubs. There are also very few recent studies that look at hamstring injuries in rugby union and much of the research today still cites the work by Brooks et al., (2006). A recent study by Kerin et al (2022) analysed video footage of hamstring injuries occurring in one rugby union team. However, this was carried out retrospectively and only covers injuries from one team over one season. Kerin et al., (2022) concluded that sprinting was not the only MOI, and hamstring injuries occurred as a result of tackling, rucking and direct trauma this builds on the original research and findings of Brooks et al., (2006).

Hamstring injuries are prevalent in other team sports, such as professional football, where they make up 12% of all injuries (Woods et al., 2004), in Australian Football League (AFL) they make up 16% of all injuries (Orchard & Seward, 2008) and in sprinters (Malliaropoulos et al., 2010 and Edouard et al., 2016). In the National Football League (NFL) in one college season 85 hamstring muscles injuries were sustained (Feeley et al., 2008). This was a total incidence of 2.2 per 1000 hours player exposure. Which equates to 1.7 per 1000 hours player training hours and 4.07 per 1000 hours player match exposure (Feeley et al., 2008). Pertinently, these incidence rates are lower than in elite English rugby union however, the sports are very different and therefore when comparing injury incidence data, we need to be careful not to make direct comparisons. Older data from the 2008 AFL season showed that this is slightly less of a problem for them as they see 6.6 hamstring muscle strains per club, per, which amounts to 25.8 games missed per club (Orchard & Seward, 2008). It has been reported that English professional football has less of a hamstring injury problem with clubs reporting on average 5 injuries and 90 days lost per club per season (Woods et al., 2004). We should be aware and mindful of the differences and similarities in injury rates, however, not make comparisons as each sports have different demands despite similar MOI. Clearly, hamstring injuries come at a substantial cost to clubs and international sides. These include direct costs like injury payments, diagnostic investigation, treatment costs, and indirect costs such as loss of team structure, loss of gate receipts, competitiveness and reduced success. Therefore, gaining a greater understanding of how hamstring injuries are managed in different sports may help reduce injury rates and allow a greater understanding. This has been shown in a recent study by Macdonald et al., (2019) who designed and implemented specific rehabilitation protocols based on the hamstring injury classification. They showed that by understanding and implementing rehabilitation specific to the classification recurrent injury rates decreased alongside the time to return to training. However only rehabilitation was looked at, as such this study could be extended to look at specific treatment strategies for specific hamstring injury classifications.

An old study by Brooks et al., (2006) reported 164 hamstring injuries over 2 consecutive seasons and reported a significant (P =0.001) difference between training (0.27/1000 hours) and match injuries (5.6/1000hours) in premiership rugby union. Hamstring injuries were reported as minor (37%), moderate (37%) and major (26%), and those that required diagnostic investigation such as ultrasound (US) or magnetic resonance imaging (MRI) were significantly more severe with 26 days lost (CI, 18-33) compared to those diagnosed with a clinical assessment (13 days lost; CI, 11-16). Brooks et al., (2006) noted that a similar number (P = 0.53, which is significant) of match and training injuries were recurrent. Brooks et al., (2006) also noted that on average first time hamstring injuries caused 17 days of lost time whereas, recurrent hamstring injuries were more severe, and caused more time lost (25 days). Additionally, 59% of recurrent hamstring injuries occurred within the first month of return from hamstring injury. Of the recurrent injures, 24% occurred during matches and 23% during training. This figure is similar to those reported in Australian rules football (Orchard & Seward, 2008). More recently Kerin et al. (2022) looked retrospectively at hamstring injuries at one club. They analysed 17 hamstring injuries, with 12% occurring in training and rest sustained during matches. One was due to a direct force, the other 26 were due to non-contact mechanisms. Kerin et al (2022) reported 47% occurred during running – more specifically when accelerating, 18% occurred as a result of kicking 6% due to a tackle and 18% as a result of rucking. No classification of injury was given and the study was done analysing videos. Only one club was involved and only one seasons worth of hamstring injuries was reported.

Positional differences were noted by Brooks et al., (2006) between forwards and backs, this is important, as it may assist practitioner's when prescribing rehabilitation and return to play testing, Kerin et al., (2022) did not report positional differences. There were no significant differences in hamstring injury incidence in training (0.27/1000 player hours CI,0.20-0.34), analysis of positions shows, backs (0.30/1000 player hours; CI, 0.19-0.42) and forwards (0.25/1000 player hours; CI 0.15-0.34). However, for match play, backs (8.6/1000 player hours; CI, 6.5-10.6) sustained significantly more hamstring injuries compared to the forwards (3.0/1000 player hours; CI, 1.9-4.1). Second row forwards sustained the least amount of hamstring injuries (2.4/1000 player hours) and the least severe (7 days lost). Hamstring injuries result in more lost time for backs than any other injury Brooks et al., (2006). This may be due to the greater number of maximal sprints they perform during a game compared to the forwards however it is not noted in the study what running activities caused injury. Brooks et al., (2006) report a significant difference in hamstring injuries that occur during match play between forwards (3 hamstring injuries per 1000 match hours CI, 1.9-4.1) and backs (8.6 hamstring injuries per 1000 match hours CI,6.5 – 10.6), however, they do not report the significance value. Therefore, practitioners should be taking position in to account when prescribing rehabilitation programs.

Running activities (although not specified what running activities caused injury) accounted for 68% of the hamstring injuries reported by Brooks et al., (2006) however, the hamstring injuries that were caused from kicking (stretching based) were more severe, causing 36 days lost. This agrees with the work by Askling et al., (2002) who identified two types of hamstring injury: slow stretch (in dancers) and explosive (sprinters and running based activity). Askling, et al., (2002) demonstrated that hamstring injuries caused by high-speed running (sprinting, football etc) took less time to recover compared to the slow stretch injuries. The study looked at 18 elite sprinters and 15 professional dancers. They were assessed and diagnosed with a hamstring injury 2, 10, 21- and 42-days post injury. The study reported the hamstring injuries that occurred in the 18 sprinters were all during sprinting when at maximum speed, compared to the dancers, where the MOI was slow stretching exercises and movements, interestingly, five occurred during a warmup, seven during warm down and three during training or performance. Only 6 of the dancers had to stop their activity whereas all 18 sprinters had to stop immediately. As 9 of the dancers did not stop it makes it hard to diagnose and define their injury. This highlights that initial impairment of the two types of hamstring injury is different, this therefore, should be taken into account during assessment and rehabilitation.

Rugby union is an under researched sport when compared to football. However, in recent years there has been a decline in hamstring related research with only one study by Kerin et al., (2022) More recently rugby union research has moved away from hamstring injuries and is focused more on tackling and concussion with studies from Burger, Lambert and Hendricks (2020) and Stokes et al., (2021), injury prevention (Barden, Stokes and McKay, 2021), training and match analysis (West et al., 2020) and youth and academy rugby (Barden and Stokes, 2018) and women’s rugby (King et al., 2019). Despite more rugby union related research and a plethora of research that focuses on the epidemiology of hamstring injuries, gaps still remain in the research surrounding the management of hamstring injuries, especially in terms of assessment, treatment, rehabilitation and prevention of rugby union injuries. Currently little is known about how acute first-time hamstring injuries are managed in rugby union. Management of hamstring injuries includes assessment, diagnosis, treatment, rehabilitation and injury reduction. Consequently, there is a need to improve both the management and prevention of hamstring injuries in elite English rugby union. Therefore, the purpose of this study is to gain an overview of the current management of hamstring injuries in elite English rugby union from the perspectives of doctors, physiotherapists and strength and conditioning staff.

The primary aim of the study was to identify current management and practice in the diagnosis, treatment and prevention of hamstring injuries in English Championship Rugby Union Clubs and the Senior England squad. Other areas related to hamstring injury that were evaluated within the study included medical staff's beliefs regarding mechanism of injury; assessment and diagnosis; treatment; rehabilitation; return to sport criteria; and prevention. The secondary aim of the pilot study was to ensure that the questions and information collected were relevant and that the data collection process was robust prior to the main study commencing.

4.2 Methods

4.2.1 Research design

For a full overview of the methods see chapter 3. This study involved a qualitative mixed methods approach to explore current practice in the diagnosis, treatment, rehabilitation and prevention of hamstring injuries in Championship Rugby union clubs and the National senior squad from a medical perspective (doctors and physiotherapists and strength and conditioners). The three clubs were chosen by the head of Sports Medicine at the Rugby Football Union (RFU). The England Saxons, and 2 championship rugby union clubs took part in the pilot study, prior to the main study commencing. Questionnaire-based questions and face-to-face interviews were conducted, and data gathered on beliefs and professional attributes, assessment, diagnosis, treatment, rehabilitation, return to sport and prevention were collected. The aim of a pilot study was to test the feasibility of the methods, which was intended to be used on a larger scale Leon et al., (2010) for the main study. Results for a pilot study can be used to inform and refine future studies, larger scale studies and to generate hypothesis (Leon et al., 2010).

4.2.2 Participants

A total of 9 participants (3 lead doctors, 3 lead physiotherapists and 3 lead S&C staff) from 2 Championship clubs and the England Saxons took part in the study. Participants were initially emailed a letter outlining the study (see Appendix 3) and to see if they were willing to take part. Interviews were arranged at a time that was convenient for the participants and a study guidance pack sent (see Appendix4) prior to the interviews taking place. All 9 participants signed a written informed consent form prior to taking part in the interviews (see Appendix 5). All participants completed an individual face-to-face semi-structured interview and questionnaire-based questions were answered alongside the face-to-face interviews. Ethical approval was granted by the local ethics committee prior to the study commencing. All information was stored according to the data protection act (1998). The interview structure and format were designed to guide the interview to ensure that all the above aspects are covered.

4.2.3 Interview procedure

A Project advisory group developed and oversaw the pilot study but do not set questions or interview structure. Questions were developed by the lead research (outline din Appendix 6) and approved by the project advisory group which consisted of medical practitioners and a strength and conditioning coach all of whom work with elite rugby teams. Semi-structured face to face interviews took take place with the lead doctors, head physiotherapists and lead strength and conditioners. Three sets of questions were developed, one for each profession (doctor, physiotherapist and strength and conditioners) to allow specific questions to be asked to the different practitioners.

The injury definitions of Fuller et al., (2007) were adopted throughout this study, and answers were based on a grade 1-2 acute hamstring injury. The principal investigator conducted semi-structured interviews and questionnaires during the 2010-11 season. Interviews lasted between 20 and 60 minutes. Interviews were recorded using a digital voice recorder (Olympus VN-713PC), anonymised, and transcribed verbatim. The transcripts were then sent by email to participants for verification. Participants were asked to make ensure they were happy with their answers. None of the participants requested to make changes to their transcripts. Transcripts were then analysed using established qualitative thematic content analysis.

Questions were constructed using 6 key headings in order to gain an insight and understanding into the current management and practice for the diagnosis, treatment and prevention of hamstring injuries in English Premiership clubs and senior

England. An overview of the questions can be seen below, but a more detailed description can be found in Appendix 6.

Beliefs: Participants were asked questions on their beliefs about the causes of hamstring injury, and whether hamstring injuries could be reduced in elite English rugby union.

Clinical assessment: Participants were asked how they assess hamstring injuries. Questions focused on subjective and objective assessments and diagnostic investigations.

Treatment and Rehabilitation: Participants were asked how they treat and rehabilitate hamstring injuries. Other questions explored the use of different treatment and rehabilitation protocols and progression criteria.

Return to sport: Participants were asked how they determine whether a player is ready to return to sport. Questions also focused on the hamstring specific tests used and the volume and loading of exercises.

Injury Prevention: Participants were asked how they screen players to reduce the incidence of hamstring injuries. Questions also explored hamstring specific prevention programmes used by participants.

Professional attributes of medical staff: Participants were asked about the resources available to them and their personal knowledge in the treatment, rehabilitation and prevention of hamstring injuries.

4.2.4 Data analysis

See chapter 3.

4.3 Results and discussion

4.3.1 Beliefs:

All nine participants believe running and eccentric overload are the most common mechanisms of injury (MOI) for acute first-time hamstring injuries. Five of the nine participants also believe fatigue is a cause of first-time hamstring injuries in elite English rugby union. Participants beliefs regarding hamstring injuries were explored during the study. Eight of the nine medical and S&C staff believe that hamstring injuries can be significantly reduced in elite English rugby union. Five reported that it was definitely possible to reduce first-time hamstring injuries and 3 reported that it was possible, one physiotherapist said it would depend on pre-existing risk factors. The one participant that believes it is not possible to reduce first-time hamstring injuries said it was due to players getting stronger and faster. All 9 participants believe that recurrent hamstring injuries can be reduced in elite English rugby union. Three feel it is definitely possible to reduce first-time hamstring injuries, one feels that only if rehabilitation is correct and the layers are monitored within the first month of return, this agrees with Brukner et al., (2013) who highlights most recurrent hamstring injuries occur within the first month post return. Participants believe that the most important components of a hamstring injury prevention programme are, eccentric strength, speed, agility, power, range of movement (ROM), core stability, flexibility and neural mobilisations. All 9 participants believe eccentric strength was the most important aspect of an injury prevention programme, this concurs with the research by Croisier et al., (2002), Mjolsnes et al., (2004) and Petersen et al., (2011) who have shown that eccentric exercises can help reduce the risk of recurrent hamstring injuries. All 9 participants believe that modifying training load could reduce the incidence of hamstring injuries. Seven participants felt that it was definitely possible, one said it depends but did not expand on this and one S&C staff said it would only be possible if you are doing the correct things in the first place. Duhig et al., (2016) demonstrated the importance of monitoring running load, they showed that increased loading increased the risk of hamstring injury.

4.3.2 Clinical Assessment

There was little variation on how hamstring injuries are assessed and treated between the 3 clubs. However, in 2 clubs the assessment will depend on who is on duty and staff availability as they are not all full time. Only one physiotherapist stated that assessment would be different depending on whether he was pitch-side or in the clinic. The participant was prompted to focus answers based on clinical assessment, not pitch side.

Subjectively all doctors and physiotherapists stated they would ask about MOI and pain levels. One doctor and one physiotherapist would ask questions on previous training to see if injury was caused from overload or fatigue. Three participants reported gait was an important part of the objective assessment, they stated that walking with a limp would indicate a more severe hamstring injury. All 9 participants felt that strength testing was important. Answers included isomeric strength, concentric strength but at inner, mid and outer range. Four participants felt that range of movement (ROM) was an important objective test to carryout, answers included active knee flexion, extension, hip flexion, hip extension and lumbar spine movements. Malliaropoulos et al., (2010) have shown that knee active ROM can be used as an objective and accurate measurement to predict time to return in elite athletes. They showed a significant correlation between active knee ROM deficit and recovery time, the greater the active knee ROM deficit, the longer the athlete would be away from sport. Neural tests were carried out by 3 participants, they used either the slump test, straight leg raise or both. There was clear agreement as to the most specific and sensitive test(s) for hamstring injury diagnosis. All doctors and physiotherapists said either strength-based tests (hamstring bridge, concentric knee flexion) or neural tests (slump test or straight leg raise). Current research by Heiderschiet et al., (2010) highlights the importance of a comprehensive assessment protocol 2 of the doctors and one of the physiotherapists felt that they need more guidance and knowledge on assessment for hamstring injuries. This could be used to formulate specific injury based continual professional development (CPD) for the medical staff working in elite English rugby union. Diagnostic imaging is used by 2 doctors, and 1 physiotherapist. Interestingly, the physiotherapist who reported using diagnostic imaging, only does if there is funding available.

4.3.3 Treatment and Rehabilitation

Treatment given is similar between doctors and physiotherapist but also between clubs. The majority of treatment is carried out by the physiotherapist at the club. All doctors and physiotherapists follow the project, rest, ice, compression and elevation (PRICE) protocol in the acute stage with one club doctor and physiotherapist stating they use the Game Ready cryotherapy system.

For the acute stage of treatment there is considerable agreement with regards to how the hamstring injury will be protected, with 2 doctors and 2 physiotherapists stating they prescribe elbow crutches following a grade 2 hamstring tear, and one doctor noting he limits loading by prescribing active rest (not working the hamstring but other areas of the body). Analgesia is prescribed by the doctors, one giving paracetamol, one local anaesthetic injections at day 1,3 and 5 post injury, and one prescribing paracetamol as soon as needed, and then non-steroidal anti-inflammatory drugs (NSAIDS) from day 4 post injury. Clanton & Coupe (1998) stated that NSAIDs should be a key component in the treatment of hamstring injuries. However, Paoloni et al., (2009) feel the use of NSAIDS for treating muscles injuries is controversial and Woo et al., (2005) feel that NSAIDs are no more effective than paracetamol in treating pain for muscle injuries. Therefore, it could be suggested that the use of paracetamol is advocated in the management of hamstring injuries, especially as they have less side effects that NSAIDs. For further information on this see Paoloni et al., (2009) as this is beyond the scope of the thesis. Other modalities used include Kinesio® tape, massage, neural mobilisations, low intensity pulsed ultrasound and electroacupuncture. The use of Kinesio® tape has gained popularity in recent years since a number of high-profile athletes were seen using it at the 2008 Olympic games (Williams et al., 2012). It has been suggested that Kinesio® tape increase mobility within the underlying muscles Callaghan & Selfe (2012), lift the skin to improve blood flow and reduce pain (Williams et al., 2012). However, the use of Kinesio® tape is still unclear. The use and efficacy of Kinesio® tape is noteworthy; however, it is beyond the scope of this thesis. For a meta-analysis on the effectiveness of Kinesio® tape see Williams et al., (2012).

In the sub-acute and chronic stages of treatment (defined in Appendix 4), all three doctors refer to the physiotherapist, with one stating, he will only be involved if there is pain. Two physiotherapists in the sub-acute stage will perform lumbar spine mobilisations and neural mobilisations. All three will perform soft tissue massage in the sub-acute stage

Other modalities used by physiotherapists include Kinesio® tape, low intensity pulsed ultrasound and electroacupuncture. All 3 physiotherapists use massage and lumbar spine mobilisations in the chronic stage, and 2 report using myofascial release and trigger point therapy in the chronic stage.

Only 1 doctor, 2 physiotherapists and 2 S&C staff used a player specific protocol, S&C staff tend to follow what the physiotherapist has designed and planned. One S&C staff stated that he followed individualised protocols. No medical or S&C staff considered MOI in the design of rehabilitation protocols, but they did take MOI in to account when considering progression criteria of rehabilitation protocols. This according to research by Heiderschiet, et al., (2010) is vitally important, as MOI should be considered when designing rehabilitation protocols. Standardised and player specific treatment and rehabilitation protocols are an area that requires future research and development, rugby specific evidence-based protocols would aid the treatment and rehabilitation of hamstring injuries.

With regards to the components of rehabilitation, most physiotherapists will use all components over the 5 stages. In the early stage of rehab, all physiotherapists rank ROM, isometric strength, core stability, and CV elements as the most important components of rehab. The early stage and pre-return to play are the two stages of rehab where there are fairly similar views on the importance of rehab components, with all three physiotherapists ranking flexibility, eccentric strength, power, speed, core stability, CV, agility and sport specific components as the most important. This is potentially an area for future research and development as there is no real consensus as to which are the most important components of rehabilitation for each stage.

Progression criteria for progressing through rehabilitation seems to be different in each club, some are very ‘number’ specific, others are more subjective and less specific. This question needed to be probed more as answers were vague, unfortunately this was not allowed by the Gatekeeper. Player position is mentioned in the later stages and nearer to return to play. This is an area that requires future research and development, as many of the recurrent injuries occur within a month of return to play (Brukner et al., 2013). This may indicate that rehabilitation may be inadequate, the player has returned to play too soon, or progressed between stages too quickly.

Two of the three physiotherapists and all S&C three staff state that progression criteria used to move players from one stage of rehabilitation to the next will change depending on the location within the hamstring muscle (muscle belly v tendon) and/or the type (slow stretch or running based explosive) of injury, this agrees with work by Askling et al., (2006). However, they stated it was not taken into consideration when designing the protocols.

The introduction of running, changing direction, speed and functional sport specific work into rehabilitation was varied between the practitioners. With regard to running, one physiotherapist could definitively say that running was introduced in the mid stage, but it was very much dependant on the player meeting certain targets. The other two physiotherapists reported that running is introduced in the early stage, the other physiotherapist stated that there was not a specific timeframe when running was introduced, it was done when the athlete was ready and had met certain strength, ROM and flexibility criteria. No physiotherapist or S&C staff said the introduction of running in to the rehabilitation programme was dependent on the MOI, grade/severity or location of the injury. Future research is needed to investigate the most optimal time to introduce running change of direction, speed and functional exercises into the rehabilitation programme. Development of individual hamstring injury running programmes may help optimise hamstring injury rehabilitation.

4.3.4 Return to Sport

All three S&C staff in the study were very passionate and enthusiastic about this part of the management of hamstring injuries as they felt they had more to offer the athlete as they progressed through their rehabilitation. All S&C staff agree that eccentric strength is very important. All S&C staff use the Nordic hamstring strength exercise, double and single leg bridges and leg curls for hamstring specific work.
At one club, the S&C staff uses rotary inertia and fly wheel technology (the Versa Pulley) for both training, prevention and rehabilitation as it works the hamstrings eccentrically in the middle and end part of the force-velocity curve, so the muscles are being eccentrically strengthened at medium and high speeds (similar to the MOI for many hamstring injuries) and not at slow speeds like with the Nordic hamstring

strength exercise. This shows innovation and applied knowledge from the S&C staff at the club. It is an area the lead S&C staff member at the club would like to explore in his own future research.

With regard to return to play, only one team also mentioned that they had return to training criteria. All 3 S&C staff agree that return to play criteria are position specific and player specific. This again is an area that potentially needs to be explored and developed through evidence-based practice.

4.3.5 Injury Prevention

All 3 clubs complete pre-season screening, with two clubs screen all players and the other club stating they only screen new players and those players at risk (those that have previously sustained a hamstring injury). One doctor recommends that positions 10-15 should be screened preseason, in the middle of the season and at the end of the season, but more frequently if a risk factor is identified. However, no specific details were given on what was screened and therefore if allowed here, a follow up question to gather details would have been beneficial. An area of future should focus on developing a standardised screening protocol.

4.3.6 Professional Attributes

Doctors feel they would like more knowledge on the stages of treatment and rehab (sub-acute and chronic stages), rehabilitation and S&C programmes, differential diagnosis and would like to see clear evidence-based protocols. Physiotherapists would like to improve their S&C knowledge and have more guidance with rehabilitation and prevention. S&C staff would like more conferences and CPD to increase knowledge base.

In terms of resources, doctors would like more integration with coaches so that players got more time to train, gradually increase training load and more time to do high speed running), more accessible diagnostic ultrasound and ultimately more time with players. Physiotherapists feel they need more staff, more time with players, especially in the acute stage of injury, access to a pool and more funding for US and MRI. S&C staff would also like more staff and one said they would like to have access to a consistent running surface. There seems to be a very positive working relationship between doctors, physiotherapists and S&Cs at all three clubs, with the physiotherapist playing a very important role in the majority of assessment, treatment and rehabilitation, return to sport and injury prevention work. Doctors felt they would like more guidance/training on the S&C practices and how they can be integrated in to of hamstring rehabilitation, return to sport and prevention. S&C staff would like to gain a greater understanding of the treatment and assessment of hamstring injuries.

All participants felt they would like to be involved in a more multidisciplinary approach to hamstring injury management. They also stated they would like the opportunity to attend more multidisciplinary conferences that incorporate both theoretical and practical workshops. A series of CPD events or short courses could be set up specifically for all medical and S&C staff on different aspects of hamstring management. This study design, methodology and questions could be applied for other commonly occurring injuries in rugby union as well in order to gain a greater insight in to how the most prevalent injuries are managed.

4.4 Limitations of the pilot study

The clubs taking part in the study were chosen by the Project Advisory group, which may have caused some bias. However, it would have been beneficial to include several more clubs to get a greater understanding of how hamstrings are managed in Championship rugby union in order to gain a wider insight. That way comparisons between professional and semi-professional teams could be made. All results gained from the main study should be analysed in relation to the RFU injury audit. This would enable the RFU to gain a greater understanding of how hamstring injury incidence rates compare to how they are managed. Unfortunately, this could not be done as the RFU felt it would be too contentious at this time. Analysis of the pilot study focused on what is done in the management of hamstring injuries, it did not focus on the complexities behind the processes in terms of athlete welfare, duty of care and scope of practice.

