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DISSERTATION ASSESSMENT PROFORMA:

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Student name:	Ross Powell	***Student ID:***	20033700
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Supervisor:	Jon Oliver		

Comments	Section
	Title and Abstract (5%) Title to include: A concise indication of the research question/problem. Abstract to include: A concise summary of the theoretical study undertake.
	Extended Introduction (20% [10%]) [2] To include: outline of context for the question; clear articulation and justification of the research question; indication of research expectations.
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SPORTS HERNIA REHABILITATION: A REVIEW AND CASE STUDY COMPARISON

Dissertation submitted under the Physiology & Health area

Ross Powell

ST20033700

SPORTS HERNIA REHABILITATION: A REVIEW AND CASE STUDY COMPARISON

BY ROSS POWELL

Cardiff Metropolitan University

Prifysgol Fetropolitan Caerdydd

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the detailed feedback and support to guide me through the current study.

ABSTRACT

This review pulls together the current literature about the characteristics, treatment, prevention methods, surgical procedures and post-surgical rehabilitation of sports hernias. Sports hernias usually occur during athletic activities that consist of sharp changes of direction, pivoting, kicking and twisting, such as those that occur during soccer, ice hockey

or football. The main cause of a sports hernia is from the weakening of the posterior inguinal wall from high rates of sheer forces going through an imbalance of abdominal and adductor muscle activation. It is so rarely diagnosed properly due to such a number of other related pathologies having to be ruled out before considering a proper diagnosis. Surgery is supported to be more effective than conservative treatment, and laparoscopic techniques are often preferred for a faster recovery time than open repair. The literature available to date addressing the cause, pathogenesis, diagnosis, and treatment of a sports hernia is confusing and difficult to pinpoint. In order to help organise and justify research, a comparison between what current literature recommends and what experience a 22 year old male soccer player had will be made. Considerations such as event of injury, exercises prescribed, type of surgery, rehabilitation programme and recovery time will be taken into account.

CHAPTER 1

INTRODUCTION

Merely mentioning a sports hernia (SH) sparks debate throughout the world of medicine as regards to its existence. Moeller (2007) believes it to be a groin injury that cannot be seen, felt, even imaged effectively, despite requiring surgery to alleviate symptoms. Moeller (2007) claims that it is the "hernia without the herniation", herniation meaning protrusion of tissue through an opening. Farber & Wilckens (2007) further mentions its difficulty to be diagnosed by physicians by the lack of understanding they have of a SH, on top of its absence of herniation. Demetrius (2011) describes a SH as being a syndrome of lower abdomen/groin pain and specifically defines it as a weakness or tearing of the transversals fascia resulting in posterior inguinal wall incompetency.

Past literature presents a diverse use of terms when researching a SH, Meyers (2008) referred to it as an 'Athletic Pubalgia' as he believed a 'SH' was far too simplistic for the amount of anatomical structures involved. There is often a lot of confusion around diagnosing the injury when there are a lot of different names associated with it. Two reviews by Swan (2006) & Farber (2008) identify a number of other key terms, just to name a few, include "Gilmore's" Groin, gracilis syndrome, hockey groin, oestitus pubis, sportsman's hernia and pectineus syndrome. Meyers (2008) suggests that the term 'SH' will be most commonly used because it is what the media has popularised due to its ease of pronunciation.

The pathology of the abdominal muscle linking to the groin pain is also often uncertain, Garrett's (1999) article briefly describes the anatomical issues. Small tearing of the lateral region of the rectus abdominis have been highlighted by Garrett, more knowingly, the adjoining oblique muscles and fascia seem to be the area of injury. This causes abdominal floor weakness which can allow formation of a direct hernia, this issue has been called a sportsman's hernia. Taylor (1991) & Meyers (1991) used the term 'Pubalgia' which signifies muscle injury/ groin pain which they found to be caused by "musculotendinous strains" of the inner groin and other muscles surrounding the hip joint, along with abnormalities in the abdominal wall. Meyers (2000) & Garrett (2000) in 2000 further summed up the mysterious injury as chronic lower abdomen and groin pain as a result of

hyperextension. "The SH is one of the least understood, poorly defined and under-researched maladies to affect the human body" (Nyland 2008, P954). Nyland argues that a SH is so rarely diagnosed properly due to such a number of other related pathologies having to be ruled out before considering a proper diagnosis.