4.6 Modifications made following the pilot study

Feedback was very positive, and all participants were enthusiastic and willing to take part. All staff were very open and provided detailed responses to all questions. I was told I was professional and conducted myself in a professional manner. Very little was changed between the pilot study and the main study. The interview procedure was easy to follow, answers were noted, however not all as the interviews were recorded. One question in the physiotherapist and S&C staff sections was modified to ensure the question was clear. Q19 in the pilot study covered the introduction of and progressions of running, change of direction and speed. Participants in the pilot study felt that the questions were very important and therefore should be split in to three individual ones to make answering the questions easier, and both data collection and analysis simpler. For the main study this was amended, and each component had its own question. I gained confidence following the pilot study and ensured I carried my professionalism and confidence to the main study.

Chapter 5

Technical expertise and Scientific knowledge and working in a multidisciplinary team.

5.1 Chapter outline

The aim of the following chapter is to present the findings under the technical expertise and scientific knowledge (TESK) and professional attributes and beliefs themes. Within the TESK theme, I show that practitioner's possession and exercising of knowledge is a vital cornerstone of the successful management of hamstring injuries in elite English rugby union. The principal finding is that there is no consensus on how to design, implement and progress rehabilitate first time grade 2 hamstring injuries or how to implement and design injury prevention programmes for these injuries. This supports current literature (Heiderschiet et al., (2010 and Schmitt, Tim & McHugh, (2012). However, there was more consistency in how to treat a player with first-time, grade 2, hamstring injuries and subsequently return them back to rugby, again this is consistent with the literature. The data gleamed from the analysis highlights the use of practitioner's technical expertise and scientific knowledge is utilised to ensure the most efficient and safe management of hamstring injuries in elite English rugby union. The data revealed that Doctors, Physiotherapists and Strength and Conditioning staff are highly qualified autonomous practitioners that form important multidisciplinary teams within elite rugby union and use technical expertise and scientific knowledge in the fast-paced environment that is elite sport. Scope of Practice and autonomy will be presented in Chapter 7. Technical expertise and scientific knowledge sit at the heart of these autonomous professions and these findings provided an insight into the approaches that are used with in elite English rugby union to manage first time grade 2 hamstring tears and how practitioners ensure duty of care. Within the professional attributes and belief's theme I show that practitioners have a wealth of qualifications and experience and that most believe they can reduce firs time hamstring injuries.

5.2 The management of acute first-time grade 2 hamstring injuries

Working in elite sport is high pressured and fast paced with little room for error and delay. In this regard, using and adapting the work of Kahneman, (2011) cited by Coutts, (2016) on thinking fast and slow is useful in understanding practitioners' approaches within this study. Kahneman proposed that you have two systems within your brain that are in conflict with each other and will try and control your actions and emotions. System 1 is the fast paced automatic one that works with instinct and emotion and system 2 is the slow-paced system that is more logical and deliberate. Harper & McCunn (2017) and Coutts (2016) have taken this and applied it to sport. According to Harper & McCunn (2017) the fast-paced environment for the medical teams and the strength and conditioner within clubs is characterised by the need to think fast and make quick decisions to deliver an effective assessment, efficient treatment session, innovative rehabilitation session or engaging conditioning session to aid the management of the hamstring injury on a daily basis within a multidisciplinary team. The decisions are usually based on experience, evidence based, technical expertise and scientific knowledge and occur in many other fast paced environments such as elite sport, nursing and medicine. Due to time constraints and the high-pressure environment often, these decisions are made with no real time to analyse or critique. Here is where the slow applied researcher coming into the elite environment can assist. They are able to take on the slower paced work that takes time, a researcher can analyse data and literature, validate new treatment, rehabilitation and training techniques, critique the evidence base and disseminate and translate research into practice in a meaningful efficient way to the fast-paced practitioners (Harper & McCunn, 2017 and Buckthorpe et al., 2018).

Key to the management of hamstring injuries is the application of the practitioner's technical expertise and scientific knowledge to all areas of the management of hamstrings injuries is vital Nassar et al., (2021) agree and highlight that physiotherapists should use a clinical reasoning approach to treat injuries. Key factors attributed to the successful management of hamstring injuries include: the application of correct techniques, timing of techniques and by a practitioner who fully understands the injury and rehabilitation protocol and what is required at different stages of management. However, striving to achieve these can put the practitioners under immense pressure especially as they often have high workloads and multiple injuries to deal with throughout the season.

5.3 Mechanism of injury (MOI)

Research by Askling et al., (2002) and Kerin et al., (2022) highlight two main MOI for hamstrings – slow stretch and high-speed running. Hamstring injuries in elite English rugby union are predominantly caused by running (Brooks et al., 2006) and high-speed running Kerin et al., (2022). Practitioners in the study concurred in their responses when identifying the hamstring MOI, they see and experience. The responses noted below agree with the literature, which means we can see commonality between running based sports. This can only help develop understanding and knowledge that can be translated into practice.

“Late swing through or at push off or when cruising or at top speed” (Physiotherapist Team 4)

“Lack of eccentric control in the terminal phase of knee extension, normally under fatigue” (S&C Team 1)

Understanding the injury and how it occurred is a crucial factor that contributes to successful management of hamstring injuries Macdonald et al., (2019). Work by Askling et al over many years and Macdonald et al., 2019) has shown that rehabilitation that is specific to the injury classification and MOI will be more successful. Therefore, the more we know about MOI and the more detailed and precise we can be with regard to the classification the more specific and individualised we can design and implement rehabilitation protocols rather than a one size fits all generic approach commonly used. Consideration of how the injury occurs and the mechanism of injury is a vital step towards correct management of an injury as they are often multifactorial, complex and require practitioners to understanding of all contributing factors. Askling et al., (2002) and Macdonald (2019) show that there is a link between the type of hamstring injury (high speed or slow stretch) and symptoms/function, as well as return to pre-injury levels. A good understanding of the different types of hamstring injuries and their different MOI can assist practitioners when formulating rehabilitation protocols and establishing return to sport criteria and importantly, help manage athletes’ expectations regarding time away from sport (Macdonald et al., (2019).

If practitioners have knowledge regarding the nuances between each grade of hamstring injury, it means that they can make rehabilitation more specific rather than taking a generic one size fits all approach and some argue provide the basis of injury prevention programmes (Takahashi et al., 2019). From this we can see that there is a lot for practitioners to consider when designing rehabilitation programmes and how they translate research into practice.

Nearly all participants noted that hamstring injuries occurred during running based activities, eccentric loading, due to fatigue and extreme ROM. Responses show that the practitioner's beliefs regarding MOI concurs with the literature.

> *"In my personal experience…………eccentric loading… more deceleration, so eccentric loading and deceleration… it tends to be more backs than forwards"* (Doctor Team 6)

> *"Under fatigue and when at top speed"* (Physiotherapist Team 7)

> *"Running at near max speeds, 80% or greater"* (S&C Team 3)

These responses show that the practitioners have a clear understanding of the MOI of hamstring injuries within their sport and that their beliefs concur with eh literature (Brooks et al., 2006) and Kerin et al., (2022). We have discussed previously that the research by Askling et al., (2002) and Macdonald et al., (2019) rehabilitation and RTP should be based on the specific MOI and be part of the clinical decision making. This specialised knowledge of MOI should then be applied to formulate specific and individualised rehabilitation and rehabilitation progressions and return to play guidelines as suggested by Askling et al., (2012) and Macdonald et al., (2019). The physiotherapist below agrees with this and stated:

> *"Rehab progressions are based on the individual, their injury, the muscle and its location*" (Physiotherapist team 6)

Despite the importance of adapting rehabilitation and RTP according to their MOI four practitioners stated that they do not change rehabilitation and progressions based on the MOI.

> *"MOI is not considered in S&C stuff"* (S&C Team 7)

This may be due to time, resources or lack of up-to-date evidence-based knowledge. Translating research into practice is vital for the effective management of hamstring injuries (Buckthorpe et al., 2018). Askling et al., (2008) reported that the location and MOI are important factors to understand as the information can be used to guide length of time out and help guide progressions during rehabilitation. This is important when managing expectations of players, staff and mangers. This is supported by the following quotes:

> *"Some progressions will be quicker, if it's a running MOI they may be slower to progress through running progressions but will be quicker through contact progressions"* (S&C Team 5)

> *"Upper hamstring injuries take longer"* (Physio team 2)

5.4 Assessment

When a hamstring injury is suspected and the MOI was visible to the practitioner, a physical assessment should be carried out in order to determine severity, location and to give an idea of return to play (Heiderschiet et al., 2010). Therefore, an accurate clinical assessment is a critical step towards the successful management of hamstring injuries (Sherry, 2012) & Kerkhoffs et al., 2013). Hamstring injuries that involve the muscle bellies and intramuscular tendon should undergo a battery of objective clinical tests that test strength, joint range of motion (linked to flexibility) and pain (Nasser et al., 2021). As these provide a reasonable estimate of how long the athlete will be out of play for (Warren, et al., 2008 and Schneider-Kolskys et al., 2006). The current study shows that there are some areas of commonality here, two physiotherapists share a similar approach to objective assessment. However, probing for more detiale din formation and further clarification would have been beneficial to gain a greater understanding.

> *"Range of movement, flexibility, strength, lumbar spine mobility, neural components"* (Physiotherapist team 4)

> *"I stress and stretch the hamstring; I test muscle power in several positions that's knee flexion and hip extension"* (Physiotherapist team 3)

This supports previous studies Hoskins & Pollard, (2005) and Malliaropoulos et al., (2010). However, variation exists between practitioners on the best way to objectively assess hamstring injuries. These variations maybe due to level of experience, scope of practice differences, education, country of origin as practitioners working in elite English rugby union come from different countries, bringing a global perspective and personal preferences. One physiotherapist explains:

> *"I think you have to look at a battery of tests"* (Physiotherapist team 2)

This is supported by another physiotherapist who believes you need to look at walking and gait following a hamstring injury as part of the assessment.

> *"Can they walk with a limp, can they walk pain free, can they walk pain free without a limp" ……objectively bridging, muscle recruitment and activation type tests to see if they are firing appropriately…. that show I would formulate my diagnosis"* (Physiotherapist team 7)

One aspect of assessment that would be beneficial to know and could be teased out in future studies is to gain more details on exactly how they undertake resisted muscle tests. Unfortunately, due to the constraints set out by the Gatekeeper further questioning and probing of questions was not allowed. Several practitioners suggest they perform bridge tests but reflecting on the data the responses are very general rather than specific details of how they carry out them. Gaining more detail on the specific of the resisted muscle testing would be beneficial as strength tests are recommended to be carried out at both the hip and knee due to the bi-articular arrangement of the hamstring muscles (Heiderschiet et al., 2010).

Accurate assessment can provide practitioners with valuable information on the severity of the injury and return to play time scales, this is important as it helps with managing player and practitioner expectations, planning rehabilitation and informing the managers and team selectors. With one practitioner stating they need to know important information about the injury

> *"Size of tear is a significant factor, position of tear, previous problems"* (Doctor team 10)

Therefore, the more accurate an assessment and diagnosis be, the better in terms of managing expectations. The current study demonstrates that there does not appear to be a single test that is widely adopted for diagnosing hamstring injuries, identifying their severity, or predicting time to return to play. This may help educators and those in curriculum development in physiotherapy schools, medical schools and sport and exercise medicine programmes or those involved with professional development of practitioners. With more focus and consideration put on what should be taught at both undergraduate and post graduate levels. Most practitioners agree that more than one test is needed to make a clear diagnosis as highlighted below.

> *"I use a few, I'm not dependent on one test"* (Physiotherapist team 8)

> *"I would not say one test, you have to put a whole picture together"* (Physiotherapist team 4)

Research by Whiteley et al., (2018) shows that we do not know the validity of many different assessment method. Therefore, if practitioner carries out two clinical assessment tests and gets different results, they will not know which test has the most valid result (Whiteley et al., 2018).

Consistency was seen between the doctors and physiotherapists when it came to the most sensitive and specific test used to assess hamstring injuries, with nearly all stating they undertake muscle testing as part of their assessment.

> *"Resisted muscle tests"* (Physiotherapist team 3)

> *"Probably the functional bridging test in terms of muscle function gives you the best indicator of your severity"* (Physiotherapist team 7)

Players and managers will ask medical teams about timescales and when return to play is likely, this will test the technical expertise and scientific knowledge of a practitioner possibly more than any other aspect of the management of a hamstring injury, this is because everyone will heal differently, healing time scales are very individualised and will depend on many factors, treatment and rehabilitation may not progress as planned, timescales will then change. However, there seems to be some agreement between the practitioners in the study as to what is the best clinical test to use to help them predict return to play. It appears as if the consistency between the around performing multiple tests however not the nature of the tests. Like previously, practitioners state there is not one test that stands out as being the best, rather it is a combination of tests.

“I don’t think one test is definitive, it’s a combination of all the information you have, together with hamstring history” (Physiotherapist team 3)

The physiotherapist from team 8 indicating the muscles tests give a good indication of predicting time to return.

“I would lean towards muscle tests” (Physiotherapist team 8)

These findings are fundamental in the development of practitioners and student practitioners. The findings can be used to formulate assessments that more efficient, effective and accurate which will ultimately lead to improved management of the injury. By knowing this as well will allow us to structure teaching and education of future practitioners’ curriculums and courses can focus on teaching the most accurate and utilised objective assessment methods. Linking back to the working fast and slow concept by Coutts (2106) and further examined by Harper & McCunn, (2017) and outlined in Chapter 3, the next step would be to look at validity and reliability testing for these objective tests mentioned by the practitioners, that way it can be said with confidence that these are the best tests for diagnosing hamstring injuries, identifying their severity, or predicting time to return to play. It will mean that practitioners will be translating research in to practice and using the most up to date evidence-based methods of assessment for hamstring injuries, rather than relying on perhaps methods they have used since they came into practice. A study by Scott-Bell & Malcolm (2017) interestingly highlighted that knowledge is important, however a recent physiotherapy graduate coming into elite sport with undergraduate and post graduate degrees is beneficial as it shows that have the scientific knowledge and understanding however, sometimes experiences outweighs the multiple qualifications. Being receptive to new methods is also important in the development as a practitioner. Findings from the study highlight that the physiotherapist at the club tends to carry out the majority of the assessments on injured players, doctors do if they are present there seems to be consistency in how the assessment is carried out between the doctor and physiotherapist at each club.

5.5 Diagnosis

We have already seen that an accurate assessment and diagnosis can aid the management process of hamstring injuries. As seen from the literature review diagnosis following a hamstring injury is usually by US or MRI. The findings of this study (See chapter 8) show that most doctors will perform the US and inform the physiotherapist of the results to help confirm diagnosis. Interpreting and reading US scans can give extra information to the physiotherapist but does require technical skills and scientific knowledge as shown below.

"Yes, we have got the luxury that our Doctor has got an ultrasound unit with him and he comes to the clinic, so if I am suspecting a strain then I am pretty confident and I would not necessarily, but if I think this is a grade 1/grade 2 then I would look and get from the ultrasound and see if there is a collection there, see if there is there is fibre disruption etc.. if I think there is a neural aspect and obviously if you injure your hamstring badly it can affect the fascia, it can affect neural tethering, so I would go for an MRI for more detail" (Physiotherapist team 11)

"Yeah we do, we tend to use Sports Medicine Dr, who's our team doctor who generally ultrasounds, well he does ultrasound, if we feel it was of a higher severity, depending on site and you know, initial clinical tests we might go straight to MRI but generally we ultrasound first…… Dr does injection therapy as well for us so it's easier to get, it's almost like a one stop shop for us so we can get it all done at once so it's practical in that respect" (Physiotherapist team 7)

"Yes, the Dr will US them, on occasions we may MRI them in severe cases or if we are not quite sure of the level of injury" (Physiotherapist team 3)

Despite most clubs using US or MRI to conform their diagnosis, one physiotherapist appears to be confident in their assessment and diagnosis ability and stated:

"No, we think our clinical skills at predicting the grade are better, maybe not better, but more efficient" (Physiotherapist team 8)

Ideally this response would have been explored further, however the researcher was unable due to the restrictions put in place by the Gatekeeper.

5.6 Treatment

In all cases, treatment commences as soon as the hamstring injury occurs, the current study shows more treatment modalities were used in the early stage of treatment than the late stage. The findings of the study indicate there was some consistency in the treatment of hamstring injuries in the later stages of treatment.

Soft tissue techniques and acupuncture were used by many practitioners within the late stage. In terms of the more controversial treatments – injection therapy is used but still debated in the literature and used by a minority of clubs in the study.

> *"So, in 72 hours, RICE and I would offer them some Traumeel, I would not push it, but I would offer them. I put local in the skin, so I infiltrate the skin at the three points, and they put the needle in deeper for Traumeel. Then days 1,3, and 5 would offer muscle stim, having said that occasionally I would actually initially give them local to try and turn off that local area, so that we can keep the other hamstrings firing, again it depends on the player"* (Doctor Team 9)

> *"The Dr will use Traumeel"* (Physiotherapist team 2)

> *"I think at about 7-10 days if there is a big neural component then I might consider an epidural, personally I have not used Traumeel for a hamstring, but I suppose I would consider it at 5 – 7 days. This is me other than rehab. It depends on how bad they were in the acute stage, I might give them analgesic, but I would not probably give them anti-inflammatories, so simple analgesia but more in the acute stage than sub-acute. In the late chronic I may repeat the epidural if it was a help, and they needed a top-up in that respect"* (Doctor team 9)

> *"Depends on the severity………we would start to consider a course of injection therapy, in the acute stage we might well consider an anaesthetic to*

reduce muscle spasm……and then we would consider a course of Traumeel, Actovegin or PRP [platelet rich plasma]" (Physiotherapist team 9)

Literature shows we should differentiate treatment and rehabilitation for different types of hamstring injury, below the physiotherapist shows just how this is done but recognises potentially issues around the methods used.

"I would, generally we do go down the sort of compression, ice as well, game ready we use, I'm sure a lot of the clubs do, game ready, ice, use k-tape to probably try and deactivate the damaged tissue initially, if you know, probably dependant again on the severity and how they respond within the next day, I say within twenty-four hours if we think It's probably not bleeding, or if it's fairly stable or if it's a fascial type issue, then we would probably start getting them to try and activate and use the muscle a little bit more and use things like compex and some low level rehab type drills to try and start, you know obviously give the central nervous system some normal input from the damaged area. Probably that would be it and within the seventy-two hours probably again image and inject if it's on, we generally use Traumeel I think there's probably a better theory out there is it the local that works is it just put the needle in, is it Traumeel… (Physiotherapist team 7)

"In some of the bigger tears what we've done is injected local straight away, like post-match, into the area, got some quite good results with it, again the only thing you would maybe worry about is if you're going to have any local muscle fibre damage when you do it, I think there's a bit of controversy around

it, but we've certainly had some good quite good results with using it straight away and out bigger tears that haven't used it really as much as in some on the ones which are thought to be more fascially more indicated"
(Physiotherapist team 7)

5.7 Rehabilitation

Rehabilitation of hamstring injuries is complex, and the literature shows little consensus with very few established protocols (Pollock et al., 2022). With many authors giving providing generalised programmes, for example Schmitt, Tim & McHugh (2012). However, the authors do recommend taking general programmes and making them specific to the individual athletes. Well designed, planned and implemented rehab programmes can help protect an athlete from reinjury Sherry & Best (2004). Rehabilitation is a skill that requires technical expertise and scientific knowledge to be intertwined with athlete welfare and individual nuances. A general rehabilitation programme would not suit everyone, therefor understanding individual players, positions and roles is key (Schmitt, Tim & McHugh, 2012).

When asked if they use a standardised or player specific protocol to guide your treatment and rehabilitation of hamstring injuries the responses varied and shows how rehabilitation is considered for players and practitioners.

"The way we work here at XXXXX, is mostly the treatment and rehabilitation is done mainly by the physio's, and it does follow a reasonably specific protocol for each player obviously with modifications depending on the players specifics, the specific protocol has changed more recently to what we were

running with a year ago and is very different to what are running with now, it's really flipped on its head" (S&C team 7)

In Chapter 2 we have looked at the importance of a clear diagnosis and understanding the MOI, Askling's work from 2008 and now more recent work by Macdonald et al., (2019) and Kerin et al., (2022) who show that we should change our rehabilitation depending on the MOI, severity, and location. This does appear to occur in rugby union, however, possibly not as much as it should or could.

"In terms of the severity of the injury the markers wouldn't change it would just be a slower progression through those stages, if the mechanism of injury was different because most of the hamstring injuries come from high intensity running so that's where a lot of the emphasis is put on in terms of progression and then the progression into contact work is quite rapid because that wasn't the mechanism of injury and it's not likely to be, the progression from running high velocity and getting though all the agility work into contact and into play is quite rapid whereas if the injury occurred in contact then there would be a more gradual progression though contact work" (S&C team 5)

"things have changed and I used to use a bog standard endurance running type programme……..I have modified it and looked at everything that is out there"……it is now modified and personalised to the player in front of me, the key is identifying what the player needs to do in a game" (Physiotherapist team 9)

This clearly highlights that the physiotherapist is taking into account player welfare (discussed in Chapter 2) and to ensure rehabilitation is successful.

Progressing rehabilitation requires technical expertise, reflecting on previous cases and experience. When asked if practitioners use hamstring specific progression criteria for moving between the following stages of rehabilitation responses included:

> *"I think calling it early, mid and late stage is difficult, we go on symptoms. So as their pain free range is improving you can progress ROM exercises and stretching. As their pain free on resisted testing improves you can progress their strength exercises. You will be treating locally with soft tissue techniques from the early stages, no deep stuff in the early stages but after the 4-5 day mark you can start treating the tissue locally and build the depth as appropriate depending on the severity of the lesion. So, I think time frames are difficult you can go on clinical signs and symptoms and move through as they improve"* (Physiotherapist team 3)

This level of technical expertise and scientific knowledge is so important in the management of hamstring injuries. Making rehab specific to the sport and position is advocated by Schmitt, Tim & McHugh, (2017). Having the foresight to reflect on what you did do and then change it based on 'what is out there' as the physiotherapist says links to both technical expertise and scientific knowledge and duty of care. It highlights that practitioners are changing what they do and using evidence-based research in their practice.

Rehabilitation techniques are varied between practitioners, with many different techniques being employed to rehabilitate hamstring injuries. The biggest area of disagreement in this study related to when running, speed and multi-directional running exercises should be introduced into the rehabilitation programme. There was also a lot of variation on the use of progression criteria. There was no agreement between practitioners regarding the appropriate progressions during rehabilitation. This lack of agreement extended to the inclusion of sprinting and change of direction drills into rehabilitation programmes. However, most S&C staff agreed it is led by the physiotherapist (see chapter 7).

> *"I have used and read about a chap called James Muir, who has done a bit of work with England, and who developed a hamstring rehab run for fast heavy athletes and first it is in 4-5 stages and generally the 1st stage is 2k walk/run and then it progresses into 75% strides over varying distances and that is at ¾ pace. Then the next stage is 80% and then the next stage is full pace, and I think that is quite a good way of grading it and it has a bit of a mix and I do work around that format, but as I said with the fascial ones I have almost ditched the first couple of stages of that, and done more of the speed agility work before I have translated into it. I think that the third stage of that hamstring rehab run for instance is about probably 2.5k, so it is a decent amount of running at a decent pace, but I feel that the fascial ones are definitely performing better with that type of running when they have done the speed agility, speed strength work prior to going into that, so as I say that is my gut instinct"* (Physiotherapist team 7)

> *“That would be the physio again. He would do the early stages of running and then he would hand them over to us*” (S&C team 4)
>
> *“That would all depend on the measure of speed. For example, you can class speed as any speed development, I class speed not just as maximal speed but as acceleration and developing mobility and working on technical drills. You need technical drills that are not hamstring bias. So, are you doing speed yes, are you working the hamstring no.? So, speed again varies on position of the player. The protocols are in the terms of the length of injury in terms to return to play. There is not a set protocol for a hamstring injury, it depends on the person”* (S&C team 4)

No clear agreement was evident concerning the criteria for progression from one stage of rehabilitation to the next. Schmitt, Tim & McHugh (2012) list several general goals and progression criteria in their study, but they are often not included in research or literature. Several practitioners used extremely specific progression criteria, such as the hamstring muscle length must be less than 10% of the contralateral leg; the player has to subjectively report discomfort of 2/10 or less; linear running speed had to be at least 70% of the pre-injury level. Other practitioners used more general criteria. Half of the practitioners modified these criteria according to the mechanism, location and/or severity of the hamstring injury. Existing research suggests that these factors should be considered and influence subsequent rehabilitation of hamstring injuries (Heiderschiet et al., 2010).

5.8 Return to play (RTP)

Predicting time to return to play is difficult, but it is always one of the first questions asked by players, coaches, and managers. Not all practitioners in the study used either specific standardised or individualised return to rugby criteria for hamstring injuries and some still used old protocols, highlighting a need to use updated and more recent evidence-based protocols.

> *"Not specifically for hamstring. There is the old RFU 1, which I do take parts of at times, but not all the time however a winger might have slightly different needs than a front row"* (Physiotherapist team 4)

There was large variation in practitioners return to sport criteria that were employed with little agreement on how to determine if a player was ready to return to play. New tests are emerging that may be useful for practitioners when evaluating if a player is ready to return to play. Askling et al., (2010) proposed that an active hamstring flexibility test is dependable and could compliment the clinical assessment process and prove useful if included in a standardised return to play protocol. Sherry, (2012) proposed that the ability to walk without pain can be used to predict return to sport. A study conducted by Malliaropoulos et al., (2010) showed that active knee extension ROM proved to be both an objective and accurate measure for predicting recovery time from first time hamstring injuries Malliaropoulos et al., (2010).

5.9 Injury prevention screening

Hamstring injuries have a high level of recurrence (Brooks et al., 2006, Mendiguchia & Brughelli, 2011 and Brukner et al., 2013). Brooks et al., (2006) demonstrated that hamstring injuries were the second most common match injury to recur in rugby union and that they would tend to be more severe. Despite this, almost all of the participants agreed that hamstring injuries and their recurrence could be reduced, and screening for certain factors may play a vital role, a view that is supported by Kerkhoffs et al., (2013) and Gabbe et al., (2006). However, there was a wide diversity in the nature and extent of hamstring injury screening that clubs employed. Many clubs did screen their players in the pre-season period but the best way to screen for players at risk of hamstring injury remains unclear. All participants used hamstring injury prevention programmes, but some were more formal than others, and there was no agreement or consistency as to what should be included.

> *"Not a formalised one. But it is off the back of screening. But the main focus on ours is isometric strength, which will be focused on players with a history or position susceptibility. They will do an increased amount of that in their gym sessions"* (Physiotherapist team 2)

This response does not align with MOI, we have seen from Chapter 3 that injury prevention should be linked to MOI. Therefore, you would expect practitioners to be basing injury prevention programmes on eccentric strength, high speed running, acceleration, deceleration and kicking, not necessarily isometric strength.

When asked if it is possible to prevent recurrent hamstring injuries responses were positive with most thinking it is possible. However, some did disagree.

"I'd like to think so, but in our experience, the people that have injured their hamstring will re-injure it again at some point, or we have certain people who we know are predisposed to it and we haven't" (S&C team 7)

From chapter 6 and 7 we can see what is implemented for injury prevention, according to Bourne et al., (2017) the focus should be on strengthening.

5.10 Strength and Conditioning

Strength and conditioner involvement with the management of hamstring injuries was varied. However, nearly all were involved with the players towards the end of the rehabilitation. For a more detailed analysis of what S&C staff do see chapter 7. Most S&C staff have responsibility for loading and monitoring volume of training and work.

"There is no typical loading of volume, because everyone is different" … "Loading, I would not be comfortable telling you that we always do this or do that, it depends on what phase of the programme we are in. If they are back from injury, we would try to develop hamstring strength and depending on the exercise we would plan from there. It is very determinate on the person, fibre type, injury history, where they are in their training life etc" (S&C team 4)

5.11 Beliefs

Linked to technical expertise and scientific knowledge is professional attributes and beliefs. A practitioner's understanding of their own beliefs is important for them to shape their own values, ideas, opinions and development (Till et al., 2019)

Practitioners need to believe in what they are doing, they need to believe that what they are doing is purposeful, has meaning and is worthwhile. Practitioners' beliefs are also important in understanding what they think, what they believe to be happening. These beliefs can be driven from research, anecdotal evidence, personal and professional experiences. Questions asking practitioners about their beliefs were important to establish their thoughts and idea surrounding hamstring injuries. Practitioners were asked if they think it is possible to reduce the risk of first-time hamstring injuries in elite English rugby union, responses were supportive and most believe they can.

> *"Yes definitely, through past experience"* (S&C team 6)

> *"Yes definitely, I definitely do"* (S&C team 7)

> *"My belief would be first time hamstring injuries we have every chance to reduce or prevent totally"* (S&C team 3)

However, one practitioner believes it is not possible to prevent first time hamstring injuries.

> *"No, I doubt anyone in the Premiership would agree"* (S&C team 4)

Despite not believing it is possible, it does not mean the practitioner would employ strategies to help prevent injuries. The practitioner would still need to work within the multidisciplinary team do all they can to prevent injuries and recurrent injuries to fulfil their role in the duty of care towards the players.

Do you think it is possible to reduce the risk of first-time hamstring injuries in elite English rugby union?

> *“Yes definitely, through past experience”* (S&C team 6)

> *“Yes, but I can’t say definitely because there's no such things as one hundred percent. I believe that if we screened people very early on, i.e. people coming through academy, coming through the Elite system, so schoolboy rugby, get them doing the right technique the right methods the right conditioning from early on then by the time they become professional they are they have formed normal habits and have not brought along bad habits that would hopefully then prevent. Obviously, some people will always be predisposed to it, but if you can identify somebody who’s got a marked lordosis from very early on and shorten hamstring, you know poor posture at squatting etc and you correct them from an early stage, you may be able to prevent that individual. Now whether you can link, you know, prehab from that sense with cause in the future then you know, you don’t know, it’s possible, I think it is possible”.* (Doctor team 6)

> “*Yes definitely, I definitely do”* (S&C team 7)

“My belief would be first time hamstring injuries we have every chance to reduce or prevent totally” (S&C team 3)

Despite not believing it is possible, it does not mean the practitioner would not do anything to help prevent injuries. The practitioner would still need to work within the multidisciplinary team do all they can to prevent injuries and recurrent injuries in order to fulfil their role in the duty of care towards the players.
Modifying training load has been researched. When asked if they (practitioners) think that modifying training load can aid hamstring injury prevention, like previously, responses were positive.

“Individually yes. You need to be very player specific” (Doctor team 6)

“Yes definitely, but it needs to be individualised because of tolerance” (S&C team 5)

We have highlighted the importance of understanding MOI in Chapter 2. So, when we asked what practitioners, think is the most common MOI for hamstring injury in elite English rugby union?

“Well, looking at the injury report we get annually. It’s high intensity running” (S&C team 5)

This shows duty of care and the application of TESK taking time to read and understand the annual injury report. But also, that hamstring injuries are consistent with the literature and therefore some inferences may be made between elite English rugby union and the existing literature from Ekstrand' s work in football.

We know from the literature Brookes et al., (2006) recurrent injuries tend to be more severe and require longer out of the game. Preventing recurring injuries is therefore key. When asked if practitioners think it is possible to prevent recurrent hamstring injuries responses included:

> *"Yes, definitely, with paying particular attention to prehab, linked to improving the stretch –reflex of hamstrings, the pitch and training surface conditions you train on"* (Doctor team 3)

> *"Well, yes, I presume that yes, it is possible, but whether it is or not, I would say yes but how you would try to reduce the risk it. So yes, I think it is yes definitely"* (Physiotherapist team 4)

One practitioner shows they really are not sure:

> *"I would say yes possibly, but not definitely" if you are lucky and you do preventative work you may get lucky and prevent those people"* (S&C team3)

> *"No. Simply no"* (Doctor team 6)

This may suggest that it is not just down to their technical expertise and scientific knowledge, but they believe there is an element of luck in what practitioners do.

5.12. Qualifications

Practitioners working in elite English Rugby Union have a vast amount of technical expertise and scientific, see table 5 below. This stems from their education and qualifications, their professional attributes. One thing is clear from the research by Malcolm & Scott (2014) often more senior practitioners have fewer qualifications than more junior practitioners but believe experience and time working in elite sport is more important than extra qualifications. This was not explored in this study but would be interesting to look at in the future. The lead doctor, physiotherapist and S&C practitioner at each club was interviewed, this was to allow us to get more information as they are effectively overseeing the whole injury management process. Analysis shows that all practitioners in the study hold formal degree level qualifications, see table 5. Note that some practitioners have more than one undergraduate qualification and some have more than one post graduate qualification.

Table 5: Practitioner qualifications

Practitioner	First/undergraduate degree	Postgraduate degree/qualification
Doctor	General Medical degree MRCGP MBBS	Diploma Sports Medicine Diploma Sport and Exercise Medicine MSc Sport and Exercise Medicine.
Physiotherapist	BSc Physiotherapy BSc Sports Science BEd Physical Education	MSc Physiotherapy MSc Sport and Exercise Medicine PhD Spinal Diploma Manual therapy Diploma MSc Sport and Exercise Science MSc Musculoskeletal Physiotherapy

		Grad Diploma Physiotherapy
S&C	BEd Physical Education BPHD Sports Science BSc Human Nutrition BSc Sport and Exercise Science	MSc Sport and Exercise Science UK Sport S&C Assessor Post Graduate Diploma Recreational Leisure UKSCA S&C Coach MSc Biomechanics PhD.

Table 6: Number of years practitioners have worked in elite ruby.

Years in Rugby	Doctors	Physiotherapists	S&C
1-5	1	2	1
6-10	6	5	5
11-15	0	1	1
15+	0	1	0
No answer	1	1	1

Practitioners were not asked about membership to professional bodies in this study. The original study by Waddington, Roderick & Parker (1999) received a lot of publicity and lead to a complete overhaul of how doctors and physiotherapists were appointed. The original study by Waddington, Roderick & Parker, (1999) based on practitioners working in football found that most doctors were fans of the club with little or no experience in sports medicine and a lot of the ‘physios’ were not chartered physiotherapists and only held the FA diploma in treatment. This was updated in 2017 by Malcolm, Scott & Waddington. The more recent results show most doctors working in elite football are GPs with SEM qualifications, many physiotherapists are charted physiotherapists with most having post graduate qualifications. However, both roles tend to be appointed to by knowing someone at the club than through formal advertisements. A recent study like this has not been conducted in elite English rugby Union.

5.13 Knowledge, training, and Continuing Professional Development (CPD)

Technical expertise and scientific knowledge are vital when managing injuries and collaborating with athletes. Technical expertise and scientific knowledge are learnt but also something that develops overtime and is linked to experience and exposure to injuries. To develop, progress and become more confident at treating injuries in any setting, professionals are required to undertake, record, and submit Continuing Professional Development (CPD). Doctors, physiotherapists, and S&C practitioners are required to complete formal CPD each year to keep up their accreditation and professional body membership. The following professional bodes CPD requirements are shown below:

Chartered Society of Physiotherapists (CSP) – it is not formally stated how many hours is required annually, but all Charted Physiotherapists are required to undertake annual CPD.

Faulty of Sport and Exercise Medicine (FSEM) - The FSEM state CPD requirements are a minimum of fifty educational credits in any one year www.fsem.ac.uk

Strength & Conditioning UK - The UKSCA state members must complete100 credits of CPD over 2 years www.uksca.org.co.uk

Therefore, the practitioners working in elite rugby union must adhere to this in order to keep up their professional membership. It is not known if practitioners adhere to these guidelines and what makes up their CPD. Further questioning here would give us an indication of how they view CPD and what makes up their CPD.

Results of the study show that the practitioners were keen to see more CPD and training for them to progress and increase their knowledge. When asked do you feel that you have sufficient knowledge and or training to optimally treat, rehabilitate and prevent hamstring injuries and what they would like to see the RFU set up for CPD responses included

> *"I think so, I mean that I would like to go on a hamstring update. I have been on one not long ago and I researched what was done on it…… but there is always room to learn more" (*Physiotherapist team 11)

> *"Yes, definitely the more CPD and development, and anything that would make the quality of care better"* (Physiotherapist team 5)

> *"I would say no because we are still getting them so it's, until you can comfortably say you are never going to have them then. I like to think that we are doing as good a job as possible, or trying to do as good a job as possible so that were doing our best possible to stop them, prevent them"* (S&C team 7)

> *"If you had asked me 3 years ago, not. It is difficult because I think the guy's we were getting before you would treat them and rehabilitate them, totally different to the way I do now, and they would still get better and get fit and get back playing, and then they might pick up another one. I think now I have*

probably got a far better understanding of risk factors, so I would say yes now" (physiotherapist team 7)

"It would be helpful to have conferences, but it would not alter my work. CPD would help.US training on the appearance of muscle tears, a session going through what you have looked at, a mentor, to be able to send scans, it is difficult to send real time images, it is difficult to reproduce what you are seeing, that would really help" (Doctor team 3)

"I would prefer more physio related information on a study day, rather than general GPS. I do not specifically feel that I need hamstring information, but I would gladly listen to it as I may be wrong, but I always try to redevelop it. I would always be interested to do anything" (Physio team 4)

"In terms of my role in that as strength and conditioner I think that I have a good knowledge of what is required" (S&C team 5)

"Yes, any extra CPD work where people present case studies or expert work, but I do read a fair bit really around it, so I think that I have a reasonable understanding. My initial answer to say 'no' as I trust the medical staff in the first stages. It is always better to know more about it, but I would not get involved in on-line forums purely because I am not that IT literate. I like to spend time away from the computer" (S&C team 5)

"Yes, definitely the more CPD and development, and anything that would make the quality of care better" (Physiotherapist team 5)

This links to the duty of care mentioned in chapter 3 and shows that even when thinking about their own attributes and development they link back to the players and duty of care. Reflecting on what you have done and how you have managed is important and reflective practice is part of the skill sets of the practitioners in the study. It is often a requirement of CPD. The doctor from team 3 talks about reflective practice:

"You can always learn from what others are doing. I am always open to new ways of management. You always think you are doing the best, but you never know what else is out there. The day you think you know everything is the day you need to get out as you are dangerous" (Doctor team 3)

5.14 Resources

Resources can be anything from small items tape, massage lotion, resistance bands and ice to expensive medical diagnostic ultrasound machines and large gym/training equipment. These resources are a vital part of the management of hamstring (and other injuries) used at the clubs to assess, diagnose, treat, rehabilitate, prevent injuries and test during return to play. Resources differ at each club, one physiotherapist does not feel he has enough resources to optimally treat, rehabilitate and prevent hamstring injuries:

"No, It would be interesting to have a dynamic ultrasound, which I use in other sports, as I work across other sports, whether that actually improves or not our way of treating it is debatable, because serial scanning, would it make any difference, but it would make a difference if we were to start doing injection therapy, which I am potentially interested in seeing" (Physiotherapist team 8)

This shows the physiotherapist is thinking about both resources and knowledge, we can see that the doctor wants to update knowledge and resources based on experience and reflection. Interestingly, the doctors from team three and five felt the needed more time, not physical resources but time.

"I would always like more time. You can always have more" (Doctor team 3)

"More physio manpower and time. The Department is under-resourced by 8 people" (Physiotherapist team 8)

"Is time a resource? Then no, as we could do with more time in training, more control over what they do particularly in pre-season, more time for end stage rehab" (Doctor team 5)

Practitioners were asked if they feel they have sufficient qualifications and training to optimally treat and rehabilitate and prevent hamstring injuries, responses were varied, but some linked back to technical expertise and scientific knowledge, duty of care and the multidisciplinary team, these themes are discussed in chapter 6 and 7.

"No [I don't think I have sufficient qualifications], but that's why we work as a team, that's why we bump heads and bump ideas, and me personally I would like to develop my ultrasonography skills, so that I can diagnose on the day or be either around the day and again it comes back to the question of when is the optimum time to image. I would like to have sonography on site for prognostication so that the physiotherapists can be laid on and they see how its progressing" (Doctor team 6)

"Imaging conference, CV courses, sponsorships, will be at Phillips or whoever wants to tag along who can loan ultrasound scans to X number of clubs obviously with the idea that the clubs love it then they will buy it, so there's that commercial idea from a sponsors point of view, and its great not just CPD for the, I mean doctors will always go and do it, because its generally its income, buts its great CPD from the physio's point of view as well. Its great anatomy, its great motivation, it lets them see what they are actually handling" (Doctor team 6)

"I would say no because we are still getting them so it's, until you can comfortably say you are never going to have them then. I like to think that we are doing as good a job as possible, or trying to do as good a job as possible so that were doing our best possible to stop them, prevent them" (S&C team 7)

"I think the only thing is I am now putting together something to actually create an Injury Prevention Department within our medical department, and they

would be solely responsible for screening, delivery of prehab/performance training on a one to one basis, and that would also include a lot of their soft tissue and fascial release type work as well, and again it would be on an individualised basis. So that to me in terms of delivering it, it is difficult when you have a squad of forty boys, we do not have quite a big a staff as some places, but you try and do the best you can with the resources you have got" (Physiotherapist team 7)

5.6 MDT

Working in a multidisciplinary team is common in elite sport, members of the MDT will usually share a common aim; that being to return the player back to the pitch following a hamstring injury. However, each professional may approach this slightly differently due to their profession (Opar & Rio, 2015). It is important that each profession works within their scope of practice, but be open to learn from others as this can provide others with extra tools and skills as their experience grows Tapley & Siesmaa (2017). This integration will enhance the multidisciplinary team as successful management of injuries in elite sport depends on the integration and communication between all practitioners. Dijkstra, Pollock, Chakraverty & Alonso (2013). It also allows each member of the MDT to understand their roles and responsibilities, therefore reducing potential conflict and blurred professional boundaries. Such issues have been well documents by researchers observing professional sport practice in other countries, for example Theberge's (2008 & 2009) work in Canadian sports (including various Olympic sports), with work by Malcolm & Scott (2014). Theberge (2009) argues that sometime professional boundaries are often challenged in pursuit of the performance goals set by different professions with the MDT. Physiotherapists within this study appear to oversee everything and effectively ‘take charge’ of all stages of assessment, treatment, rehabilitation, return to play and injury prevention, this was also noted by Scott-Bell et al., (2015). According to Scott-Bell et al., (2015), Doctors see the injured players the least whilst S&C practitioners really only get involved in the later stages just prior to the player returning, this agrees with Armstrong et al., (2021). Good communication within a multidisciplinary team is important and good communication has been shown to reduce injury incidence and improve the quality of care. Due to the fast-paced nature of elite sport, it is imperative that each practitioner must work autonomously to the highest standard within an integrated high communicating multidisciplinary team. Managing players within a multidisciplinary team can be challenging. Ensuring everyone gains the same level of care is key to the successful management of injuries.

> *“My role would be I'm in the same room as the physio's so if someone is not training, I would see them daily anyway”* (Doctor team 9)

> *“I would see them daily until then, and then I would see them on average every other day, and by that it’s not that I would see them and take them into my examining room and examine them, but I would say for example, in the gym how are you getting on with the. programme and may not even go and talk to them but make sure that I’ve clocked them and see that they are doing things”* (Doctor team 9)

5.16.1 Multidisciplinary team

All clubs that took part in the study have a multidisciplinary team that look after the squad. In the case of this study "the team behind the team" comprises of the medical doctor, physiotherapist and the strength and conditioner. All play an important role in the management of hamstring injuries. With more and more emphasis being put on medical teams to manage large squads. The medical teams must also work alongside coaching staff, skills coaches, sports psychologists etc, and recently is has become popular to hire a researcher who is employed to assist the team behind the team. Each member if the multidisciplinary team should understand their role and responsibilities. This is highlighted in teams 3 and 6 when asked about whether they use standardised or player specific protocol to guide treatment and rehabilitation? It suggests that the physiotherapists and S&C know and understand their role within the multidisciplinary team.

> *"we have a rehab S&C guy, the physio follows a process from the rehab/medical side of it"* (S&C team 3)

> *"that's under the manager, so basically, we get involved at the end stage, so with that the physio would generally led…. we would contribute to certain drills….we could help with the protocols that these guys set [physios] so it's player specific initially"* (S&C team 6)

Responses from practitioners seem to show that there is a natural, conventional hierarchy within the multidisciplinary team. With the physiotherapist sitting at the top, which supports work by Scot-Bell et al., (2015).

“our department is more like a merged department, part medical staff, part physio staff. The original diagnosis and initial treatment is done by the physio department, and they start the rehab end and then discussion for the proportion of work done by the S & C team and the physio and we try to work as a single entity, and we call them the Rehab Team, and then as the injury progresses in terms of a return to play the physio team pass over to the S & C team” (S&C team 4)

Being specific, successful injury prevention according to (Talpey and Siesmaa (2017) relies on a multidisciplinary approach, when asked do you have a hamstring injury prevention programme team seven highlight this:

“*Yes, integration with the S&C, physio and S&C physio”* (S&C team 7)

The hand over between the medical team and the strength and conditioning staff is important as the player is nearing the end of their time with the medical staff. So, handovers are important to ensure communication continues and information shred between the team. When asked about the hand-over between the medical staff and strength and conditioners, different responses were noted, some are presented in the chapters 5 and 6, but those relating to scope of practice and autonomy are presented here.

“We are an integrated team, and we talk every day, so we have a briefing every day and in that we talk about everything from treatment, rehabilitation

planned and the S&C proposed. It is essential to discuss each player" (Physiotherapist team 9)

"S&C, Physio, coach, sports science and sports medicine, led by S&C and physio in discussion, the doc is here, and we work to a rationale a fully integrated team" (Physiotherapist team 9)

"We sit and have a discussion about where we are at, the physio will say what they have achieved in terms of strength, grading and expectations of where they will be able to go and hand that over to the S & C's. You do not dictate their plan, but you try and direct them where you want them [S&C coaches] to go" (Physiotherapist team 4)

"*The handover is created from day 1, because we have a meeting every morning, so we discuss the players… so really we try and work together"* (Physiotherapist team 6)

"In terms of exercise prescription, it would be us, the physio's would dictate that and relate to S & C about what they can and cannot do" (Physiotherapist team 11)

This analysis supports the work by Tapley & Siesmaa (2017) who state that open communication between practitioners is important in the management of hamstring injuries. Developing this work, Ekstrand et al., (2019) who show the quality of the communication between practitioners in a team as an important part of risk factors for injury. Results from Ekstrand et al., (2019) show that the best communication was found within the medical teams, so between the doctors and physiotherapists, however, communication between other practitioners within the team was more varied.

> *"it's on going conversations, and it wouldn't be at that handover point when the conversation would start it would be ongoing through the early and mid-stages, and it's a less formal changeover I guess for us than other clubs, I know some other clubs the strength and conditioning staff don't see the player until he's nearly ready to play and then they would take them. Whereas we work together a little bit more than that, a really integrated approach? We certainly try. And it's still the physios will lead the early and mid-stage, but we might take the player for some sessions in the mid stage, just because of resource implications if the physios busy with treating other people and we can take a player through the sessions then and it might be better that we do that. So, we try to make it more of an ongoing conversation than a formal handover really"* (S&C team 5).

> *"We discuss what they have done. That will occur throughout not just at the end. So, we say this is what we have been doing rehab wise, what isometric work, what eccentric work. They will know the exercises and various progressions; we will tell them what progression we are at. We will tell them what running volume we have done and speed, but they would have probably been speed tested by them anyway. So, they will know if they are a million*

miles away or if they are pretty much back to pretty much what we would expect, so that's the most objective measure (Physio team 2)

The following two quotes highlight lower levels of communication, future analysis would benefit from looking at injury levels within these clubs and seeing if the teams that appear to have high levels of communication (like above) have lower injury rates compared to the two below that appear to have lower levels of communication. For the present study the RFU would not allow this type of analysis.

> *"it's relatively informal, it's a case of medical staff saying that they have ticked these boxes in terms of functional performance and these in terms of clinically. And they give us parameters to work around and then it's us to take them forward and build them up to full function"* (S&C team 2)

Team thee appear to only give handover documents, rather than verbal communication.

> *"Rehab physio and S&C will give me a handover document that outlines lifts, speeds, GPS distances"* (S&C team 3).

The current study supports this as shown in the quotes previously. Interestingly, Ekstrand et al., (2019) showed that teams with higher communication scores have a lower injury burden, fewer severe injuries and attendance at training was high. In contrast to this, Ekstrand et al., (2019) found that low communication scores between the medical team and fitness coaches resulted in fewer at training compared to those with higher levels of communication. This study shows communication between the medical staff and S&C coaches is good, with most clubs holding handovers. Communication within elite sport is important, Lausic et al., (2009) report that more communications within a team resulted in more wins.

7.4.2 Role delineation: hierarchy, specific roles specific jobs, protocols and procedures within the MDT.

Establishing roles and responsibilities based on scope of practice is important for successful management of injures. Scott-Bell et al., (2015) cite work by Malcolm (2006), Theberge (2008) and Reid et al., (2004) which highlight relationships between the MDT usually demonstrate cooperation and are collaborative but need to be cultivated over time. This is evident when asked who designs and leads each stage of rehab, team 3 response shows they work in a multidisciplinary team.