A number of studies have found that a SH is most common in high impact team orientated sports. Polglase et al (1991) supports this and found a substantially unbalanced posterior wall of the inguinal canal in 85% of the 64 Australian Rules football players with chronic lower abdominal and adductor pain who participated in their study. Morelli et al (2005) found out that especially sports such as Australian Rules Football, soccer, tennis, ice and field hockey, groin injuries may represent 5–7% of all injuries. Garvey et al (2010) further support SHs being most common in soccer players, but also agree that it can occur in any sport that involves repetitive energetic kicking, sudden acceleration, twisting, turning, cutting movements or even coughing and sneezing soon after sustained injury.

Preventative programmes are mainly assigned to "at risk" sportsman, Garvey (2010) helps shed further light on what preventative measures are taken to help such athletes. He suggests that adductor strengthening, motor control, muscular balance and flexibility could help prevent against sustaining a SH. There are two ways of rehabilitation, one is conservative treatment which is a period of physiotherapy with no surgical intervention. Le Blanc's (2003) study shows that traditional conservative methods tend to have low success rates. Nyland (2008) highlights that conservative treatment is a continued version of the preventative programme after diagnosis for about 10 weeks and agrees with Le Blanc's (2003) research by stating that pain does gradually return to region at some point during season, resulting in more rest and ceasing of sporting activity, limiting performance. Farber & Wilckens (2007) along with Polglase (1991), found that SHs, unlike other groin injuries, do not improve without surgery. Nyland (2008) suggest that there are two types of procedures, *open* and *laparoscopic,* regardless of which one used, Meyers et al (2002) found a 65-95% success rate was evident to those who showed symptom relief and activity resumption.

Post rehabilitation literature combined from Garvey (2010), Nyland (2008), Demetrius (2011) and Meyers (2007) generally suggests very minimal movement in the early stages days after surgery. Garvey (2010) believes a focus should be put on implementing core stabilisation exercises, maintenance of good motor control and strength around pelvis and

adductor muscles. Garvey (2010) also suggests a 3 month rehabilitation period in 2 week stages of progression of core exercise repetitions, weight and cardiac intensity on treadmill/ indoor cycling. Despite Garvey (2010) providing an ample amount of evidence to support a 3 month programme, Hemingway (2003) provided a programme taking half the time to recover in 6 weeks with just one week progressions. Partial agreement was shown with similar target areas such as core, weights and cardiovascular work but Hemingway (2003) focused more on the range of motion in the hip and flexibility exercises. In brief, this included one week progression steps such as starting with isometric core exercises and stair climbing for week 1, week 2/3 rotational stretching around pelvis, progressing up to sprinting and multidirectional running and light ball work in weeks 5-6. A 90% success rate of recovery in the study was shown with a strong body of evidence to support the 6 week programme such as Gilmore (1995), Fricker (1997), Kemp (1998) and Norris (1998).

This review will explore the evidence shown for the diagnosis and characteristics of a SH, the conservative treatment and prehabilitation process, surgery and postoperative rehabilitation. Recommendations will be made based on the evidence and then those recommendations will be compared to a case study of a 22 year old male.

CHAPTER 2

CHARACTERISTICS OF A SPORTS HERNIA

2.1 Pathogenesis

Demetrius (2011) refers to a SH as being a syndrome of lower abdomen/groin pain and specifically defines it as a weakness or tearing of the transversals fascia resulting in posterior inguinal wall incompetency (See figure 1).