> *"it's a collaboration between S&C and rehab and rehab physio"* (S&C team 3).

Building trust within the MDT is critical as role and responsibilities between the practitioners are so different. It is closely related to scope of practice and autonomy. There does not appear to be intra professional conflict between members of the MDT working in elite English rugby union. Therefore, practitioners must trust each other to work autonomously within their scop of practice which will ultimately enhance payer welfare and duty of care as they will all be working towards shared objective and goals (Layland, 2018). Unlike the inter professional conflict highlighted by Malcolm & Scott (2014) who showed in their study that there appears to be a lot of conflict between physiotherapists working in Olympic sports. They also mention blurring of professional boundaries between doctors and physiotherapists, which again does not appear to happen between the doctor and physios within the MDT teams. However, it is worth noting that questions were not designed to show inter or intra professional conflicts. A future study could perhaps expand on this work and follow the work of Malcolm & Scott (2014) to look at workplace relationships with in elite MDT. Some clubs always constantly refer to the physiotherapist, others talk more about the members of the multidisciplinary team. When physiotherapists and S&C practitioners were asked about progressing between stages of rehab and establishing hamstring rehabilitation progression criteria it seems the physiotherapists will lead.

> *"Physio led"* (S&C team 6)

> *'initially the physio will determine………….. the physio will do most of the running for a hamstring initially.. the physio is sharp and assesses when they move on" (*S&C team 3)

This continues when asked whether they have specific standardised or individualised return to competition criteria for hamstring injuries:

> *"Not really as S&C department, the physio's do"* (S&C team 3)

> *"The physio staff will generally lead with input from the S & C, and will help the handing over of the strengthening aspects, but we will still lead it really, with a period of allowing the S & C to do what they want"* (Physio team 5)

Rehabilitation programs traditionally begin with a physiotherapist who will deigns and implement the programme (Tapley & Siesmaa, (2017). This occurs in all clubs asked in the study. This demonstrated scope of practice and role delineation which helps with expectations and duty of care. However, it is not known how the other members of the multidisciplinary team feel about this, a future study could look at the dynamics of the multidisciplinary team and how it functions and how different practitioners integrate with each other.

Is this about shared responsibility or maintaining a hierarchy or is it other members of the entourage absolving themselves if this go wrong? What does the physiotherapist in team 8 mean by controlling physio? As the study only interviewed the lead physio for each club. Perhaps it is the physio at the match? At training? On duty on the day, this may be what he means if they have a pool of physios that work with them on a rotational basis.

> *"Whoever the controlling physio is"* (Physiotherapist team 8)

> *"No, it's the physio's that do it, I have no idea what they do but they do it"* (S&C team 5)

> *"Early to mid-stage, more physio jurisdiction, but it will be pain dependent"* (S&C team 1)

Interestingly, when looking at speed progressions and how clubs determine once a player is ready to progress all responses showed it was dominated by the physiotherapist. However, this is one of the few responses in the study that show the physiotherapist is willing to hand over to S&C.

> *"The S&C would probably do more of that, once they are ready to do a speed session, I would hand them over to the S & C guys and they have their certain specific drills that they use"* (Physio team 4)

In contrast to this, the response from team 6 when asked about the completion of the physiotherapy led late stage (so now with the S&C) what hamstring specific exercises do you include in your strength and conditioning programme and what volume of loading would you typically work the players at shows that despite being in an S&C phase, the physiotherapist still controls what is being done:

> *"Physio still has control over that"* (S&C team 6)

> *"Well generally that depends on the physio to decide where the players are at" (*S&C team 6)

> *"Again, it depends on what they get told from physio" (*S&C team 6)

This appears to show agreement between practitioner that the physio leads the management process. When a player has return it could be assumed that the physiotherapists' role would reduce to more of a monitoring role and the S&C would become more involved to maintain the work that has been done by the physiotherapist in rehabilitation as this would free them up to focus on other injured players. When asked about what happens once the player has returned to sport the following response shows both duty of care and technical expertise and scientific knowledge. Consistent with the literature from Brooks et al., (2006) and Brukner, 2013), hamstring reinjury is very common in the first 4 weeks back Brukner (2013). However, it could also be perceived by some as not wanting to let go, not wanting to trust the S&C practitioners.

> *"I think to be honest from a physio point of view we keep an eye on them because I think that is when I am most concerned, because once they go back to their first game ……I would probably still treat them maybe for a couple of weeks to get them back until they are 100% confident and have not felt anything whatsoever, and this is more reassurance for them and even though they have got back into playing Rugby"* (Physio team 11)

It is clear from chapters 5 and 6 and previous research by Scott-Bell & Malcolm, (2015) & Arnold et al., (2019) that physiotherapists seem to dominate and lead on the management of hamstring injuries. Whereas doctors appear to have the least involvement in the management of hamstring injuries. As highlighted in the following quotes:

> *"Me personally, as doctor I don't, is the answer, unless there is an issue. Once a diagnosis is made and rehab is going as planned then there's no reason for the doctor to see them because that's what the physiotherapist do, it's their job"* (Doctor team 6)

"Well, I don't generally see them acutely, certainly if they are training injuries then I won't see them, as I am just not here when they injure them. On match day if they injure them then I will see them" (Doctor team 8)

This shows that the doctors appear to show trust in the multidisciplinary team and are happy for the physiotherapist to lead. This is also true for S&C practitioners who also seem to have minimal involvement.

"By the time they get to me they are already running. Physio gets them running early" (S&C team 2)

"We rely on the medics, we will make subjective assessments of posture and running gait but quantifiable stuff is done by the medical staff" (S&C team 2)

"It is one for the physio's. We have a return to play protocol, which is somewhat position, and it will be individual specific if we have a personal history of their injury profile and have known them for a while" (S&C team 9)

When asked about predictors that will tell you a player needs to take more or less time to return to Rugby, the S&C from team six shows that the physiotherapist leads this, but also shows trust in the physiotherapist:

"Again, this is physio's bag, but looking at the hamstring protocol that they use everything is exit and entrant criteria based to get through the programme. So, knowing where someone is in that and knowing what grade their

hamstring injury was in the first place, I think most physio's would be spot on with their prediction to return to play" (S&C team 9)

This section highlights that the physiotherapists within the team do tend to lead and take charge of the management process. However, the S&C practitioners appear to support this and almost recognise that the physiotherapists have a higher ranking in terms of injury management. However, the relationships within the multidisciplinary teams were not explored, so we can only make assumption son this, not definitive conclusions. Future work could look at the dynamics of the MDT within elite English rugby union as this was beyond the scope of this study.

5.16 Conclusion

The aim of this chapter was to present data to show and identify how technical expertise and scientific knowledge (TESK) and working in a multidisciplinary team is used to by practitioners in the management of acute grade two hamstring injuries in elite English rugby union. The secondary aim of the chapter was to outline practitioner beliefs and professional attributes. These aims have been met and analysis shows practitioner responses that both support and disagree with the literature. The practitioners working in elite English rugby union have high level of technical expertise and scientific knowledge this is displayed in both responses and qualifications which help them understand the complexities surrounding the management of hamstring injuries. The chapter also shows that technical expertise and scientific knowledge is important in all aspects of the management process. Often practitioners are working in a fast-paced environment under pressure and are required to make quick decisions which supports work by Arnold et al., (2019). This chapter had provided us with valuable evidence that practitioners use technical expertise and scientific knowledge to manage all aspects of the hamstring injury management process. This chapter shows that practitioners working in elite English rugby union work well as a MDT. The relationships between the MDT appear to be collaborative and show cooperation between all of the professions and practitioners. This can only enhance the management of hamstring injuries and lead to better decision making and more successful outcomes as high level communication regarding decisions making and management process can enhance player welfare and duty of care. It is clear and shown consistently that physiotherapists take the lead in managing players with hamstring injuries as they play a varied and key role in the MDT. With the physiotherapists showing dominance and eagerness to be involved and cover all aspects of the management of hamstring injuries. In contrast, doctors seem happy to say they have limited involvement in the management of hamstring injuries. The S&C practitioner talk a lot about work of the MDT and their role with in it, they also appear happy to say the more S&C type work is also lead by the physio. This may cause hidden tensions and stressors to working conditions for the S&C staff, which could impact on duty of care and player welfare, however, this was not questioned and explored.

Chapter 6

Hamstring injuries in elite English Rugby Union: A survey of doctor and physiotherapy practice.

6.1 Introduction

There is an increased risk of acute first-time hamstring injuries in sports that demand running, sprinting and kicking such as rugby union, soccer and athletics and sports that involve extensive lengthening of the muscles, for example dance (Askling et al., 2000 & Askling et al., 2007b and Kerin et al., 2022). The majority of hamstring injuries occur in competition compared to training (Brooks et al., 2006 & Ekstrand et al., 2011) and in non-contact situations (Ekstrand et al., 2011 and Kerin et al., 2022). Furthermore, rugby union, soccer and athletics have demonstrated high levels of recurrent hamstring injuries (Woods et al., 2004; Brooks et al., 2006, Hagglund et al., 2006; Ekstrand et al., 2011; Petersen et al., 2011 & Malliaropoulos et al., 2012). These recurrent hamstring injuries are particularly challenging as they cause more time lost from playing than the original injury (Brukner et al., 2013).

Ekstrand et al., (2011) reported that acute first-time hamstring injury and recurrent hamstring injury rates have not reduced over the last three decades in elite soccer despite changes to training, rehabilitation, prevention methods and extensive research. There are high incidence rates of both first time and recurrent hamstring injuries, these are associated with poor and slow healing times (Mendiguchia & Brughelli, 2011) as well as complex and lengthy rehabilitation (Croisier, 2008). By gaining an insight into current practice of hamstring injuries from a medical

practitioner's point of view, the management of hamstring injuries could be improved, and the incidence of both first time and recurrent hamstring injuries reduced.
Acute and recurrent hamstring injuries are known to be prevalent in elite rugby union Brooks et al., (2006). Brooks et al., (2006) investigated hamstring injuries in elite English rugby union over two consecutive competitive seasons, hamstring injury diagnosis was based on clinical examination and injuries were reported using the Orchard sports injury classification system (Orchard, 1995). The study revealed that 164 hamstring injuries were reported across the two seasons. Also noted, was a significant difference (P =0.001) between match and training injuries with 94 match injuries (5.6/1000 player match hours) and 70 training injuries (0.27/1000 player training hours) occurring. Interestingly, Brooks et al., (2006) report a significant difference in hamstring injuries that occur during match play between forwards (3 hamstring injuries per 1000 match hours CI, 1.9-4.1) and backs (8.6 hamstring injuries per 1000 match hours CI,6.5 – 10.6), however, they do not report the significance value.

First time hamstring injuries caused 14 days of lost time whereas recurrent injures were more severe and caused 25 days of lost time. A total of 59% of the recurrent injuries occurred within the first month of return to play. Of the recurrent injuries, 24% occurred during matches and 23% during training (P = 0.53). This figure is similar to those reported in Australian rules football (Orchard & Seward, 2002). The study demonstrated that each Premiership club sustained on average 7.5 (range 1-20) hamstring injures each season, this is slightly higher than results from Woods et al. (2004) who demonstrated that in professional soccer each club would sustain 5 hamstring injuries per season.

With the high seasonal burden of hamstring injuries being demonstrated by Brooks et al., (2006) and Woods et al., (2004), quick and accurate assessment and diagnosis of injury is of utmost importance in elite sport (Kerkhoffs et al., 2012) & Malliaropoulos et al., 2010). If clinical assessment is completed accurately, it can inform rehabilitation; provide an estimate regarding the length of rehabilitation and therefore give clearer timescales for return to sport. Assessment of a hamstring injury should include a subjective history taking, physical examination, assessment of strength, ROM at the hip and knee as the hamstrings are biarticular, palpation and if required or accessible radiographic imaging (Heiderschiet et al., 2010).

Diagnosis of injury is based upon findings from a detailed clinical assessment and knowledge on injury mechanism, location and severity (Askling et al., 2002, Hoskins & Pollard, 2005 and Macdonald et al., 2019). Treatment of acute hamstring injury focuses on healing, pain reduction and minimising scar tissue formation and like rehabilitation and injury prevention should be based upon findings from a detailed clinical assessment and knowledge on injury mechanism, location and severity Hoskins & Pollard, (2005). Rehabilitation focuses on the use of exercise to return the player to optimal fitness with minimal risk of recurrent injury (Heiderschiet et al., 2010).

Rehabilitation of hamstring injuries is complex Sherry & Best, (2004), multifactorial and should be progressive (Coole & Gieck, 1987, Askling et al., 2010 and Macdonald et al., 2019). Authors concur that there is a need to improve both rehabilitation programmes (Askling et al., 2010 & Mendiguchia & Brughelli, 2011) and testing of hamstrings (Askling et al., 2010 and Whiteley et al 2018). Research shows that hamstring rehabilitation programmes should include eccentric strengthening (Crosier, 2002; Askling et al., 2003; Brooks et al., 2006 & Crosier et al., 2008) and agility and trunk stability work Sherry & Best, (2004). However, only eccentric exercise has been shown to be effective at reducing the rate of hamstring injury (Crosier 2002; Askling et al., 2003; Brooks et al., 2006; Proske; Gabbe et al., 2006; Arnason et al., 2008 & Petersen et al., 2011). According to Crosier, (2002) the eccentric hamstring programme should be individualised and sports specific.

Due to high levels of recurrent hamstring injuries shown by Woods et al., (2004) and Brooks et al., (2006) especially within one month following return, there has been speculation that current rehabilitation protocols are not as effective as they could be Mendiguchia & Brughelli, (2011). It may also indicate that players are being exposed to greater training and playing demands too soon and returning to play before the hamstring has healed or can manage the load required. A multidisciplinary approach to hamstring management has been advocated Croisier et al., (2008) and should be specific to the type, severity (Kujala et al.,1997) and the location of the injury (Askling et al., 2006).

Despite a recent increase in the amount of research surrounding the management of hamstring injuries, there remains limited evidence or consensus regarding the best or most effective way to treat, rehabilitate, safely return an athlete to sport (Worrell & Perrin 1992; Sherry & Best 2004; Hoskins & Pollard 2005; Orchard et al., 2005 Pizzari et al., 2010 and Macdonald et al., 2019) and what the best methods for hamstring injury prevention are. There is little efficacy regarding the treatment and rehabilitation techniques for hamstring injury (Brukner et al., 2013), therefore it is imperative that this is carried out in order to construct successful rehabilitation programmes (Hoskins & Pollard 2005 & Brukner et al., 2013) and to minimise the number of recurrent injuries.

Very little is known about how hamstring injuries are managed within elite rugby union. The aim of this study is to identify current practice in the diagnosis, treatment, rehabilitation and prevention of hamstring injuries in elite rugby union clubs and the National senior squad.

6.2 Methods

See chapter 3.

6.3 Results

6.3.1 Clinical assessment

The clinical assessment methods used to assess acute first-time hamstring injuries were manual muscle tests (strength), palpation, muscle length tests (flexibility), range of motion and neural tests. Practitioners did not state if any equipment was used to quantify assessment, such as dynamometers or inclinometers. The number of practitioners using these methods are shown in table 7.

Table 7: Clinical assessment methods used by practitioners to assess acute first-time hamstring injuries. (NB participants were allowed more than one answer).

Clinical assessment method	Number of practitioners using method
Manual muscle tests (Strength)	8 (6 physiotherapists, 2 doctors)
Palpation	6 (5 physiotherapists, 1 doctor)
Muscle length tests (Flexibility)	6 (5 physiotherapists, 1 doctor)
Range of movement (ROM)	6 (3 physiotherapists, 3 doctors)
Neural tests	6 (4 physiotherapists, 2 doctors)

Double or single leg bridge tests were the most frequently used manual muscle tests for pain provocation and testing the strength of the hamstring muscles with 50% of practitioners reporting using them in the assessment of acute first-time hamstring injuries. Other less frequently used tests included assessment of eccentric strength, inner/mid/outer range strength and raging bulls.

The majority of practitioners (13/18) used diagnostic imaging like ultrasound or (MRI) to assist the assessment and diagnosis of acute hamstring injuries. Only two practitioners did not use diagnostic imaging to assist with clinical assessment and diagnosis. One of the practitioners who did not use diagnostic imaging felt that the diagnosis of an acute hamstring injury could be made very specific without the use or MRI or US. One practitioner only uses diagnostic imaging for recurrent hamstring injuries.

6.3.2 Treatment

The most common forms of treatment used by practitioners in the acute stage of healing (0-72 hours post injury) were protection, rest, ice compression and elevation (PRICE) (used by 8 practitioners), injection therapy (used by 5 practitioners), analgesia and soft tissue techniques (both used by 3 practitioners) were. Further modalities were not reported as they were only used by one or two practitioners. (NB participants were allowed more than one answer).

In the sub-acute stage of healing (72hrs up to 21 days post injury), there was less variation in treatment modalities. The most commonly used treatment modalities were soft tissue techniques (used by 5 practitioners), analgesia (used by 3 practitioners) and acupuncture (used by 3 practitioners). Practitioners used fewer treatment modalities in the late stage of healing (beyond 21 days post-injury). There was general agreement between doctors and physiotherapists regarding the use of soft tissue techniques and acupuncture.

6.3.3 Rehabilitation

6.3.3.1 Stages of rehabilitation

Symptoms, functional and clinical tests were used as progression criteria between the stages of rehabilitation. The most frequently occurring responses are shown in table 8.

Table 8 The most frequently occurring progression criteria used by practitioners during rehabilitation. (NB participants were allowed more than one answer).

Early to mid-stage progressions	Responses
By symptoms	Check symptoms the next day Checking the pain-resistance relationship Pain free contractions Pain free palpation of the injured area
By clinical test	Strength, power, ROM, weight-bearing, neural (SLR) and flexibility tests Need to clear Lumbar spine
Mid stage to late Stage progressions	
By symptoms	Pain and/or soreness The player must not react to the previous loading
By clinical test	ROM Strength Right equals left The player needs to be near their pre-injury levels
By function	Relate to speed and agility Based on 20m-20m-20m acceleration, hold and deceleration protocol 80-90% full speed and pain-free
Late stage to pre discharge stage progressions	Responses
By clinical test	Negative tests on all objective markers ROM Strength Right equals left
By function	Speed tests Clearing rugby specific drills High-speed drills repeated under fatigue with no reaction

Only half of the practitioners modified progression criteria according to the mechanism, location and/or severity of the hamstring injury.

Table 9 shows the rehabilitation exercises used by physiotherapists and the timing of their introduction were varied.

Table 9: Exercises used by physiotherapists and the rehabilitation stage they are introduced. (NB participants were allowed more than one answer).

Exercise	Early-stage rehab	Mid stage rehab	Late-stage rehab	Predis-charge stage	Post return to sport
ROM (Range of Motion)	8	6	7	1	2
Flexibility	6	6	7	1	2
Isometric Strength	7	6	6	1	2
Concentric Strength	6	9	7	1	2
Eccentric Strength	3	9	7	1	3
Endurance Strength	2	8	7	0	1
Power	0	3	8	0	1
Running	1	8	7	1	1
Speed	0	2	7	2	1
Core stability/strength	9	6	7	1	1
CV (Cardiovascular)	4	7	8	1	1
Agility	1	3	7	1	2
Sport Specific drills	0	4	1	2	1
Conditioning work	4	5	6	0	1
Neural exercises	1	1	2	0	2
Gluteal Strengthening	0	1	1	0	1
Hydrotherapy	6	5	7	0	0
Proprioception	1	0	0	0	0
SAQ (Speed, Agility, Quickness)	0	1	1	0	0
Muscle Stimulation	1	1	1	0	0

6.3.3.2 Running

An area of inconsistency between practitioners was the introduction of running in the mid stage of rehabilitation. With, one practitioner introducing running within the early stage and one practitioner introducing running as soon as possible, another said it depends on pain, and another practitioner noted, *“we are not interested in time frames”.* Running progression criteria in rehabilitation also varied considerably between practitioners. Most practitioners indicated that running was progressed using a 20 m acceleration, 20 m hold and 20 m deceleration protocol. Running distance was changed in order to load the hamstring more. The monitoring of symptoms as an indication of readiness for increasing training loads was a common theme.

6.3.3.3 Speed

The introduction of speed work into the rehabilitation programme varied between practitioners. Most agreed that good performance during linear running was an important factor in when deciding to introduce speed to the rehabilitation programme however, no practitioner defined a ‘good performance’. A follow up question here would have been beneficial to establish what was meant by ‘good performance’. One practitioner waited until completion of several sessions of sub-maximal ‘tempo’ runs, whilst another practitioner introduced speed training once players had trained for two weeks and completed a ‘conditioning’ block of low intensity running. Some practitioners stated that speed is introduced during a specific time these included mid stage, in the late stage or in the return to training stage. In contrast another practitioner said there were no time frames as the introduction of speed was based on symptoms. Only one practitioner stated the introduction of speed into the rehabilitation programme would depend on severity of the hamstring injury. Practitioners generally agreed that speed was progressed in either 10 or 15% increments over set distances until players reached maximum speed, however no practitioner stated if this was quantified and therefore a question to probe this would have been beneficial.

6.3.3.4 Multi-directional Running

As with running and speed, the introduction of change of direction work in rehabilitation was varied. Some practitioners introduced change of direction work within the early stage, others waited until late stage. An area of consistency between practitioners was evident as many were insistent that players reached other criteria first; one stated that they start change of direction work as soon as the player can jog; another that they introduce it as soon as possible - but at a low pace. The majority of practitioners focused more on players reaching a certain speed before change of direction is introduced, with one stating that they introduce change of direction when straight line speed is at 80-90% of their maximum. Many practitioners used T-runs, figure of 8 runs and shuttle runs to monitor players' progression. The angles of the runs were made more acute and distances changed to make them more demanding as time progressed. Some practitioners introduced stop-starts and unplanned movements, progressing exercises from closed to open skills and thereby better mimicking game dynamics. One practitioner used cross-training, having players play squash as changes in direction are unplanned and multi-directional.

6.3.4 Return to sport

Eighty percent (8/10) of practitioners use specific standardised or individualised return to rugby criteria following hamstring injuries. Return to rugby criteria varied between practitioners, but most reported that they depend on the player, the injury and playing position. Some practitioners require the player to pass clinical tests

(ROM, strength and neural) before they can return to sport. One practitioner will re-scan (ultrasound) the injury before allowing return to sport. Nearly all practitioners use field-based tests including running without problems, maximum speed testing and max velocity running drills.

6.3.5 Screening and Injury prevention

All participants implement injury prevention programmes; however, these did differ in content. The majority of clubs screen their players in the pre-season period but the best way to screen for players at risk of hamstring injury remains unclear as there was a wide discrepancy in the nature and extent of hamstring injury screening that participants employed.

6.3.6 Participant beliefs

The majority of participants believed that first time hamstring injuries and recurrent injuries could be prevented though managing load.

6.4 Discussion

The aim of this study was to identify current practice in the diagnosis, treatment, rehabilitation and prevention of hamstring injuries in elite English rugby union clubs and the National senior squad. Rehabilitation and injury prevention of hamstring injuries in elite rugby union and the National senior side was varied and shows no consensus on the management of hamstring injuries. This finding agrees with previous research by Worrell & Perrin, (1992); Croisier, (2004); Hoskins & Pollard (2005); Pizzari et al., (2010) & Malliaropoulos et al., (2010). In contrast, there was greater consistency in the assessment and treatment of hamstring injuries between clubs and practitioners. This may be due to the fact that most treatment strategies are based around the well-established PRICE and protect, optimal loading, rest, ice, compression and elevation (POLICE) protocols to reduce inflammation (ACPSM, 1998). Hamilton (2012) states, that the foundations for the current strategies used for the management of hamstring injuries were established by the mid-20th century. Despite these advances, we have only made small progress in the understanding of the highly prevalent and complex injury (Mendiguchia & Brughelli, 2011). Research also shows greater evidence regarding treatment of hamstring injuries, compared to rehabilitation. In recent years, treatment-based studies have increased in quality, to include RCTs, systematic reviews and meta-analysis of hamstring injuries (Hamilton, 2012). However, Hamilton, (2012) still highlights limited evidence base for the management of hamstring injuries. It maybe because of this those practitioners are also able to translate research in to practice easier.

An accurate clinical assessment is a critical step towards the successful management of hamstring injuries (Sherry, (2012) and Kerkhoffs et al., 2013). The current study shows that there are some areas of consistency, however variation exists between practitioners on the best way to objectively assess hamstring injuries, this supports previous studies Hoskins & Pollard, (2005) and Malliaropoulos et al., (2010). The current study demonstrates that there does not appear to be a single test that is widely adopted for diagnosing hamstring injuries, identifying their severity, or predicting time to return to play. Instead, the majority of practitioners rely on several tests, perhaps because there is still little evidence to show the validity of individual tests (Whiteley et al., 2018).

In all cases, treatment commences as soon as the hamstring injury occurs, the current study shows more treatment modalities were used in the early stage of treatment than the late stage. However, there was some consistency in the treatment of hamstring injuries in the later stages of treatment. Soft tissue techniques and acupuncture were used by the majority of practitioners within the late stage. Rehabilitation techniques are varied between practitioners, with many different techniques being employed to rehabilitate hamstring injuries. The biggest area of disagreement in this study related to when running, speed and multi-directional running exercises should be introduced into the rehabilitation programme. There was also a lot of variation on the use of progression criteria. There was no agreement between practitioners regarding the appropriate progressions during rehabilitation. This lack of agreement extended to the inclusion of sprinting and change of direction drills into rehabilitation programmes. There is no clear evidence in the literature surrounding running, high-speed running and rehabilitation. According to Whiteley et al., (2018) progressing running too quickly may aggravate the injury and exacerbate the symptoms which may mean the athletes return to play is delayed. However, if it too slow to progress, return to play may also be delayed.

No clear agreement was evident concerning the criteria for progression from one stage of rehabilitation to the next. Several practitioners used very specific progression criteria, such as the hamstring muscle length has to be less than 10% of the contralateral leg; the player has to subjectively report discomfort of 2/10 or less; linear running speed had to be at least 70% of the pre-injury level. Other practitioners used more general criteria. Half of the practitioners modified these criteria according to the mechanism, location and/or severity of the hamstring injury.

Existing research suggests that these factors should be considered and influence subsequent rehabilitation of hamstring injuries (Heiderschiet et al., 2010). However, again we do not know if this was visual or measured as probing questions were not asked.

Predicting time to return to play is difficult, but it is always one of the first questions asked by players, coaches and managers. Not all practitioners in the study used either specific standardised or individualised return to rugby criteria for hamstring injuries. There was large variation in practitioners return to sport criteria that were employed with little agreement on how to determine if a player was ready to return to play. Tests are useful for practitioners when evaluating if a player is ready to return to play. Askling et al., (2010) proposed that an active hamstring flexibility test is reliable and could compliment the clinical assessment process and prove useful if included in a standardised return to play protocol. Sherry, (2012) proposed that the ability to walk without pain can be used to predict return to sport. A study conducted by Malliaropoulos et al., (2010) showed that active knee extension ROM proved to be both an objective and accurate measure for predicting recovery time from first time hamstring injuries Malliaropoulos et al., (2010).

Hamstring injuries have a high level of recurrence (Brooks et al., 2006; Mendiguchia & Brughelli, 2011 & Brukner et al., 2013). Brooks et al., (2006) demonstrated that hamstring injuries were the second most common match injury to recur. Recurrent hamstring injuries also tend to be more severe (Brooks et al., 2006). Despite this, almost all of the participants agreed that hamstring injuries and their recurrence could be reduced, and screening for certain factors may play a vital role, a view that is supported by Kerkhoffs et al., (2013) & Gabbe et al., (2006). However, there was a wide diversity in the nature and extent of hamstring injury screening that clubs employed. The majority of clubs did screen their players in the pre-season period but the best way to screen for players at risk of hamstring injury remains unclear. All participants used hamstring injury prevention programmes, but some were more formal than others, and there was no agreement or consistency as to what should be included.

6.4.1 Limitations:

Only elite level clubs were involved in the study. Therefore, we cannot make any inferences on how hamstring injuries are managed at lower levels. The results also only give a national perspective (UK) not international. Results of the current study only include those from lead doctors and physiotherapists. It does not consider other medical practitioners within the club. Comparisons to other sports is difficult as is the first study of this nature within rugby union. We can only compare to a recent AFL study (Pizzari, et.al., 2010). Rehabilitation, return to play and injury prevention of hamstring injuries in elite Rugby Union and the National senior side was varied and shows no consensus on the management of hamstring injuries. However, some areas of consistency were evident in the assessment and treatment of hamstring injuries. Questions did not probe (due to the fact that this was not allowed by the Gatekeeper) how practitioners quantified assessment methods, rehabilitation or progression criteria. Therefore, it appears that practitioner are basing their assessment and rehabilitation on subjective analysis and pain responses. The Gatekeeper outlined before the pilot study started that deviation from the approved questions was not permitted. This has meant that some responses have left more questions, these have been highlighted throughout the study. Looking at levels of consensus within responses would strengthen the study, however this was not the aim of the study. Seeing levels of agreement and consensus would give more in depth analysis.

6.5 Conclusion

The study shows that the management of hamstring injuries is varied and shows no consensus on the management of hamstring injuries. However, commonality is seen in the areas explored from assessment, through to beliefs. Results of the study can be used to help guide and develop the management of hamstring injuries at all levels of rugby union. It is vital for clinicians to develop individual and evidence-based assessment, treatment and rehabilitation protocols that highlight the complexity of this group of muscles. In addition, the study can be used to guide future research into the management of hamstring injuries.

Chapter 7

Hamstring injuries in elite English Rugby Union: A survey of strength and conditioning practice

7.1 Introduction

Hamstring injuries are a complex problem for all involved in the management of them (Worrell et al., 1992 & Croisier et al., 2002) and a multidisciplinary approach to hamstring treatment is recommended (Croisier, 2004). Croisier, (2004), and Opar, Williams & Shield, (2012) highlight the importance of everyone who is involved with hamstring injures understanding of their complexity and how to manage them, in order to help reduce the incidence of acute first-time injuries (injury reduction) and to minimise the time away from sport. Traditionally, physiotherapists oversee the management of injury however, strength and conditioning staff are now involved in the management of injured athletes and will work collaboratively together (Armstrong et al.,2021). Although the S&Cs role is not clearly defined, previously it has been proposed that the S&C practitioner should be involved in later stages of rehabilitation and training prior to the athlete returning to sport (Kraemer et al., 2009). However, Reiman & Lorenz (2011) suggest S&C principles such as periodization, maximal strength training and sports specific training should be integrated into rehabilitation. There is only one study to look at how these roles are conducted in practice. One study by Armstrong et al, (2021) has explored the perspectives of physiotherapists and S&C coaches in New Zealand on the role of S&C coaches in athlete rehabilitation. The study noted that most of the S&C coaches only had a small role in conducting performance training at the end of rehabilitation prior to the athlete returning to sport, however they thought they should be involved earlier in the injury management stage. They identified barriers to this including poor communication, and poor collaboration with the physiotherapists. S&C coaches in New Zealand suggest that they should be more involved in injury management following a diagnosis. Another study to look at S&C practices was conducted by Jones et al., (2016). They looked at the variances in S&C practices in elite rugby union to compare northern and southern hemisphere teams. However, the current study and the study by Armstrong et al., (2021) only focused on S&C practices for non-injured players and the current study is looking at their involvement in the injury management process. Chapters 4, 5 and 6 have provided an insight into the management of hamstring injuries from a medical practitioner's point of view, and there is a plethora of information surrounding strength and conditioning practices for non-injured athletes, but very little is known about how hamstring injuries are managed from a strength and conditioning point of view within elite rugby union. The aim of the study was to examine current practice in the diagnosis, treatment, rehabilitation and prevention of hamstring injuries in elite Rugby Union clubs and the National senior squad from a strength and conditioning perspective.

Strength and conditioning (S&C) and training with a specialised S&C coach is usually part of a non-injured athletes training to build, maintain physical fitness and optimise performance (Triplett et al., 2017). Rehabilitation and S&C training should aim to develop athlete's functional abilities whilst minimising injury risk (Mendiguchia & Brughelli, 2011) they are usually seen as separate phases within an athlete's recovery process (Reiman & Lorenz, 2011). Chapters 4, 5 and 6, demonstrate that physiotherapists report taking charge of the assessment, treatment, rehabilitation, RTP and injury prevention work with S&C staff stating they follow what the physiotherapist has prescribed. Rehabilitation is a process that injured athletes undertake prior to returning to sport under the care of a sports therapist, sports rehabilitator or physiotherapist. Rehabilitation will usually include a series of low risk, high demand movements (Mendiguchia & Brughelli, 2011) that will progress as healing takes place and musculoskeletal adaptations occur within the components of rehabilitation being targeted. As the healing process within the hamstring advances from the initial inflammatory phase to muscle regeneration, scar tissue formation and though to remodeling there will be a gradual increase in strength, flexibility and neuromuscular control, coupled with this, there will be an improvement in function. With this, there is a need for the athlete to transition from rehabilitation and care of the physiotherapist into strength and conditioning work with the S&C staff. For this to be successful, clear communication between the staff involved and an understanding of what has been completed so far and what will be completed next is imperative. The importance of eccentric exercise in rehabilitation is advocated by Crosier et al., (2002); Askling, Karlsson & Thorstensson (2003); Brooks et al., (2006); Brockett, Morgan & Proske (2004), Arnason et al., (2006), van der Horst et al., (2014) and Bourne et al., (2017). Eccentric exercise has been shown to reduce recurrent hamstring injuries (Petersen et al., 2011) and to provide a protective mechanism against hamstring injury (Brockett et al., 2006 and Askling et al., 2013).

A common criticism of recent studies previously highlighted regarding rehabilitation of hamstring injuries is the lack of research into how adjacent muscles and groups of muscle contribute to hamstring strength and function and how different rehabilitation protocol outcomes compare (Macdonald et al., (2019). Sherry & Best, (2004) were one of the first studies to look at bridging the gap between conventional hamstring rehabilitation by comparing 2 rehabilitation programmes, one consisted of progressive agility and trunk stabilisation exercises (PATS) and the other isolated hamstring stretching and strengthening (STST). They demonstrated a significant reduction in recurrent hamstring injuries when athletes were treated with progressive agility and trunk stabilization work compared to the traditional isolated strength and flexibility approach. The authors concluded that a rehabilitation programme should therefore comprise of progressive agility and trunk stabilization exercises rather than isolated hamstring stretching and strengthening exercises.

Sports medicine practitioners and sports injury researchers alike need to appreciate the complex nature of HSIs and understand that no one-single approach can be considered the gold standard for HSI prevention or rehabilitation. For example, understanding the different types of hamstring injuries and how their rehabilitation will differ is important. Askling et al., (2006) and Askling et al., (2012) show that if practitioners understand high-speed running hamstring injuries generally have a greater initial physical impairment, and require a less aggressive rehabilitation approach early on, but usually have shorter rehabilitation periods. This is in contrast to the slow stretch hamstring injuries which have less physical impairment initially and therefore, can be progressed more rapidly in the earlier stages of rehabilitation. However, the slow stretch hamstring injuries will require a prolonged period of rehabilitation.

However, it is now becoming increasingly accepted that many S&C principles can be integrated into the rehabilitation phase and used with injured athletes.
Chapter 5 demonstrated that S&C staff would like to become more autonomous rather than involved in the rehabilitation phase and more strength and conditioning

staff are becoming part of the rehabilitation process. However, there is very little literature available on how to implement S&C principles into the rehabilitation process (Reiman & Lorenz, 2011 and Armstrong et al., 2021).

There is still no real agreement regarding the best way to rehabilitate hamstring injuries, safely return an athlete to sport (Worrell & Perrin, 1992, Sherry & Best, 2004, Hoskins & Pollard, 2005, Orchard, Best & Verral, 2005 and Pizzari, et al., (2010) and what the most effective methods for prevention are. The efficacy of rehabilitation techniques should be explored and established in order to make rehabilitation successful (Hoskins & Pollard, 2005, Brukner et al., 2013 and Macdonald et al., 2019) Rehabilitation of hamstring injuries is complex, Sherry & Best, (2004) and multifactorial and should be progressive, Coole & Gieck, 1987, Askling, Nilsson & Thorstensson, (2010) and based on MOI (Askling et al., 2006) and classification of injury (Macdonald et al., 2019). Authors agree that there is a need to improve both rehabilitation programmes and testing, (Askling, Nilsson &Thorstensson, 2010, Mendiguchia & Brughelli, 2011 and Macdonald et al 2019). Due to high levels of recurrent hamstring injuries, there has been speculation that current rehabilitation protocols are not as effective as they could be, Mendiguchia, Alentorn-Geli & Brughelli, (2012) with no studies comparing rehabilitation protocols (Macdonald et al., 2019). Research shows that hamstring rehabilitation programmes should include eccentric strengthening (Croisier, Ganteaume, Binet, et al., 2008, Brooks et al., 2006, Crosier, et al. 2002 and Askling, Karlson & Thorstensson 2003) and agility and trunk stability work Sherry & Best, (2004). However, only eccentric exercise has been shown to be effective at reducing the rate of hamstring injury Brooks et al., (2006), Crosier, et al., (2002), Askling, Karlson & Thorstensson (2003), Brockett, Morgan & Proske (2004) and Gabbe, Branson & Bennell (2006). According to Croisier, et al., (2002) the eccentric programme should be individualised and sports specific. Macdonald et al., (2019) has advocated that rehabilitation protocols should be planned based on the classification of injury. Rehabilitation programmes should follow the principles outlined by Macdonald et al., (2019), these are: include an accurate diagnosis that follows the BAMIC injury classification, work collaboratively with the medical and science team, utilise shared decision making by involving the coach and athlete, train the muscles and movement pattens, prescribe strength exercises (develop high eccentric force, increase hamstring fascicle length, develop muscle-tendon unit specificity, work on fatigue resistance and overcome inhibition, apply individual non reductionist approach with a focus on risk factors. However, all of the work by Macdonald is based on British Athletics and therefore work needs to be carried out to see if these principles can be transferred into other sports.

Due to the fact that acute first-time hamstring injury and recurrent injury rates have not reduced over the last three decades Ekstrand, Hägglund & Waldén, (2011) despite changes to training, rehabilitation and prevention methods. High incidence and risk of injury, combined with poor and slow healing times, Mendiguchia, Alentorn-Geli & Brughelli, (2012) and complex and lengthy rehabilitation Croisier, et al., (2008) means that developing knowledge and gaining an insight in to current practice in the management of hamstring injuries is important, in order to reduce the risk of both first time and recurrent injury. The current study is not able to compare with other rugby union studies as this is the first to look at S&C practices for acute first-time hamstring injuries. The aim of this study is to identify current strength and conditioning practice in the diagnosis, treatment, rehabilitation and prevention of hamstring injuries in elite RU clubs and the National senior squad. The research question is: How are acute first-time hamstring injuries managed from a strength and conditioning perspective in elite English rugby union?

7.2 Methods

See methodologies chapter.

7.3 Results

7.3.1 Treatment

Strength and conditioning practitioners were not involved in the treatment of hamstring injuries.

7.3.2 Rehabilitation

All 8 S&C practitioners reported using both standardised and player specific rehabilitation protocols. Three S&C practitioners reported that the rehabilitation protocols for each stage of rehabilitation (rehabilitation definitions can be found in Appendix 4 were designed by the physiotherapist at the club. Table 10 shows the rehabilitation exercises designed by the physiotherapists and used by S&C practitioners and when they are introduced.

Table 10: Exercises designed by the physiotherapists used by strength and conditioning practitioners and the rehabilitation stage when they are introduced. (NB participants were allowed more than one answer).

Exercise type	Early-stage rehab	Mid stage rehab	Late-stage rehab	Predis-charge stage	Post return to sport
ROM (Range of Motion)	1	2	3	3	2
Flexibility	1	1	1	3	1
Isometric Strength	1	2	2	3	2
Concentric Strength	0	2	2	4	3
Eccentric Strength	0	2	6	5	5
Endurance Strength	0	1	2	3	2
Power	0	0	4	5	4
Running	0	2	4	5	4
Speed	0	0	4	4	2
Core stability/strength	1	1	2	3	2
CV (Cardiovascular)	0	0	2	4	2
Agility	0	0	2	5	3
Sport Specific drills	0	0	2	4	3
Conditioning work	0	0	3	5	4

Symptoms and functional tests were used as progression criteria between stages of rehabilitation. The most frequently occurring responses are shown in table 11. Three S&C practitioners reported that progression criteria were set by the physiotherapist at the club which they then followed.

Table 11: The most frequently occurring progression criteria used by strength and conditioning practitioners during rehabilitation. (NB participants were allowed more than one answer).

Early to mid-stage progressions	Responses
By functional test	Speed testing Testing stability around the pelvis Strength and/or power ROM Weight-bearing Neural Straight leg raise (SLR) Flexibility tests
Mid stage to late stage progressions	
By symptoms	Pain and/or soreness during or after exercises
By functional test	Speed testing Based on 20m-20m-20m acceleration, hold and deceleration protocol Straight line speed must be 80-90% of full speed and pain-free Testing stability around the pelvis
Late stage to pre discharge stage progressions	Responses
By functional test	Speed testing Clearing rugby specific drills Drills must be repeated under fatigue with no reaction
Pre discharge stage to return to play progressions	Responses
By functional test	Rugby specific drills must be completed Speed and high-end velocity drills must be completed with and without a ball Complete fatiguing sessions

	Multidirectional sessions with acceleration and deceleration

There was some commonality shown surrounding progression criteria, as 3 S&C practitioners modified progression criteria according to the mechanism, location and/or severity of the hamstring injury. However, none of the participants stated how these are measured and the metrics used. Two stated they do not and 3 reported the physiotherapist would make the decisions. Of the three S&C practitioners that did modify progression criteria, one changed the criteria according to the severity of the injury whereas, 2 reported that mechanism of injury (MOI) would determine progression; one reporting that if the MOI was high-speed running, then progression in running drills will be slower than other components. The other reported that if the MOI was high intensity running, that would be the main focus of rehabilitation and progression criteria would be based on the MOI.

7.3.2.1 Running

The introduction of running in to rehabilitation varied between the S&C practitioners. However, there was some consistency as 3 reported that all running in rehabilitation is conducted by the physiotherapist(s), 3 S&C practitioners stated that running is introduced in the mid stage with one saying late stage of mid stage. One S&C practitioner stated that as a strength and conditioner he only gets the injured player for running work when they are doing other S&C work. Most S&C practitioners agreed that running was progressed using the 20-metre acceleration, 20-metre hold and 20-metre deceleration protocol. This is due to the fact that it is set by the physiotherapists and therefore the S&C practitioners are unable to make changes.

Two S&C practitioners progressed running after assessing gait patterns for asymmetries and looking at running.

7.3.2.2 Speed

There was no real consistency as to when speed work was introduced into the rehabilitation programme and responses varied between S&C practitioners. Some suggested that speed should be introduced in the mid stage, with one strength and conditioning staff stating that when the injured athlete is running at 80% of their maximum speed, speed work should be introduced. Only two S&C practitioners felt that the introduction of speed should depend on the individual or the position played. One S&C practitioner said that speed work was introduced in the return to training phase (pre-discharge) and interestingly one S&C practitioner stated that there is always an element of speed in rehabilitation. S&C practitioners generally agreed that speed was progressed after certain other components were met, these included after acceleration work, after speed, agility and quickness (SAQ), after technique and mobility and one stated speed was progressed after the conditioning bock. Only one stated speed was progressed based on the injured players times. Another S&C practitioner was not involved with speed and speed progressions as it was taken and lead by the speed coach.

7.3.3.3 Change of direction

As with running and speed, the introduction of change of direction work in rehabilitation was varied. One of the S&C practitioner stated that change of direction work was within the early stage, but it was individual and specific, another said that at their club, the physiotherapist will decide. An area of consistency between the strength and conditioning practitioners was evident as several said that it depends on MOI or the severity of the injury. Six of the S&C practitioners stated that change of direction work was progressed using multidirectional runs, slalom and diagonal runs based around figure of 8s and S runs. The angles of the runs were made more acute and distances changed to make them more demanding as time progressed. One of the S&C practitioner stated that the physiotherapist will progress change of direction work, and another said that it depends on how the glute-hamstring activation is.

7.3.3 Sports Specific work

All 8 S&C practitioners stated that sports specific work was introduced as early as possible. One stated that sports specific work was implemented from the start in order to maintain skill sets. Two S&C practitioners said that it will depend on the position of the players as to when sports specific work will be introduced. Other responses included, "there is a gradual introduction of sports specific work", "we start introducing sport specific work when they are 1 week away from being totally fit", and another S&C practitioner stated that sport specific exercise is only introduced when they start doing full S&C work. Progression of sports specific work was varied, 5 S&C practitioners reported that progression is dependent on the position of the player, whereas 3 S&C practitioners stated the physiotherapist will decide how to progress the sports specific work.

7.3.4 Return to play

All S&C practitioners reported using specific standardised or individualised return to rugby criteria following hamstring injuries, three S&C practitioners stated that the physiotherapist at the club use their own RTP criteria. An important role of the S&C staff is to bridge the gap between rehabilitation and return to play, this is done in blocks of training that is overseen by the S&C practitioners. The majority of S&C practitioners used posterior chain exercises in the first block of training after late-stage rehabilitation. The most popular posterior chain exercises used included the Nordic hamstring exercises, they are used by 5 out of the 8 S&C practitioners, glute-hamstring-gastrocnemius raises, Romanian deadlifts, “good mornings”, supine hip bridging, and straight leg deadlifts. Two S&C practitioners included a lot of plyometric jumping and landing into this block of training, with more emphasis on landing and single leg work.

The volume and loading of these exercises varied depending upon the player, his position, when they were training, anthropometric considerations, strength, hip mobility, practitioner knowledge of fibre type and the muscle and the exercise(s) being performed. However, there seemed to be some agreement, and the most common strength training loading parameters was 3 to 5 sets of 4 to 8 repetitions.

Speed based drills used in the first block of training following completion of rehabilitation included variations of sprint drills, these included acceleration, max speed and deceleration, fast Nordics (the Nordic hamstring strength exercise), plyometrics (skipping, bounding and jumping) and Olympic lifting. Only one of the S&C practitioners stated that this phase was designed and lead by the physiotherapist.

Speed progressions in the first block of training after late-stage rehabilitation were varied and showed no consistent answers. One of the S&C practitioners stated that they do not isolated speed sessions. Some stated that speed progressions were dependent on the player (starter v nonstarter, first-time hamstring injury or recurrent hamstring injury and the type of hamstring injury), one stated it depends on how long they have been in the rehabilitation process for and when in the season it is. Other answers included, our speed progressions will take players from 80% - 100% and under fatigue, SAQ progressions are included for backs, and another stating 'it's just a continuation from late-stage rehabilitation' and one reporting that volume and intensity is increased week by week. Only 1 of the S&C practitioners reported using Global Positioning Systems (GPS) to monitor progression. Adding follow up questions focused on how outcomes are measured and quantified here would be beneficial. However, the stud did not allow this.

Volume and load in the first block of training after late-stage rehabilitation was managed in different ways by the strength and conditioning staff, 4 strength and conditioning staff reported using GPS to manage load and volume in the first training block following rehabilitation and another stated that they used heart rate monitors and rate of perceived exertion (RPE). Only one of the strength and conditioning staff differentiated between feet v off feet load and volume, interestingly, one strength and conditioner stated that "hamstring load and volume does not change, it is constant". Only 2 strength and conditioning staff made sure that sufficient recovery was given between sessions. All but one of the strength and conditioning staff ensure they modify other components of the first conditioning block post rehabilitation.

7.3.5 Screening and Injury prevention

Three S&C practitioners screen players to identify risk of hamstring injury. However, 5 S&C practitioners reported that the physiotherapist will perform the screening. Of the three that are involved in screening, one stated that “it is an opportunity once a year in August to get a detailed look at all components – strength, running, conditioning, working under fatigue and non-fatigued conditions and comparing right and left sides”. Another stated that the main focus of screening was a shuttle-based endurance test. They suggested that if the payers performed badly at this, they have a higher risk of hamstring injury. The final strength and conditioner stated that the screening was not formalised, but gym sessions would flag those at risk. All S&C practitioners implement injury prevention programmes, but they differ in content. Four S&C practitioners reported using eccentric strength exercises in their hamstring injury prevention programmes. Two of the S&C practitioners placed greatest emphasis on the Nordic hamstring exercise in particular.

Incorporating prevention work into regular gym sessions was mentioned by 2 S&C practitioners. One of the S&C staff stated that speed endurance work was the core component of the injury prevention programme whereas another reported using a lot of co-contraction and gluteal, hamstring exercises as part of the injury prevention programme.