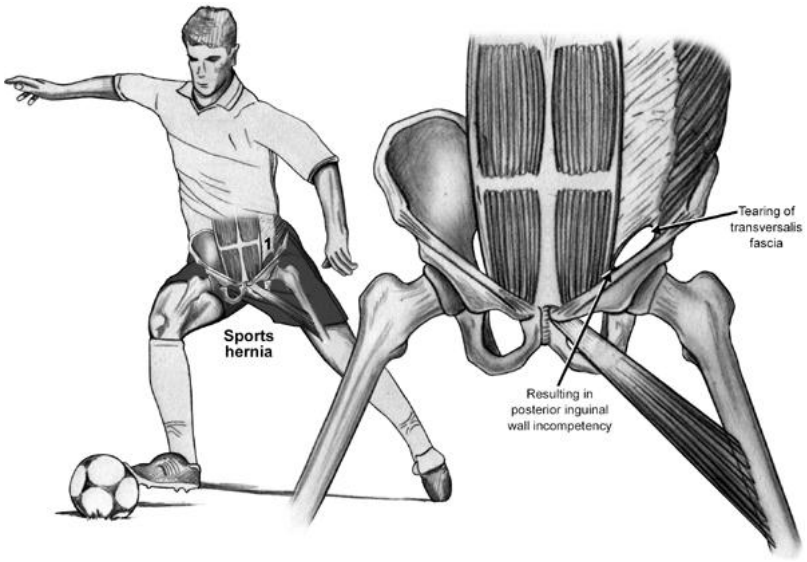


Figure 1: Mechanism of injury of sports hernia (Gerhardt, 2007, p531)

The anatomy of the injury is expressed in more depth by Larson (2014) as the pubic symphysis represents a kind of centre piece for the anterior pelvis, and the structure involved in the emerging SH/ Gilmore's groin, have a close relationship with the centre piece. From the surface of the injury to deep within it, the abdominal wall's framework is "external oblique connective tissue (fascia) and muscle, internal oblique fascia and muscle, transversus abdominus muscle and fascia, and the transversalis fascia" (Larson, 2014). Larson (2014) also suggests that Rectus abdominus fibres, a conjoint tendon (combined internal oblique and transversus abdominus), and external obliques all merge to form the 'pubic aponeurosis'. (Whitish fibrous membrane) This pubic aponeurosis joins with the adductor and gracilis origin, also known as the rectus abdominus (Figure 2).

A lot of literature such as Malycha & Lovell's (1992) work describe a SH as a 'bulge' that creates lower stomach or

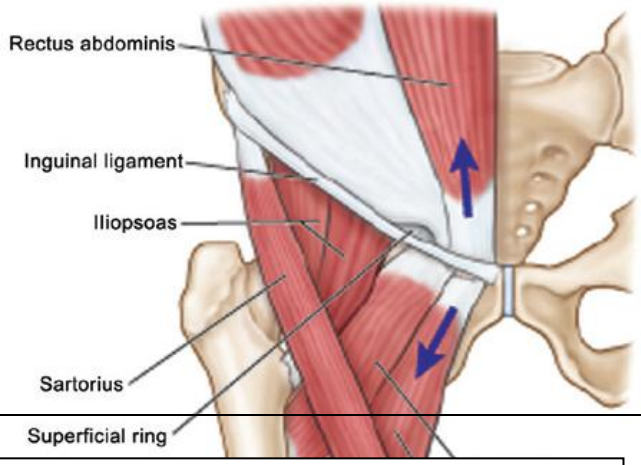


Figure 2. Injury site at abdominal wall, the fascial attachments of the rectus and adductors as pubis is implicated in a SH.

adductor pain, resulting in a loss of inguinal canal integrity with absence of a true hernia. This nature of the SH is explained by Nyland (2008) as being due to the bulge being only present for a few days after the injury and must be palpitated in order for the bulge to reappear for diagnosis and treatment. Multiple other SH definitions by the likes of Paluska (2005) include irregularities of the rectus abdominis muscle (shown figure 2), tearing part of the internal oblique muscle fibres from the pubic tubercle or irregularities of the aponeurosis. Nyland (2008) adds that the inguinal wall may be caused to dilate and weaken by these variant conditions highlighted by Paluska (2005). “Anterior inguinal wall defects have also been identified via surgical exploration in up to 80% of athletes who experience chronic groin pain” (Nyland, 2008). Nyland (2008) implies with this statement that the true origin of SHs is hard to properly examine without surgical investigation, confirming its difficulty to diagnose.