7.3.6 Participant beliefs

S&C practitioner beliefs surrounding hamstring injuries were explored. Seven of the of the S&C practitioners believe it is possible to reduce the risk of first-time hamstring injuries, six stated that it was definitely possible, and one said it would depend on different factors, but he did not expand on what the factors would be. Six S&C practitioners think it is possible to prevent recurrent hamstring injuries in elite English rugby union, with four stating it would definitely be possible to prevent recurrent hamstring injuries in rugby union, with two stating they can possibly be reduced, both stated prevention of recurrent injuries is a key factor. Two S&C practitioners only stated yes, they did not discuss the answer further, further probing here would have been beneficial to gain more specific detail. S&C practitioners believe that concentric and eccentric strength, flexibility, hip mobility, strength endurance and core stability are the most important components of a hamstring injury prevention programme. Six of the S&C practitioners believe that modifying training load can aid hamstring injury prevention. One S&C practitioner stated that he believes players need to rest and recover completely before playing and training to allow the hamstrings to regenerate fully.

7.4 Discussion

The aim of the study was to explore current practice in the diagnosis, treatment, rehabilitation and prevention of hamstring injuries in elite English rugby union clubs and the National senior squad from the perspective of S&C practitioners was achieved. S&C practices based on rehabilitation and injury prevention of hamstring injuries in elite rugby union and the National senior side was varied and no agreement on the management of hamstring injuries from a S&C practitioner perspective was found. Results of the study supports previous research (Croisier, 2004, Worrell & Perrin 1992, Hoskins & Pollard 2005, Pizzari, et al., 2010 and Malliaropoulos & Maffulli 2012). However, some areas of agreement were evident in the rehabilitation and injury prevention of hamstring injuries. In a similar study, Jones et al., (2016) looked at the variances in S&C practices in elite rugby union to compare the northern and southern hemisphere teams. However, the study only focused on S&C practices for non-injured players. They found that S&C practitioners tend to become more involved in the management of acute hamstring injuries towards the end of the rehabilitation process as the player is moving away from the care of the medical team and approaching return to play and full fitness. This maybe because S&C practitioners have little knowledge about the injured athlete, or it may be because they have the knowledge, but there is little literature on how to implement S&C principles into rehabilitation (Reiman & Lorenz, 2011). For the transition between rehabilitation and S&C, there needs to be clear communication between the staff involved and an understanding of what has been completed so far and what will be completed next.

All 8 S&C practitioners in the study reported that the standardised and player specific rehabilitation protocols were designed by the physiotherapist which shows that physiotherapists play a vital role in the management of hamstring injuries. Table 10 shows that strength and condition staff have very little input in to the early and mid-stages of rehabilitation but become more involved as the player nears the later stages of rehabilitation and the return to sport stage. This demonstrates transition of care as the rehabilitation process progresses. With physiotherapists taking more care of the athletes when they are injured and S&C practitioners taking over and implementing S&C practices as the player return to full fitness.

Even though all of the S&C practitioners were aware of the progression criteria used to progress athletes from one stage of rehabilitation to the next, 5 stated that the progression criteria were set by the physiotherapist. The S&C practitioners stated they were only involved in testing. Interestingly, 3 S&C practitioners stated that they were involved in setting progression criteria. The 3 S&C practitioners that said they were involved in setting progression criteria reported that the criteria set, were modified according to the MOI, location and/or severity of the acute hamstring injury, this is an important part of rehabilitation according to Askling et al., (2006).

There were slight variations in the responses regarding the introduction of running in to rehabilitation, this is consistent with chapter 4. As running has been identified by Askling et al., (2000) as a cause of hamstring injuries, it needs to be a key factor in hamstring rehabilitation. However, Duhig et al., (2016) state the importance running in the rehabilitation of hamstring injuries. It has been reported by Duhig et al., (2016) that too much running, can have a detrimental effect on hamstring injury risk. As there is no agreement as to when running should be introduced into rehabilitation or how it should be progressed, designing running drills and protocols for hamstring rehabilitation is usually done based on anecdotal evidence and practitioner experience, whereas is should be based on empirical evidence form high quality studies. All 8 S&C practitioners reported that they used the 20-metre acceleration – 20-metre – hold – 20m deceleration protocol once running had been introduced, but there has been no research into this and how it affected by fatigue or how it should be progressed, therefore a follow up question here would be beneficial to see why it has been implemented. Where this has come from This is similar for many other running based drills and protocols.

Askling et al., (2000) demonstrated that high-speed running and explosive movements were responsible for causing hamstring injuries. Therefore, like running, speed drills and protocols must be fully understood if they are to be included into rehabilitation programmes. Due to the lack of research into how speed drills are affected by fatigue or, how they contribute to overall loading of the hamstrings it is now wonder the current study shows variation surrounding the introduction of speed work into the rehabilitation process. Progression of speed drills and protocols like running also showed some varied responses, One of the S&C practitioners reported that speed was progressed depending on the players times, or progressions were made by the speed coach at the club. Due to the variations in both the introduction of running and speed and how to progress these, future research needs to focus on optimal ways to introduce running and speed within a rehabilitation programme. Linked to speed is change of direction, a number of S&C practitioners said that introducing change of direction into rehabilitation was dependent on the MOI and severity of the injury. S&C practitioners reported that change of direction work was progressed using multidirectional runs, slalom and diagonal runs based around figure of 8s and S runs. One of the S&C practitioners said the physiotherapist decided when to introduce change of direction, and another said it was introduced at the start in early stage. These variations show that more research is required to help determine when to introduce change of direction into rehabilitation and when to progress it.

Responses relating to sports specific work being introduced into rehabilitation were varied. Several S&C practitioners said it was introduced as early as possible, others reported that it was gradually introduced, and one said, “it was not introduced until the player was 1 week away from being totally fit”. Progressing sport specific work was varied, with some saying it is the physiotherapist that decides and others saying it depends on the player's position.

Return to play is an important stage for the athlete and the staff involved in the management of an injured player. All of the S&C practitioners reported that they use specific and standardised return to rugby criteria, however 3 said that this was determined by the physiotherapist. With regards to what exercises to complete with injured athletes, the majority of S&C practitioners reported implementing posterior chain exercises. The most popular posterior chain exercise prescribed was the Nordic hamstring strength exercise. Other popular exercise prescribed were the glute-hamstring-gastrocnemius raises, Romanian deadlifts, 'good mornings' supine hip bridges and straight leg deadlifts. The Nordic hamstring strength exercise may have been the most popular response due to the increase in research on the exercise over the last few years with high profile papers showing that it can help reduce the risk of hamstring injury (Brockett et al., Brookes et al., 2006; Petersen et al., 2011) and its ease of use (Oakley, Jennings & Bishop, 2017). "There is a growing body of evidence on the Nordic hamstring strength exercise and its impact on hamstring injury reduction" Oakley, Jennings & Bishop, (2017, p.1). Despite the high-profile research on the Nordic hamstring strength exercise and the dissemination of the benefits the evidence-based research is not being adopted or adhered to in some elite level football clubs (Bahr, Thorberg & Ekstrand, 2015). This may explain the 4% annual rise in hamstring injuries noted by Ekstrand, Walden & Hagglund, (2016).

A possible reason for practitioners not fully adopting and adhering to the Nordic hamstring strength exercise may be because they are aware that it is not the only eccentric exercise to utilise during hamstring injury rehabilitation (Oakley, Jennings & Bishop, 2017). They may also prefer other eccentric based exercises, like the deadlift, single leg deadlifts etc. More studies are needed to show how each exercise compares and which is the best for specific grades of injury. Despite most research only focusing on the Nordic hamstring strength exercise. Translating research in to practice takes 17 years according to Morris, Wooding & Grant, (2011). There are often barriers to translating research in to practice (Murphy et al., 2021). Murphy et al., (2021) feel that often research can be lost in translation and implementation as practitioners do not feel they will get the same outcomes as the research study and have difficulties implanting the practice if they do not feel their participants match the ones used din the studies. It may also be down to the fact that new research takes several years to be filtered down in to practice, therefore, 'new' exercises in practice are sometime considered 'old' in terms of research. Caution must be applied when looking at research surrounding the Nordic hamstring strength exercise as most is carried out on highly trained athletes and those that are involved in field-based sports such as rugby union and football. Therefore, its use for the general population and other sports must be viewed with caution. Hamstring injuries have a high level of recurrence (Brooks et al., 2006 and Brukner et al., 2013). Recurrent hamstring injuries tend to be more severe and takes the injured player longer to return to play. Therefore, it is important to reduce the risk of both first time and recurrent hamstring injuries. Screening for injury and risk factors is an ongoing process and is common practice with athletes (Goldman & Jones, 2011).

All S&C practitioners reported that their players were screened for risk factor of hamstring injury. However, 5 stated that it was conducted by the physiotherapist at the club, one said it was done as part of a gym session where those deemed at risk would be flagged. Another reported the main focus of screening was a shuttle-based endurance test, if a player performed badly, they were considered at risk of a hamstring injury. Therefore, there is no agreement on how to screen player for hamstring injuries in elite English rugby union. All of the S&C practitioners reported implementing hamstring injury prevention programmes at their clubs, however, there were variations in the content of the injury prevention programme. Most stated that eccentric exercises were performed but there was no agreement as to which eccentric hamstring exercise.

Rehabilitation and strength and conditioning are usually seen as separate phases within an athlete's recovery process (Reiman & Lorenz, 2011). However, there are areas where we can see from the results that the medical teams are working alongside the strength and conditioning staff so that the management of acute hamstring injuries is more multidisciplinary, an approach advocated by Crosier (2004).

7.5 Limitations

A possible limitation of the current study maybe recall bias, where the S&C practitioners were not able to clearly recall information regarding the management of hamstring injuries at their club. Therefore, answers may not be as accurate or a true reflection of how hamstring injuries are managed. Future studies could conduct interviews and complete questionnaires after each phase on the injury so that we limit recall bias (Jackman et al., 2021). Participants responses may also be biased as at the time of the study hamstring injury research was at its peak, therefore, participants may have included in their answers what they had seen in the research, as they thought it was the correct answer or what was expected of them, even though it was not adopted by their club. Future studies should seek to reduce unconscious bias. The five clubs that did not take part may have chosen not to as they have higher hamstring rates than the clubs that did take part or did not want to share injury management procedures and processes, reasons for nonparticipation were not probed. Therefore, it would have been good to look at hamstring injury rates between the clubs that did take part and those that did not. However, this was not part of the study as the gatekeeper who links the clubs to the Rugby Football Union (RFU) felt this could be too contentious. The gatekeeper also did not allow further questioning an probing of answers during the interviews and completion of the questionnaires. This would have added more clarification, depth and detail to answers. Only lead strength and conditioners were included in the study, however some clubs have specialist rehabilitation S&C practitioners, one club employ a running S&C, so future studies should look at exploring the current practice of all members of the multidisciplinary team that are involved in the management of hamstring injuries to get an even clearer indication of how hamstrings injuries are managed are manged. This is the first study to look at the management of hamstring injuries from an S&C perspective, therefore further work needed to be able to make comparisons between other sports and to gain a greater understanding of how S&C practices are embedded into the management of other injuries.

7.6 Conclusion.

The study shows that the management of hamstring injuries is varied and shows no consensus on the management of hamstring injuries from a strength and conditioning perspective. However, commonality is seen in the areas explored from rehabilitation, injury prevention, through to beliefs. Results of the study can be used to help guide and develop the management of hamstring injuries at all levels of rugby union and assist the integration of S&C practices and processes into injury management. In addition, the study can be used to guide future research into the management of hamstring injuries from the perspective of S&C practitioners and multidisciplinary teams.

Chapter 8

Discussion.

8.1 Chapter outline.

In this chapter I will discuss the main findings from the thesis. I will also highlight the strengths and limitations of the study which will lead to future research recommendations.

8.2 Thesis discussion

The overarching aim of the thesis was to explore professional Sports Workers Practice in pursuit of Athlete Welfare with a focus on how hamstring injuries managed within elite English rugby union. The study has explored the complexities of what it means to undertake sports work in a professional setting with reference to the application of technical expertise and scientific knowledge and working in a MDT team. It has also sought to understand how lead doctors, lead physiotherapists and lead strength and conditioners manage hamstring injuries.

Prior work has documented that there is no consensus on how to manage hamstring injuries Worrell & Perrin, (1992), Croisier (2004), Hoskins & Pollard (2005), Pizzari, et al., (2010), Malliaropoulos et al., (2010), Mendiguchia & Brughelli (2011), Malliaropoulos & Maffulli 2012 and Buckthorpe et al., (2018). Previous literature has also indicated that little is known about how S&C practitioners integrate into the MDT and assist in the management of injuries (Jones et al., 2016).

For example, Pizzari, et al., (2010) report that assessment, diagnosis, and treatment showed some consistency however, there was more variation in the rehabilitation, injury prevention and return to play. However, this study was based in Australia and only considered hamstring injury management from a physiotherapists perspective. A study by Jones et al., (2016) found that S&C staff in New Zealand become more involved in the management of acute hamstring injuries towards the end of the rehabilitation process as the player is moving away from the care of the medical team and approaching return to play and full fitness. However, they only focused on S&C practices in New Zealand for non-injured players. In this study we have looked at the management of hamstring injuries from the perspective of the lead doctors, lead physiotherapist and lead strength and conditioners at elite English rugby union clubs. We found that rehabilitation and injury prevention of hamstring injuries in elite rugby union and the National senior side was varied and shows no consensus on the management of hamstring injuries in elite rugby union and the National senior side was varied and showed no agreement on the management of hamstring injuries However, there was some commonality in the assessment and treatment of hamstring injuries. These findings agree and support previous research by Worrell & Perrin, (1992), Croisier (2004), Hoskins & Pollard (2005), Pizzari, et al., (2010) Malliaropoulos et al., (2010), Mendiguchia & Brughelli (2011, Malliaropoulos & Maffulli 2012 and Buckthorpe et al., (2018). In addition, the study shows that the practitioners working in elite English rugby union have high level of technical expertise and scientific knowledge with most of what they implement coming from research, therefore it appears that they are translating research in to practice. However, no practitioners mentioned specific research or literature.

This study therefore indicates that the management of hamstring injuries in elite English rugby union is varied, with some commonality in assessment and treatment. More variation was found in the rehabilitation, RTP and injury prevention. The practitioners work within a MDT and most physiotherapists lead the management process. Most notably this is the first study to look at how hamstring injuries are manged in elite English rugby union from a lead doctor, lead physiotherapists and lead S&C perspective. And the first study to explore professional Sports Workers Practice in pursuit of Athlete Welfare with a focus on how hamstring injuries managed within elite English rugby union. However, some limitations are worth noting which are outlined in the next section.

8. 3 Strengths and limitations of the study

8.3.1 Strengths

The study is the first of its kind to look at how hamstring injuries are manged in elite English rugby union include doctors, physiotherapists and strength and conditioners therefore giving us more of an insight in to how practitioners work within an elite setting. Literature surrounding how hamstring injuries are managed within the wider context of professional sports work and athlete welfare is scant, and most that is out there only focuses on physiotherapists, or doctors, or doctor and physiotherapists perspectives. It is also the first study to look at not just what is implemented but the complexities and process behind the management with regard to technical expertise and scientific knowledge, professional attributes and beliefs.

The qualitative mixed methods approach to the study had been beneficial as it has meant we can see what is done and implemented but it has also allowed us to explore and analyse themes within the management of hamstring injuries.

The study design and subsequent interviews were deemed successful and as I researcher I gained positive feedback following the pilot study, in terms of question design, the way I conducted myself during the interviews and the professionalism I showed. As a result, the gatekeeper of the study allowed me full access to the Premiership Clubs and the National squad.

8.3.2 Limitations

When designing a qualitative MMR study, participant numbers is an important factor to consider. High participant numbers are well suited to online surveys and questionnaires as they are less time consuming as they do not require face to face contact. Therefore, they are quicker to conduct. However, they do not allow for different avenues to be explored (Harper & McCann, 2017) Semi structured interviews allow this deeper exploration, but the trade-off is usually working with smaller participant numbers. The narrative collected from the semi-structured interview requires the researcher remain neutral and they must try to remain detached from the data and not impart their own beliefs, bias and thoughts during the thematic content analysis. In keeping with constructivist deign the role of the researcher is to recognise their own positionality and potential bias yet stay impartial and analyse the data to provide a trustworthy and accurate account of participant's experiences which imparts new knowledge and enriches existing data. Upon reflection, this was achieved and as a researcher I was able to be completely impartial during the interviews. As I was unable to probe questions and delve deeper in to answers I have missed out on some data however allowed me to listen carefully and allow the practitioners to talk freely. As a new qualitative researcher, I had no previous experience thematic analysis and therefore went into the process with no preconceived ideas or thoughts.

Semi structured interviews are based on the interpretation of language. Language can cause confusion, bias, misinterpretation and confusion. The researcher will need to recognise how the research language can affect analysis, we need to move away from what we think and what we assume and acknowledge our preconceived ideas in order to analyse the data impartially (Hughes, Kohe & Purdy, 2019). Recognising this and employing methods to increase research rigour and trustworthiness are vital in order to reduce the ambiguity of language. Issues with understanding what is being said, making assumptions and incorrect inference can reduce the reliability of these types of study. Having said that there is a notion that what we take from the interviews it will still be authentic. As researchers relying on the use of language for data collection, should we be doing more to consider how language used could affect data acquisition (Hughes, Kohe & Purdy, 2019). To mitigate against this during the is study, all participants were sent a respondent's pack (see Appendix 4) that clearly outlines terminology and definitions. As a researcher we need to decide whether the recount of what they do and the summary of how things are done is authentic? Trustworthy? And dependable. Despite these limitations there is an understanding that narrative they give will be authentic (Hughes, Kohe & Purdy, 2019). Hughes, Kohe & Purdy, (2019) invite researchers to engage in and challenge the way in which their data is obtained more within qualitative research. As they argue this may lead to more authenticity within the research.

Reducing bias within qualitative research is important. In this research, member checking was undertaken to reduce the amount of bias within this thesis and to increase rigor and trustworthiness. Bias, according to Polit & Beck, (2014), cited in Galdas, (2017), comprises any influence that distorts a studies result. However, in qualitative research rigor and trustworthiness are often seen as more important (Galdas, 2017). Galdas (2017) questions the use of deeper, more probing questions being asked in qualitative research as these are potentially the researcher delving for the data that will confirm their ideas and beliefs. Questions that were ‘digging’ for more data, controversial answers were not asked in in this study. It may be argued that this thesis involved certain bias as the research was driven by the RFU as hamstring injuries were highly prevalent at the time the thesis was developed. However, questions were shaped and developed by the researcher who was not employed by the RFU or held any connections to any of the clubs in the study but has experience and has worked as a practitioner in professional football and amateur rugby union. The questions were developed independently and only reviewed and ‘signed off’ by the study steering group. The project advisory group did not dictate questions or ask for any areas to be explored more than others. Questions were developed based on the previous work by Pizzari, et al., (2010) and the current literature at the time of planning with no conscious bias. Only elite level clubs participated in the study. Therefore, we cannot make any inferences on how hamstring injuries are managed at lower levels. The results also only give a national perspective (UK) not international. Results of the current study only include those from lead doctors, physiotherapists. It does not consider other medical practitioners within the club. Comparisons to other sports is difficult as is the first study of this nature within rugby union. We can only compare to a recent AFL study (Pizzari, et al., 2010). Rehabilitation, return to play and injury prevention of hamstring injuries in elite Rugby Union and the National senior side was varied and shows no consensus on the management of hamstring injuries. However, some areas of consistency were evident in the assessment and treatment of hamstring injuries. It is worth noting a limitation of the pilot study, a convenience sample was used, and we did not approach all Championship clubs. The inclusion of more clubs and practitioners would have been useful to strengthen analysis, enhance areas of consistency and highlight further areas of inconsistency. Another limitation to note is timing, each semi structured interview could last no longer than one hour, this was agreed with RFU and the gate keeper. It was clear from early on in some of the interviews the participants could have talked for longer, but to keep consistent with the rest of the participants and within the guidelines outlined by the gatekeeper, I was required to keep to time. The interviews required participants to recall and to remember what they do, therefore, giving a recount and answering from memory, this can be problematic as there may be some issues with recall, forgetting certain aspects and including some inaccuracies. However, all practitioners were involved in managing first time grade 2 hamstring strains and questions were tailored to the practitioner specialism (doctor, physiotherapist and strength and conditioner) to ensure participants did not need to answer question on areas of the management process they are not familiar with or if it is out of their scope of practice. Due to the careful and meticulous panning of this methodology, the study could easily be transferred to other sports, injuries, and populations. Based on this, future work is highlighted in the next section.

8.4 Recommendations for future research

Future research and collaborations could explore the ideas of Coutts (2016) who talks of the importance to work fast and work slow in high performance settings, with practitioners working at a fast paced to manage the injuries, and a researcher to be employed to look at the efficacy of the interventions used. Bandholm, Henriksen & Thorberg (2017) align with this and agree with the need to slow down the pace in order to strength sports medicine research.

The professionals are generally able to employ researchers with strong links to academia to conduct the research for them, semi-professional environments are not as fortunate due to lack of funding and links to researcher in academia.
Future research should also explore more first-hand experiences of the practitioners, their thoughts and feelings of how the multidisciplinary team works, how they view the working relationships, pracitotner hierarchy and role delineation.

Future studies should also explore communication levels and injury rates as highlighted by Ekstrand et al., (2019). Due to the sensitivity of the data the RFU would not allow use to report the individual clubs hamstring injury incidence rates, this would have deepened the analysis and given even more of an insight into what is being done compared to injury incidence rates. This would enable even more studies to look at developing best practice protocols.

Chapter 9

Conclusion

9. 1 Chapter outline

In this chapter I will draw together the findings from the thesis and highlight new findings that can be used in the management of hamstring injuries and the wider context of injury management. I will also highlight the strengths and limitations of the study which will lead to future research recommendations. A final reflection will bring the chapter to an end.

9.2 Key findings

The focus of the thesis was to explore and analyse Professional Sports Workers Practice in pursuit of Athlete Welfare. Within the thesis I will explore the complexities of the professional context in which injury management takes place. I also explored the wider related issues of technical expertise and scientific knowledge and working within a multidisciplinary team. The second aim of the thesis was to identify current practice in the diagnosis, treatment, rehabilitation and prevention of hamstring injuries in elite English rugby union clubs and the National senior squad.

9.2.1 TESK key findings

My research has shown that practitioners working in elite English rugby union apply a technical expertise and scientific knowledge approach to the management of first-time grade two hamstring injuries. They work in a MDT to manage the injury in order to return the player back to sport. Practitioners working in elite sport

work in a face paced environment under pressure and are required to make quick decisions (Coutts, 2016; Harper & McCunn, 2017 & Arnold et al., 2019).
In chapter 5, I have shown the complexities behind the technical expertise and scientific knowledge approach and how the practitioners work in a MDT. The chapter has also outlined the professional attributes of the practitioners within the study and their beliefs surrounding hamstring injuries. The results show that the practitioners have high levels of qualifications, and this is reflected in their high level of technical expertise and scientific knowledge. This will allow them to understand the intricacies of injury management. Intertwined with this chapter are areas where we see aspects of chapter 6 being introduced. Such as player welfare being discussed in terms of the technical expertise and scientific knowledge involved in rehabilitation alongside player welfare.

Applying technical expertise and scientific knowledge and seeing what is done, is shown in chapters 6 and 7. Within those chapter we see how they apply their technical expertise and scientific knowledge when managing hamstring injuries, these results align to previous work by Pizzari, et al., (2010). The rehabilitation and injury prevention of acute first-time grade 2 hamstring injuries in elite rugby union and the National senior side is varied and shows no consensus. These findings agree with previous research by Worrell & Perrin, (1992) Croisier, (2004) Hoskins & Pollard (2005); Pizzari, et al., (2010) and Malliaropoulos et al., (2010). In contrast, there was greater consistency in the assessment and treatment of hamstring injuries between clubs and practitioners. This may be because most treatment strategies are based around the well-established protect, rest, ice and compress (PRICE) and protect, optimal loading, rest, ice, compression and elevation (POLICE) protocols to reduce inflammation (ACPSM, 1998). Hamilton (2012) states, that the foundations for the current strategies used for the management of hamstring injuries were established by the mid-20th century. Despite these advances, we have only made small progress in the understanding of the highly prevalent and complex injury (Mendiguchia & Brughelli, 2011). Research also shows greater evidence regarding treatment of hamstring injuries, compared to rehabilitation. In recent years, treatment-based studies have increased in quality, to include RCTs, systematic reviews and meta-analysis of hamstring injuries (Hamilton, 2012). However, Hamilton (2012) still highlights limited evidence base for the management of hamstring injuries. This chapter provides us with important evidence that practitioners use technical expertise and scientific knowledge to manage all aspects of the hamstring injury management process which can be used to inform other practitioners. Results from this chapter also show that there is a clear practitioner hierarchy and role delineation, with physiotherapists take the lead role within the multidisciplinary team for most aspects of the management of hamstring injuries. This is consistent with work by Scott-Bell et al., (2015).

9.2.2 Hamstring injuries in elite English Rugby Union: A survey of doctor and physiotherapy and strength and conditioning practice key findings

Results of the study can be used to help guide and develop the management of hamstring injuries at all levels of Rugby Union. In addition, they can be used to guide future research into the management of hamstring injuries. It is vital for clinicians to develop individual and evidence-based assessment, treatment and rehabilitation protocols that highlight the complexity of this group of muscles.

The results of the study show that there is some agreement in how hamstring injuries are managed from a S&C perspective. The study demonstrates that S&C staff became more active in the management of players as their rehabilitation progresses, however it is the physiotherapist that have the autonomy on how the hamstring injuries are managed. It is vital for strength and conditioners to develop individual and evidence-based assessment, treatment and rehabilitation, return to play and injury reduction protocols that highlight the complexity of this group of muscles.

9.3 Final reflections

I close this study with some concluding reflections. The studies carried out were successful. The processes in which they were conducted and analysed challenged me a researcher and I have learnt many new skills during the time spent on the thesis. The key findings offer an original insight into the management of hamstrings in elite English rugby union and has explored Professional Sports Workers Practice in pursuit of Athlete Welfare. The results can be used to inform other sports, teams and practitioners who are managing hamstring injuries. I have explored the complexities of the professional context in which injury management takes place and explored the wider related issues of technical expertise and scientific knowledge and working within a multidisciplinary team. Professional Sports Workers Practice in pursuit of Athlete Welfare. To finish, I have identified how practitioners in elite English rugby union practice in the diagnosis, treatment, rehabilitation and prevention of hamstring injuries in elite English rugby union clubs and the National senior squad.

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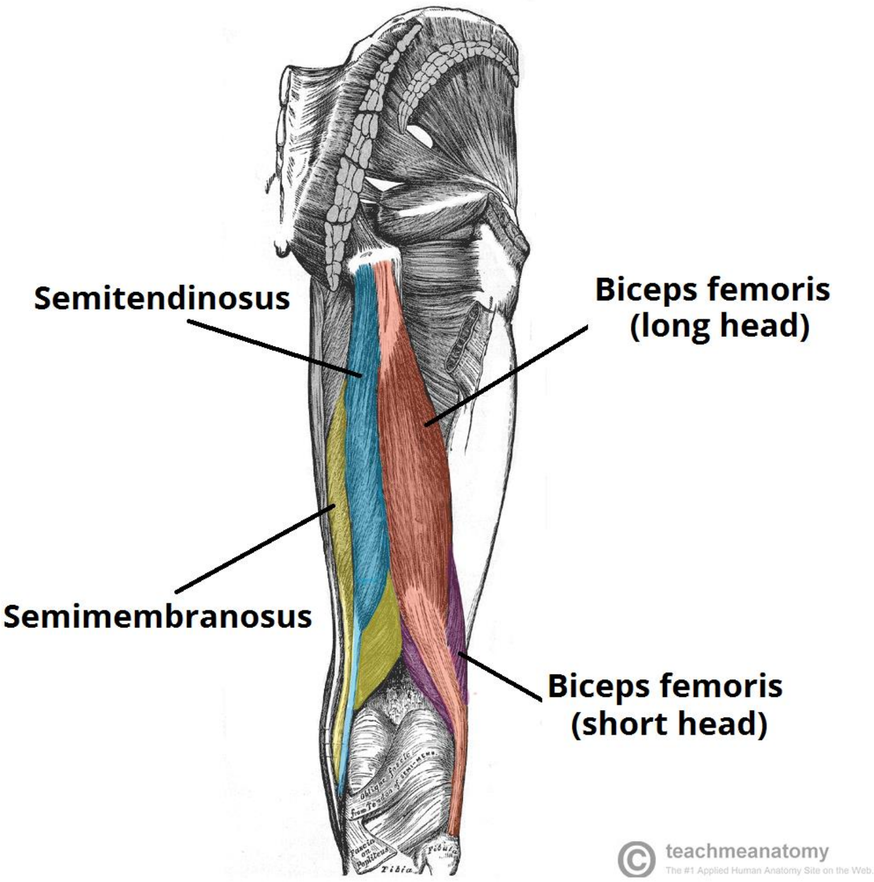
Appendix 1

Hamstring anatomy



The muscle of the posterior right thigh – the hamstrings.

Table 11**:** Hamstring muscle anatomy overview (adapted from Moore, Dalley & Agur 2014).

Name	Origin	Insertion	Nerve supply	Action
Semitendinosis	Ischial tuberosity	anterior medial surface of the tibia	tibial division of sciatic	Hip: extension Knee: flexion and medial rotation (with knee flexed)
Semimembranosus	Ischial tuberosity	posterior medial tibial condyle	tibial division of sciatic	Hip: extension Knee: flexion and medial rotation (with knee flexed)
Long head of biceps femoris	Ischial tuberosity	Lateral surface of the head of fibula	tibial division of sciatic	Hip: extension Knee: flexion and medial rotation (with knee flexed)
Short head of biceps femoris	Lateral aspect of the supracondylar line and the		fibular division of sciatic	Knee: flexion and medial rotation (with knee flexed)

	linea aspera of the femur			

Biceps femoris

The biceps femoris is the most lateral of the hamstring muscles. It is a fusiform muscle (Moore, Dalley & Agur, 2014) consisting of two heads that fuse together. Their attachment on to the lateral side of the head of fibula is via a long-rounded tendon (Moore, Dalley & Agur, 2014) that is easily palpated. The short head of biceps femoris has a different nerve supply to the long head of biceps femoris and medial hamstrings. It is innervated by the fibular division of the sciatic nerve (Moore, Dalley & Agur, 2014). So, an injury to one head may cause problems with one and not the other.

Semitendinosis

The semitendinosis is located on the medial side and is superficial to the semimembranosus. The semitendinosis is a tendinous muscle with a fusiform muscle belly. Emerging two-thirds of the way down the muscle from the muscle belly is a long-rounded cord like tendon (Moore, Dalley & Agur, 2014). This tendon wraps around to attach on the anterior medial aspect of the tibia.

Semimembranosus

The semimembranosus is a broad flattened membranous muscle (Moore, Dalley & Agur, 2014) that attaches to the posterior aspect of the tibia via a flattened membranous tendon (Moore, Dalley & Agur, 2014). It is located deep to the semitendinosis.

Appendix 2

Injury definitions

The following definitions have been adopted for the thesis and are consistent with the International Rugby Board (IRB) consensus statement on injury definitions. They have been used in previous studies of injuries in rugby union, namely, Brooks et al., (2006). All definitions are taken from Fuller et al., (2007).

Injury

An injury was defined as ‘any injury that prevents a player from taking a full part in all training activities typically planned for that day and/or match play for more than 24 hours from midnight at the end of the day the injury was sustained’. Fuller et al., (2007).

Injury severity

Injury severity was measured as time (days) lost from competition and practice. It was recorded as the number of days from the date of the injury to the date that the player was deemed to have regained full fitness not including the day of injury or the day of return. A player was deemed to have regained full fitness when he was ‘*able to take a part in training activities (typically planned for that day) and was available for match selection.’* Fuller et al., (2007).

Recurrent injury

An injury of the same type and at the same site as an index injury and which occurs after a player’s return to full participation from the index injury.

For the purpose of this study, the following definitions will also be used to describe specific hamstring injuries.

Non injured – never sustained a hamstring injury before

Prior hamstring injury – hamstring injury more than 3 months ago (either a type 3a, 3b or type 4 structural muscle injury) Muelluer-Wohlfhart et al., (2013). The injury can be to any part of the muscle from the origin to the insertion.

Current hamstring injury – hamstring injury within the last three months
Injury (either a type 3a, 3b or type 4 structural muscle injury) Mueller-Wolfhart et al., (2013). The injury can occur to any part of the muscle from the origin to the insertion.

Appendix 3

Email sent to invite participants to the study

Management of hamstring injuries in elite English Rugby Union:

A survey of current practice.

Dear

My name is Sadie Jones. I am a Sports Therapist and Lecturer at the University of Kent and am currently working towards a PhD. My supervisors are Karen Hambly and Professor Louis Passfield.

I am inviting you to take part in the pilot element of a study intended to gain an insight into the current management of hamstring injuries in Elite English Rugby Union.

Hamstring injuries are known to be a significant problem in English Rugby Union and have consistently been associated with very significant day's absence as a result of both match and training injury.

The need for this research study was agreed by delegates at the RFU/Premiership Rugby 2009 Medical conference that focused on hamstring injuries and supported by the Professional Game Board in January 2010 on their receipt of the 2009-10 England Rugby Injury and Training Audit. They recommended that: *A detailed analysis of current elite game medical and strength and conditioning staff practices* *regarding hamstring injury prevention, diagnosis, treatment and rehabilitation should now be undertaken*

The study is needed because:

- Little detail is known about current practice in the prevention and treatment of hamstring injuries in Elite English Rugby Union and there does not appear to be consensus as to what constitutes best practice.

- Information gained can be used to design a prospective hamstring specific injury audit, shape prevention and treatment interventions and inform future practice.

The purpose of the study.

- To gain a detailed and comprehensive understanding of the management and current practice (assessment, diagnosis, treatment, rehabilitation and prevention) among the medical and sport science staff (Doctors, Physiotherapists, Strength and Conditioners and Rehabilitation specialists).
- To expand and develop our understanding of risk factors and imaging correlates.
- Ultimately to reduce the prevalence and cost of hamstring injuries and to improve the treatment, management and prevention of hamstring injuries in Elite English Rugby Union.

Semi-structured face to face interviews will be recorded and take place with the lead doctors, head physiotherapists, lead strength and conditioners at the 12 Premiership Clubs and the England Senior team.

The medical staff and sport science staff at each club will be contacted by letter to explain the purpose of the study. They will then be telephoned to determine if they are willing to take part in the study. Interviews will be arranged at a time and location that is convenient to the participant.

All participants will be asked to sign a written informed consent form prior to taking part in this study. Each participant will complete a face-to-face semi-structured interview separately. Other members of the medical and strength and conditioning team will be welcome to participate in the study if they wish and resources allow. Interviews will take no more than 90 minutes each and are planned for January, February, and March 2011.

The Interview questions have been developed by me together with a project advisory group comprising Dr Simon Kemp (Sports Physician), Kevin Lidlow (Physiotherapist) and Faye Downey (Strength and Conditioner). A similar approach was used to beneficial effect in the Australian Football League (AFL).

The Study needs to be piloted with medical and strength and conditioning staff that are not taking part in the main survey.

I hope that you will agree to take part in the pilot study.

I will contact you via telephone to determine if you are willing to take part in the pilot study. Interviews will then be arranged at a time and location that is convenient to you. You will be asked to sign a written informed consent form prior to taking part in the study.

You will be given a guidance pack in advance to help you to prepare for the interviews.

All interviews will be recorded, transcribed, and analysed using established qualitative analysis methodologies. After the interview, your answers will be typed up and the transcripts will be sent to you for verification. All transcripts will be anonymised. All information will be stored according to the data protection act (1998). Ethical approval will be sought from the local ethics committee at the University of Kent prior to the study commencing.

Questions will be constructed using 5 key headings in order to gain an insight and understanding into the current management and practice for the diagnosis, treatment and prevention of hamstring injuries in English Premiership clubs and England.

1. Clinical assessment and Diagnosis

2. Treatment and Rehabilitation

3. Prevention

4. Professional attributes of medical staff

5. Beliefs

The study outputs will be:

1. Project reports (technical) with the findings will presented under the six key headings
2. Project report (lay/non-technical)
3. Development of an algorithm to inform clinical decision making
4. A paper for submission for peer reviewed publication

Thank you for your time, I look forward to meeting you.

Sadie Jones

S.Jones@Kent.ac.uk

07825417447

Appendix 4

Respondent's Guidance Pack

HAMSTRING INJURIES IN RUGBY UNION

Sadie Jones

School of Sort and Exercise Sciences -

University of Kent

This pack is designed to assist and guide you through the interview process. It will allow you to prepare in advance for the interviews so you are aware of what you will be asked.

The primary aim of the study is to identify current management and practice in the diagnosis, treatment and prevention of grade 1-2 acute hamstring injuries in English Premiership Rugby Union clubs. Please keep this in mind throughout the interview, as your answers to the interview questions need to be answered with respect to this scenario. Other areas related to hamstring injury that will be evaluated within the study will include your beliefs regarding mechanism of injury; assessment and diagnosis; treatment; rehabilitation; return to sport criteria; and prevention.

Your answers to the interview questions need to be answered with the following scenario in mind: Grade 1 -2 biceps femoris strain to the muscle belly/MTJ. Please use the following definitions when answering the questions.

Definitions:

Due to the variation of definitions within the medical and strength and conditioning professions please use the following definitions when answering the interview questions.

Accepted by the Rugby Injury Consensus Group (RICG)

Injury – Any physical complaint, which was caused by a transfer of energy that exceeded the body's ability to maintain it's structural and/or functional integrity, that was sustained by a player during a rugby match or rugby training, irrespective of the need for medical attention or time-loss from rugby activities. An injury that results in a player receiving medical attention is referred to as 'medical attention' injury and an injury that results in a player being unable to take full part in future rugby training or match play as a 'time-loss' injury.

Recurrent injury – An injury of the same type and the same site as an index injury and which occurs after a player's return to full participation from the index injury. A recurrent injury occurring within 2 months of a player's return to full participation is referred to as an 'early recurrence'; one occurring 2 to 12 months after a player's return to full participation as a 'late recurrence'; and one occurring more than 12 months after a player's return to full participation as a 'delayed recurrence'.

Injury severity – Time (days) lost from competition and practice – The number of days that have elapsed from the date of injury to the date of the player's return to full participation in team training and availability for match selection.

ROM - a test carried out to determine ROM at the knee and hip

Active – movement produced by the athlete

Passive – movement carried out by the Doctor or Physiotherapist

Muscle Length test (MLT) -a test carried out to determine the length/flexibility of the hamstring muscles

Strength tests – a test carried out to determine the strength of the hamstring muscles

Isometric – increase in tension without movement (performed at inner, mid and outer range)

Concentric – shortening of the muscle under tension (performed through range)

Eccentric – lengthening of the muscle under tension

Strength endurance - the ability of a muscle or group of muscles to repeatedly contract and relax

Functional tests – a test carried out to replicate the pain/symptoms

Pain provocation test – a test carried out to replicate the pain/symptoms

Neural tension test – a test carried out to examine the tension within nerves (SLR, slump)

Palpation - palpation of the injured and surrounding area to determine the location, extent of injured area, pain, a palpable defect, heat

Treatment – the use of modalities to treat an injury (analgesics, NSAID's, corticosteroid injections, ice, compression, elevation, electrotherapeutic modalities (US, TENS, Interferential, laser, muscle stimulation), acupuncture, dry needling, traumeel injections, taping, manual therapy, mobilisations, massage, soft tissue work (trigger pointing, myofascial release, positional release) etc)

Acute stage of healing – Acute inflammatory stage, can last up to 0-72 hours after injury.

Sub acute stage of healing - Proliferation/repair stage; from 72hrs up to 21 days post injury)

Chronic stage of healing – Remodeling/maturation stage (After 21 days).

Rehabilitation – the use of exercises to return the athlete to full functional fitness (ROM, strength (isometric, concentric, eccentric, endurance), power, speed, agility, flexibility, proprioception, core stability/strength, hydrotherapy, etc

Early stage – > 3 days after injury

Mid stage - > 10 days after injury

Late stage – post 21 days (released from physiotherapy lead rehabilitation)

After discharge from physiotherapy treatment/ pre return to competition stage - once the player has been discharged form the Physiotherapist

Post return to competition – once the player has returned to competition

Subjective assessment – questions asked by the Doctor or Physiotherapist that covers patient history, injury history etc.

Objective Assessment – (Physical assessment of the injured area plus above and below) - the hands on part of the assessment that includes observation of injured area, examination of movement (ROM), examination of flexibility (muscle length tests), examination of strength, examination of pain, palpation, clinical tests etc

Clinical test – a hands on test carried out to help confirm or deny your diagnosis or to allow differential diagnosis

Volume – total number of weight lifted in a session (Baechle and Earle, 2008)

Repetition – the number of times an exercise is performed (Baechle and Earle, 2008)

Set – group of repetitions (Baechle and Earle, 2008)

Repetition volume – total number of reps performed in a session (Baechle and Earle, 2008)

Load volume – total number of sets x number of reps per set x weight lifted per rep (Baechle and Earle, 2008)

Intensity - the degree of difficulty of the exercise. How hard the workload is

Load – (work) the amount of weight assigned to an exercise set. (Baechle and Earle, 2008)

Frequency – how often the exercise session is performed

Appendix 5

Informed consent form for pilot study

PILOT INTERVIEWS: INFORMED CONSENT

I volunteer to participate in a research study conducted by Sadie Jones from the University of Kent. The full details of the study have been explained to me. I am clear about what will be involved. I am aware of the purpose of the study, and what is expected from me.

I understand that the project is designed to evaluate the current management of hamstring injuries in elite English Rugby Union. I will be one of approximately 36 people being interviewed for this study.

My participation in the study is voluntary; I am not obliged to take part. I understand that I will not be paid for my participation in the study. If I decline to participate or withdraw from the study, no one will be made aware.

Participation in the study requires me to be interviewed by Sadie Jones from the University of Kent. The interview will last approximately 60 minutes. The interview will be recorded using a digital voice recorder. Notes will also be taken during the interview. If I don't want to be taped, I will not be able to participate in the study. If feel uncomfortable in any way during the interview, I have the right to not answer or to end the interview.

I understand that the researcher will not identify me by name in any reports using information obtained from this interview, and that my confidentiality as a participant in this study will remain secure under the Data Protection Act 1998.

I understand that this study has been reviewed and approved by the Ethic Committee at the University of Kent.

I have read and understand the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study and have been given a copy of this consent form.

Name of Participant…………………………………………………………………………………………………..

Signature of Participant

…………………………………………………………………………………………...

Date …………………………..

Name of

Researcher……………………………………………………………………………………

……………….

Signature of Researcher

………………………………………………………………………………………………..

Date …………………………..

Appendix 6

Question detail

HAMSTRING INJURIES IN RUGBY UNION

Sadie Jones

School of Sport and Exercise Sciences - University of Kent

Q1

Section

Beliefs

Who is the question for?

All, Doctors, Physiotherapists and Strength & Conditioners

Question

What do you think is the most common mechanism of injury for a hamstring injury in Elite (England Rep and Premiership) English Rugby Union?

Possible themes for analysis

Extreme stretch, High speed running, Forced hip flexion with full knee extension

Other

My question prompt

How do you think hamstring injuries are occurring in elite English Rugby Union?

My answer guidance

Extreme stretch

High speed running

Forced hip flexion with full knee extension, position

Other

Respondents guidance

Extreme stretch

High speed running

Forced hip flexion with full knee extension

Other

Justification/rationale for asking question

Research shows that the MOI is important in determining treatment and rehabilitation.

Different MOI for hamstring injuries needs to be treated differently.

Q2

Section

Beliefs

Who is the question for?

All, Doctors, Physiotherapists and Strength & Conditioners

Question

Do you think it is possible to significantly reduce the risk of first time hamstring injuries in Elite (England Rep and Premiership) English Rugby Union?

If yes, how?

If no, why?

1	Yes	
2	No	
3	No opinion	

1	Yes, definitely	
2	Yes, depends on MOI, severity, location	
3	No opinion	
4	No, not really	
5	No, not at all	

If yes, how? Ql and Qt

If no, why? Ql and Qt

Possible themes for analysis

Training - load modification, specific prevention protocols

Demands - of game/training, anatomy/biomechanics of the hamstrings

Specific prevention protocols

Other

My question prompt

Is it possible to prevent first time hamstring injuries?

My answer guidance

Training - load modification, specific prevention protocols

Demands - of game/training, anatomy/biomechanics of the hamstrings

Specific prevention protocols

Other

Respondents guidance

Training - load modification, specific prevention protocols

Demands - of game/training, anatomy/biomechanics of the hamstrings

Specific prevention protocols

Other

Justification/rationale for asking question

Inadequate rehabilitation is often cited as a reason for increased recurrent hamstring injuries (Sherry and Best, 2004)

Are there any prevention/rehabilitation protocols that can be used to help guide the rehabilitation of hamstring injuries?

To help develop best practice/evidence based rehabilitation protocols

Q3

Section

Beliefs

Who is the question for?

All, Doctors, Physiotherapists and Strength & Conditioners

Question

Do you think it is possible to prevent recurrent hamstring injuries in Elite (England Rep and Premiership) English Rugby Union?

If yes, how?

If no, why?

1	Yes	
2	No	
3	No opinion	

1	Yes, definitely	
2	Yes, possibly but will depend on MOI, severity, location	
3	No opinion	
4	No, not really	
5	No, not at all	

If yes, how? Ql and Qt

If no, why? Ql and Qt

Possible themes for analysis

Training - load modification, specific prevention protocols

Demands - of game/training, anatomy/biomechanics of the hamstrings

Specific prevention protocols

Other

My question prompt

Can recurrent hamstring injuries be prevented?

My answer guidance

Training - load modification, specific prevention protocols

Demands - of game/training, anatomy/biomechanics of the hamstrings

Specific prevention protocols

Other

Respondents guidance

Training - load modification, specific prevention protocols

Demands - of game/training, anatomy/biomechanics of the hamstrings

Specific prevention protocols

Other

Justification/rationale for asking question

Inadequate rehabilitation is often cited as a reason for increased recurrent hamstring injuries (Sherry and Best, 2004)

Are there any prevention/rehabilitation protocols that can be used to help guide the rehabilitation of hamstring injuries?

To help develop best practice/evidence-based rehabilitation protocols

Q4

Section

Beliefs

Who is the question for?

All, Doctors, Physiotherapists and Strength & Conditioners

Question

What would you consider to be the most important components of a hamstring injury prevention programme? Why?

Components of Prevention	Tick if Important	Rank (1-5)
ROM		
Flexibility		

Strength – isometric		
Strength – concentric		
Strength – eccentric		
Strength endurance		
Power		
Speed		
Core stability		
Cardiovascular		
Agility		
Sport specific skills		

Rank the components of rehabilitation	
1	Most important
2	
3	
4	
5	Least important

Possible themes for analysis

Strength, strength endurance, strength – isometric, strength – concentric, eccentric loading, functional, game specific work, CV, agility, speed, power, core stability, flexibility, ROM

My answer guidance

Strength, strength endurance, strength – isometric, strength – concentric, eccentric loading, functional, game specific work, CV, agility, speed, power, core stability, flexibility, ROM

Respondents guidance

Strength, strength endurance, strength – isometric, strength – concentric, eccentric loading, functional, game specific work, CV, agility, speed, power, core stability, flexibility, ROM

Justification/rationale for asking question

Previous research form Brooks et al (2006) shows that hamstring injuries are common in Elite English Rugby union. Can we look to prevent them?

What is being done to help prevent them already? Can we develop best practice/evidence-based prevention protocols?

Q5

Section

Beliefs

Who is the question for?

All, Doctors, Physiotherapists and Strength & Conditioners

Question

Do you think modifying training load can decrease the incidence of hamstring injuries?

If yes, how?

If no, why?

1	Yes	
2	No	

3	No opinion	

1	Yes, definitely a problem	
2	Yes, somewhat of a problem	
3	No opinion	
4	No, not really a problem	
5	No, not a problem at all	

Possible themes for analysis

Rest/recovery, demands of match/training, anatomy/biomechanics of the hamstrings, quality of training, quantity of training, amount of S&C, type of S&C

Demands of match/training, anatomy/biomechanics of the hamstrings

My answer guidance

Rest/recovery, demands of match/training, anatomy/biomechanics of the hamstrings, quality of training, quantity of training, amount of S&C, type of S&C

Demands of match/training, anatomy/biomechanics of the hamstrings

Respondents guidance

Rest/recovery, demands of match/training, anatomy/biomechanics of the hamstrings, quality of training, quantity of training, amount of S&C, type of S&C

Demands of match/training, anatomy/biomechanics of the hamstrings

Justification/rationale for asking question

The incidence of hamstring injuries occurring in training has risen (Brooks et al, 2006)

Why?

Q6

Section

Clinical Assessment

Who is the question for?

Doctors and Physiotherapists

Question

When you carry out the initial assessment (< 72 hrs) of a hamstring injury, what are the critical clinical assessment tests (subjective and/or objective) that you use to make your diagnosis?

Possible themes for analysis

Subjective - MOI, previous injury, pain, etc

Objective –

Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the hip, Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the knee,

SLR, 90-90 SLR,

Active, Passive ROM (Knee),

Active, Passive ROM (Hip)

Muscle Length Tests (MLTs)

Weight bearing

Pain provocation test

Palpation

Other functional tests

My question prompt

When you carry out an assessment on a suspected hamstring injury what are the most important questions you ask and assessments tests you do?

My answer guidance

Subjective - MOI, previous injury, pain, etc

Objective –

Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the hip, Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the knee,

SLR, 90-90 SLR,

Active, Passive ROM (Knee),

Active, Passive ROM (Hip)

Muscle Length Tests (MLTs)

Weight bearing

Pain provocation test

Palpation

Other functional tests

Respondents guidance

Subjective - MOI, previous injury, pain, etc

Objective –

Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the hip, Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the knee,

SLR, 90-90 SLR,

Active, Passive ROM (Knee),

Active, Passive ROM (Hip)

Muscle Length Tests (MLTs)

Weight bearing

Pain provocation test

Palpation

Other functional tests

Justification/rationale for asking question

To gain an understanding of who assesses the hamstring injuries that occur and what they do.

From Heiderschiet, Sherry, Silder, Chumanov and Thelen (2010)

What is being done in a subjective assessment?

Audible pop is often heard with proximal tendon injuries, limited by pain

Pain on ischial tuberosity when seated, common with proximal tendon injuries

MOI, high speed running – usually BF, extreme stretch (kick) usually SM free tendon

Without a specific MOI consider other causes of posterior thigh pain.

Q7

Section

Clinical Assessment

Who is the question for?

Doctors and Physiotherapists

Question

Which clinical test do you believe to be the best (most sensitive and most specific) when you are making a specific diagnosis of a hamstring injury?

Possible themes for analysis

Subjective - MOI, previous injury, pain, etc

Objective –

Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the hip, Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the knee,

SLR, 90-90 SLR,

Active, Passive ROM (Knee),

Active, Passive ROM (Hip)

Muscle Length Tests (MLTs)

Weight bearing

Pain provocation test

Palpation

Other functional tests

My question prompt

During your assessment what test do you think is best for giving you a specific diagnosis of a hamstring injury?

My answer guidance

Subjective - MOI, previous injury, pain, etc

Objective –

Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the hip, Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the knee,

SLR, 90-90 SLR,

Active, Passive ROM (Knee),

Active, Passive ROM (Hip)

Muscle Length Tests (MLTs)

Weight bearing

Pain provocation test

Palpation

Other functional tests

Respondents guidance

Subjective assessment – questions asked by the Doctor or physiotherapist that covers patient history, injury history etc.

Objective Assessment **–** (Physical assessment of the injured area plus above and below) the hands on part of the assessment that includes observation of injured area, examination of movement (ROM), examination of flexibility (muscle length tests), examination of strength, examination of pain, palpation, clinical tests etc

Muscle length test - a test carried out to determine the length/flexibility of the hamstring muscles

Strength - tests carried out to determine the strength of the hamstring muscles (isometric, concentric, eccentric, endurance)

Functional tests - test carried out to replicate the pain/symptoms

Pain provocation test - test carried out to replicate the pain/symptoms

Palpation - palpation of the injured and surrounding area to determine the location, extent of injured area, pain, a palpable defect, heat

Other functional tests, please specify

Justification/rationale for asking question

Are there any tests that can be done to help guide treatment and rehab in terms of specific diagnosis? Identifying grade/severity? And predicting time to return?

Q8

Section

Clinical Assessment

Who is the question for?

Doctors and Physiotherapists

Question

Which clinical test do you consider to be the best for identifying the grade/severity of a hamstring injury?

Possible themes for analysis

Subjective - MOI, previous injury, pain, etc

Objective –

Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the hip, Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the knee,

SLR, 90-90 SLR,

Active, Passive ROM (Knee),

Active, Passive ROM (Hip)

Muscle Length Tests (MLTs)

Weight bearing

Pain provocation test

Other functional tests

My question prompt

During your assessment what test do you think is best for identifying the grade/severity of a hamstring injury?

My answer guidance

Subjective - MOI, previous injury, pain, etc

Objective –

Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the hip, Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the knee,

SLR, 90-90 SLR,

Active, Passive ROM (Knee),

Active, Passive ROM (Hip)

Muscle Length Tests (MLTs)

Weight bearing

Pain provocation test

Palpation

Other functional tests

Respondents guidance

Subjective assessment – questions asked by the Doctor or physiotherapist that covers patient history, injury history etc.

Objective Assessment – (Physical assessment of the injured area plus above and below) the hands on part of the assessment that includes observation of injured area, examination of movement (ROM), examination of flexibility (muscle length tests), examination of strength, examination of pain, palpation, clinical tests etc

ROM - a test carried out to determine ROM at the knee and hip

Muscle length test - a test carried out to determine the length/flexibility of the hamstring muscles

Strength - tests carried out to determine the strength of the hamstring muscles (isometric, concentric, eccentric, endurance)

Functional tests - test carried out to replicate the pain/symptoms

Pain provocation test - test carried out to replicate the pain/symptoms

Palpation - palpation of the injured and surrounding area to determine the location, extent of injured area, pain, a palpable defect, heat

Other functional tests, please specify

Justification/rationale for asking question

Are there any tests that can be done to help guide treatment and rehab in terms of specific diagnosis? Identifying grade/severity? And predicting time to return?

Q9

Section

Clinical Assessment

Who is the question for?

Doctors and Physiotherapists

Question

Which clinical test do you consider to be the best for predicting time to return from a hamstring injury?

Possible themes for analysis

Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the hip, Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the knee,

SLR, 90-90 SLR,

Active, Passive ROM (Knee),

Active, Passive ROM (Hip)

Muscle Length Tests (MLTs)

Weight bearing

Pain provocation test

Palpation

Other functional tests

My question prompt

During your assessment what test do you think is best for predicting time to return from a hamstring injury?

My answer guidance

Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the hip, Isometric strength, concentric strength, eccentric strength, strength endurance of the hamstrings at the knee,

SLR, 90-90 SLR,

Active, Passive ROM (Knee),

Active, Passive ROM (Hip)

Muscle Length Tests (MLTs)

Weight bearing

Pain provocation test

Palpation

Other functional tests

Respondents guidance

Objective Assessment – (Physical assessment of the injured area plus above and below) the hands on part of the assessment that includes observation of injured area, examination of movement (ROM), examination of flexibility (muscle length tests), examination of strength, examination of pain, palpation, clinical tests etc

ROM - a test carried out to determine ROM at the knee and hip

Muscle length test - a test carried out to determine the length/flexibility of the hamstring muscles

Strength - tests carried out to determine the strength of the hamstring muscles (isometric, concentric, eccentric, endurance)

Functional tests - test carried out to replicate the pain/symptoms

Pain provocation test - test carried out to replicate the pain/symptoms

Palpation - palpation of the injured and surrounding area to determine the location, extent of injured area, pain, a palpable defect, heat

Other functional tests, please specify

Justification/rationale for asking question

Are there any tests that can be done to help guide treatment and rehab in terms of specific diagnosis? Identifying grade/severity? And predicting time to return?

Q10

Section

Clinical Assessment

Who is the question for?

Doctors and Physiotherapists

Question

Do you typically use diagnostic investigations like diagnostic US and/or MRI, in your assessment of acute hamstring injuries?

If yes, which tests, when (for which conditions and at what time after injury) and why

If no, why?

1	Yes	
2	No	

If yes which ones and why?

If no why?

No opinion

Ql and Qt

Possible themes for analysis

MRI, diagnostic US,

Exact location, severity, size of injury, aid treatment and rehabilitation etc

Cost, practicalities

My question prompt

Do you use MRI or diagnostic US to help you assess acute hamstring injuries?

My answer guidance

MRI, diagnostic US, CT

Exact location, severity, size of injury, aid treatment and rehabilitation etc

Cost, practicalities

Respondents guidance

MRI, diagnostic US, CT

Exact location, severity, size of injury, aid treatment and rehabilitation etc

Cost, practicalities

Q11

Section

Clinical Assessment

Who is the question for?

Doctors and Physiotherapists

Question

If you do not routinely use diagnostic investigations like diagnostic US and/or MRI in your assessment of acute hamstring injuries how specific do you believe that you can make your diagnosis?

1	Very specific	
2	Somewhat specific	
3	Not at all specific	

Possible themes for analysis

My question prompt

How specific is your diagnosis if you do not use diagnostic investigation like diagnostic US or MRI?

Q12

Section

Treatment and Rehabilitation

Who is the question for?

Doctors and Physiotherapists

Question

How do **<u>you</u>** typically treat (use of modalities) an acute hamstring injury in: *<u>Push Doctors re injection Rx</u>*

The acute (<72hours) stage of healing

The subacute (72-21 days) stage of healing

The late (chronic) (>21 days) stage of healing

Possible themes for analysis

PRICE, Cryotherapy, Injection Therapy, Electrotherapeutic modalities, Other

My question prompt

How are you treating the hamstring injuries that occur at your club?

My answer guidance

PRICE

Cryotherapy

Injection Therapy

Electrotherapeutic modalities

Other

Respondents guidance

PRICE

Injection Therapy

Electrotherapeutic modalities

Other

Q13

Section

Treatment and Rehabilitation

Who is the question for?

All Doctor, Physiotherapists and S&C

Question

Do you use a standardised or player specific protocol to guide your treatment and rehabilitation of hamstring injuries? If you use a player specific protocol, what specific factors do you consider when creating the protocol?

If you use a player specific protocol, what specific factors do you consider when creating the protocol? Ql

Do you use a standardised or player specific protocol to guide your treatment and rehabilitation of hamstring injuries?

1	Yes	
2	No	

1	Yes, in all cases	
2	Yes, sometimes, depends	
3	No opinion	
4	No, not all the time, depends	

5	No, never	

Possible themes for analysis

MOI, Location, Severity, Player position, other.

My question prompt

Do you use or follow a standardised or player specific protocol to guide your treatment and rehabilitation of hamstring injuries

If you do use a player specific protocol, what specific factors do you consider when creating it?

My answer guidance

MOI

Location

Severity

Player position

Other

Respondents guidance

MOI

Location

Severity

Player position

Other

Justification/rationale for asking question

What evidence based/best practice protocols are currently being used?

Q14

Section

Treatment and rehabilitation

Who is the question for?

Physiotherapists and S&C

Question

Who designs and leads each stage of rehabilitation (use of exercise(s)) after injury?

Early (> 3days after injury)

Mid (> 10 days after injury

Late (>21 days after injury)

After discharge from physiotherapy treatment (modalities)/pre-return to competition

Post return to competition

Stage of rehabilitation	Who designs	Who leads
Early		
Mid		
Late		
Discharge from Physio/ pre return to sport		
Post return to competition		

My question prompt

Who designs the rehab stages for hamstring injuries? Who leads (takes) the rehab for hamstring injuries?

Q15

Section

Treatment and Rehabilitation

Who is the question for?

Physiotherapists and S&C

Question

What rehabilitation exercises do you do in each of the following stages of rehabilitation?

Early (> 3days after injury)

Mid (>10 days after injury)

Late (>21 days after injury)

After discharge from physiotherapy treatment (modalities)/pre-return to competition

Post return to competition

Components of Rehabilitation	Early	Mid	Late	Pre-return to competition	Post return To competition
ROM					
Flexibility					
Strength – isometric					
Strength – concentric					
Strength – eccentric					
Strength endurance					

Power					
Speed					
Core stability					
Cardiovascular					
Agility					
Sport specific skills					
other					

If other, please specify

Possible themes for analysis

Strength, strength endurance, strength – isometric, strength – concentric, eccentric loading, functional, game specific work, CV, agility, speed, power, core stability, flexibility, ROM, other.

My question prompt

In each stage of rehabilitation, what do you do?

My answer guidance

Strength, strength endurance, strength – isometric, strength – concentric, eccentric loading, functional, game specific work, CV, agility, speed, power, core stability, flexibility, ROM, other

Respondents guidance

Strength, strength endurance, strength – isometric, strength – concentric, eccentric loading, functional, game specific work, CV, agility, speed, power, core stability, flexibility, ROM, other

Q16

Section

Treatment and Rehabilitation

Who is the question for?

Physiotherapists and S&C

Question

What are your (hamstring specific) progression criteria for moving between the following stages of rehabilitation?

Early to mid-stage

Mid to late stage

Late to after discharge from physiotherapy treatment (modalities)/pre return to competition

Discharge from Physio to return to competition

Physio to return to competition

Possible themes for analysis

Weight bearing, ROM, strength, pain

My question prompt

How do you know a player is ready to progress to the next stage of rehabilitation?

My answer guidance

Weight bearing, ROM, strength, pain

Respondents guidance

Weight bearing, ROM, strength, pain

Justification/rationale for asking question

Q17

Section

Treatment and rehabilitation

Who is the question for?

Physiotherapists and S&C

Question

Do these progression criteria change depending on MOI, location or severity of the hamstring injury or any other factors?

1	Yes	
2	No	

1	Yes, in all cases	
2	Yes, sometimes, depends	
3	No opinion	
4	No, not all the time, depends	
5	No, never	

Possible themes for analysis

My question prompt

Do your progression criteria change at all?

Q18

Section

Treatment and Rehabilitation

Who is the question for?

Doctors and Physiotherapists

Question

How often do you see an injured player for hamstring treatment and/or rehabilitation?

Treatment

Acute(<72 hours) stage of healing

Subacute (72hrs – 21 days) stage of healing

Late (chronic) (>21 days) stage of healing

Rehabilitation

Early (> 3days after injury)

Mid (>10 days after injury)

Late (>21 days after injury)

After discharge from physiotherapy treatment (modalities)/pre return to competition

Post return to competition

Stage of treatment	How often do you see a player for treatment?
Acute (<72hrs)	1x day

	2xday
	Every other day
	1 x week
	Other, please specificy
Subacute (72hrs - 21 days)	1x day
	2xday
	Every other day
	1 x week
	Other, please specificy
Late (chronic) (>21 days	1x day
	2xday
	Every other day
	1 x week
	Other, please specificy

Stage of rehabilitation	How often do you see an injured player for rehabilitation?
Early stage (>3days after injury)	1x day
	2xday
	Every other day
	1 x week
	Other, please specificy
Mid stage (>10 days after injury)	1x day
	2xday
	Every other day
	1 x week
	Other, please specificy
Late stage (>21days after injury)	1x day
	2xday
	Every other day
	1 x week
	Other, please specificy

After discharge from Physio treatment (modalities)/pre return to competition	1x day
	2xday
	Every other day
	1 x week
	Other, please specificy
Post return to competition	1x day
	2xday
	Every other day
	1 x week
	Other, please specificy

My question prompt

When treating a player who has a hamstring injury, how often do you see them?

When rehabilitating a player who has a hamstring injury, how often do you see them?

Q19

Section

Treatment and Rehabilitation

Who is the question for?

Physiotherapists and S&C

Question

When do you introduce running to the rehabilitation programme?

How? – What running progressions do you use and how do you determine when a player is ready to progress?

When do you introduce change of direction into the rehabilitation programme?

How? - What change of direction progressions do you use and how do you determine when a player is ready to progress?

When do you introduce speed to the rehabilitation programme?

How? - What speed progressions do you use and how do you determine when a player is ready to progress?

When do you introduce functional/sports specific work to the rehabilitation programme?

How? - What functional/sports specific work progressions do you use and how do you determine when a player is ready to progress?

Stage of rehab	Running	Change of direction	Speed	Functional/sport specific
Early				
Mid				
Late				
After discharge from Physio treatment (modalities)/pre return to competition				
Post return to competition				

How? – What running progressions do you use and how do you determine when a player is ready to progress? QI

How? - What change of direction progressions do you use and how do you determine when a player is ready to progress? QI

How? - What speed progressions do you use and how do you determine when a player is ready to progress? QI

How? - What functional/sports specific work progressions do you use and how do you determine when a player is ready to progress? QI

My question prompt

When is running introduced? How do you introduce it? How do you progress it? And when do you know when a player is ready to progress?

When is change of direction introduced? How do you introduce it? How do you progress it? And when do you know when a player is ready to progress?

When is speed introduced? How do you introduce it? How do you progress it? And when do you know when a player is ready to progress?

When is functional/sport specific introduced? How do you introduce it? How do you progress it? And when do you know when a player is ready to progress?

My answer guidance

Respondents guidance

Early, mid, late, after discharge from Physio treatment (modalities)/pre return to competition, post return to competition

Q20

Section

Return to Sport

Who is the question for?

Physiotherapists and S&C

Question

What happens in the handover between the Medical staff and S&C? (when, how is it done? – paper based, practically done i.e physio's show S&C what they want/have done and visa versa)?

Possible themes for analysis

Meetings, Email, Notes, Practical, Other

My question prompt

How is the handover done between the Physio and the S&C?

My answer guidance

Meetings, Email, Notes, Practical, Other

Respondents guidance

Meetings, Email, Notes, Practical, Other

Justification/rationale for asking question

Q21

Section

Return to Sport

Who is the question for?

S&C

Question

Are there any strength-based hamstring specific tests that you would incorporate into an S&C programme during the first block/cycle of a training programme after late stage rehabilitation (>21days) to determine adequate performance levels in healthy players? What are they?

Possible themes for analysis

Bridging (double leg, single leg), Repetition Maximum (RM) (1, 5, 10), deadlifts, single leg deadlifts, eccentric strength, isokinetic dynamometer, other

My question prompt

Do you do any strength-based hamstring specific tests in your S&C programme during the first block/cycle of a training programme after late stage rehabilitation (>21days) to determine adequate performance levels in healthy players?

My answer guidance

Bridging (double leg, single leg), Repetition Maximum (RM) (1, 5, 10), deadlifts, single leg deadlifts, eccentric strength, isokinetic dynamometer, other

Respondents guidance

Bridging (double leg, single leg), Repetition Maximum (RM) (1, 5, 10), deadlifts, single leg deadlifts, eccentric strength, isokinetic dynamometer, other

Q22

Section

Return to Sport

Who is the question for?

S&C

Question

After completion of physiotherapy led late stage (>21 days), what hamstring specific exercises, volume and loading would you typically include in the S&C programme?

Possible themes for analysis

Exercises, Volume, Loading

My question prompt

Once the injured player has finished with the Physio, what are the hamstring specific exercises you do in the S&C programme? What load and volume are they performed at?

My answer guidance

Respondents guidance

Exercises

Volume

Loading

Q23

Section

Return to Sport

Who is the question for?

S&C

Question

Other than strength-based exercises, what if any, velocity-based drills or exercises would you include and with what volume progressions during the first block of training?

Possible themes for analysis

My question prompt

What velocity-based drills or exercises would you include in your programme during the first block of training? What volume progressions would you include during the first block of training?

Q24

Section

Return to Sport

Who is the question for?

S&C

Question

During this block what speed progressions would you incorporate? How would the volume of these speed progressions develop?

Possible themes for analysis

My question prompt

During the first block of training, what speed progressions would you include? How would the volume of these speed progressions develop?

Q25

Section

Return to Sport

Who is the question for?

S&C

Question

How is the volume load of the player managed during this first block if training?

Possible themes for analysis

My question prompt

How do you manage the volume loading of a player during the first block of training?

Q26

Section

Return to Sport

Who is the question for?

S&C

Question

Are there any other of the physical conditioning sessions or pitch sessions modified during the first block of training?

Possible themes for analysis

Anaerobic sessions, taper before return etc

My question prompt

My answer guidance

Anaerobic sessions, taper before return etc

Respondents guidance

Anaerobic sessions, taper before return etc

Justification/rationale for asking question

Q27

Section

Return to Sport

Who is the question for?

Physiotherapist and S&C

Question

Do you have specific standardised or individualised return to competition (rugby) criteria for hamstring injuries? What factors influence these criteria?

Possible themes for analysis

Strength, ROM, Pain, training completed

My answer guidance

Strength, ROM, Pain, training completed

Respondents guidance

Strength, ROM, Pain, training completed

Q28

Section

Return to Sport

Who is the question for?

All, Doctor, Physiotherapist and S&C

Question

Do you have any predictors that will tell you a player needs to take more or less time to return to rugby?

Question type

Do you have any predictors that will tell you a player needs to take more or less time to return to rugby? Ql and Qt

1	Yes	
2	No	
3	No opinion	

If yes, what are they?

Q29

Section

Injury Prevention

Who is the question for?

All, Doctors, Physiotherapists and S&C

Question

Do you screen all (or some) players to identify players at increased risk of hamstring injuries?

If yes, what do you do and when do you screen?

If no, why?

1	Yes	
2	No	

Possible themes for analysis

Biomechanical, Postural, Strength, Range of Movement (ROM), Previous injury

My answer guidance

Biomechanical, Postural, Strength, Range of Movement (ROM), Previous injury

Respondents guidance

Biomechanical, Postural, Strength, Range of Movement (ROM), Previous injury

Q30

Section

Injury Prevention

Who is the question for?

Physiotherapists and S&C

Question

What elements do you see as the most important/valuable factors in the screening process?

Possible themes for analysis

Biomechanical, Postural, Strength, Range of Movement (ROM), Previous injury

My answer guidance

Biomechanical, Postural, Strength, Range of Movement (ROM), Previous injury

Respondents guidance

Biomechanical, Postural, Strength, Range of Movement (ROM), Previous injury

Q31

Section

Injury Prevention

Who is the question for?

Physiotherapists and S&C

Question

From a screening report, what are the key components that you use to design an individual programme for hamstring injury prevention and performance development?

Possible themes for analysis

Biomechanical, Postural, Strength, Range of Movement (ROM), Previous injury

My answer guidance

Biomechanical, Postural, Strength, Range of Movement (ROM), Previous injury

Respondents guidance

Biomechanical, Postural, Strength, Range of Movement (ROM), Previous injury

Q32

Section

Injury Prevention

Who is the question for?

Physiotherapists and S&C

Question

What are the key elements of an individual hamstring injury prevention and performance development programme?

Components of	Key component	Rank (1-5)
Prevention		
ROM		
Flexibility		
Strength – isometric		
Strength – concentric		
Strength – eccentric		
Strength endurance		
Power		
Speed		
Core stability		
Cardiovascular		
Agility		
Sport specific skills		
other		

Rank the components of prevention	
1	Most important
2	
3	
4	
5	Least important

Possible themes for analysis

Strength, strength endurance, strength – isometric, strength – concentric, eccentric loading, functional, game specific work, CV, agility, speed, power, core stability, flexibility, ROM, other.

My answer guidance

Strength, strength endurance, strength – isometric, strength – concentric, eccentric loading, functional, game specific work, CV, agility, speed, power, core stability, flexibility, ROM, other.

Respondents guidance

Strength, strength endurance, strength – isometric, strength – concentric, eccentric loading, functional, game specific work, CV, agility, speed, power, core stability, flexibility, ROM, other.

Q33

Section

Professional attributes of staff

Who is the question for?

All, Doctors, Physiotherapists and S&C

Question

Do you feel you have sufficient knowledge and/or sufficient training to optimally treat, rehabilitate and prevent hamstring injuries?

If yes, why?

If no why? What do you feel would help you to optimally treat, rehabilitate and prevent hamstring injuries?

No opinion

1	Yes	
2	No	

If yes, why?

If no why?

No opinion

Possible themes for analysis

Assessment, treatment, rehabilitation, S&C, biomechanics, prevention, return to sport, physiology, psychology

My answer guidance

Assessment, treatment, rehabilitation, S&C, biomechanics, prevention, return to sport, physiology, psychology

Respondents guidance

Assessment, treatment, rehabilitation, S&C, biomechanics, prevention, return to sport, physiology, psychology

Q34

Section

Professional attributes of staff

Who is the question for?

All, Doctors, Physiotherapists and S&C

Question

Do you feel you have enough resources to optimally treat, rehabilitate and prevent hamstring injuries?

1	Yes	
2	No	

If no, why? What would help you to optimally treat, rehabilitate and prevent hamstring injuries?

Possible themes for analysis

Equipment, gym space, pool, outdoor space, indoor space,

My answer guidance

Equipment, gym space, pool, outdoor space, indoor space,

Respondents guidance

Equipment, gym space, pool, outdoor space, indoor space,

Q35

Section

Professional attributes of staff

Who is the question for?

All, Doctors, Physiotherapists and S&C

Question

How long (full seasons) have you worked in Elite (professional) Rugby union and what are your qualifications?

Justification/rationale for asking question

To gain an understanding of staff experience.