2.2 Differential diagnosis

As briefly touched upon before, a SH has a variety of terms associated with it as identified by Swan (2006) & Farber (2008) such as ‘Gilmore’s Groin’ ‘Athletic Pubalgia’, ‘gracilis syndrome’, ‘hockey groin’, ‘oestitus pubis’, ‘sportsman's hernia’ and others.

Farber & Wilckens (2007) suggests that SHs are characterised by entrapment, overuse, gradually worsening with time, one sided groin pain that may spread to the scrotum or perineum and upper middle thigh. Pain radiating to the scrotum is reportedly present in approximately 30% of symptomatic individuals according to Morelli’s (2006) study. Anderson (2001) argues that despite there being clear description of signs and symptoms of chronic groin injury, it’s not clear how they contribute to differential diagnosis. According to Diaco et al (2005), an in depth history questionnaire with a focused physical examination is usually carried out and an important aspect of consultation with the doctor or physiotherapist. Moeller (2007) discovered that between 27% and 90% of sports people who showed SH-type symptoms had multiple pathologies which supports its difficulty to diagnose and boosts the need for a multidisciplinary examination.

2.3 Physical examination

Kachingwe (2008) found that patients tended to remember the small vague event of when the injury happened during an activity. Garvey (2010) extends on this and mentions how the pain is usually present for just a day or two after the event of injury, usually involving stiffness and difficulty getting out of the car or out of bed in the morning. Garvey (2010) states that a SH pain only lasts a day or two but when resuming the activity (i.e. football), pain will come back and gradually worsen.

Farber & Wilckens (2007) believes this is the reason why athletes are out for so long with a SH, taking season transition off as rest, not knowing that as soon as they start preseason in a month, the pain will return. Hemingway (2003) agreed with Farber & Wilckens (2007) and Garvey's (2010) outlook on the injury and suggested that without surgical intervention, rehabilitation is very unlikely to take place without the return of symptoms.

Brown et al (2013) among others such as Nyland (2008) and Garvey (2010) all agree that physical examination is the best method to diagnose a SH, along with a pre examination questionnaire involving the lead up to the injury and history. Brown et al (2013) highlighted the following upon examination of a SH;

- Tenderness on touch around pubic symphysis
- Dilation of the superficial inguinal ring.
- A 'Direct Stress' test is issued, involving: Feeling over the superficial inguinal ring while person is lay down in a supine positon causes distress. Further continuing to apply the same pressure over the superficial ring and getting the patient to a straight-leg raise causes increased pain, (see figure 3).

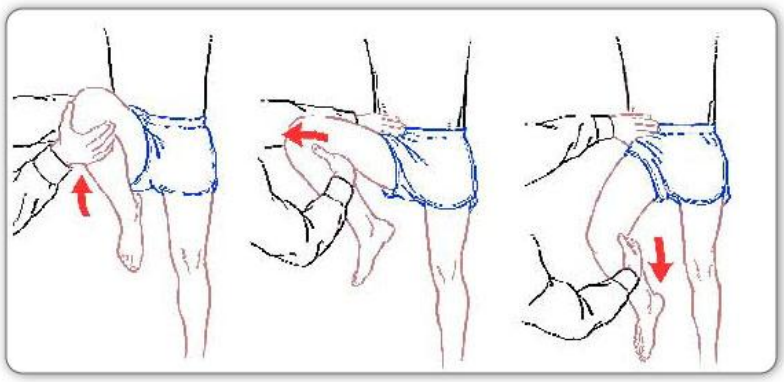


Figure 3. Diagram of a 'Direct Stress Test' (Moore, 2014)

Kachingwe (2008) drew from their own experiences and case studies, with 5 signs and symptoms that they felt most indicated a SH: "(1) a subjective complaint of deep groin/lower abdominal pain, (2) pain that is exacerbated with sport-specific activities such as sprinting, kicking, cutting, and/or sit-ups and is relieved with rest, (3) palpable tenderness over the pubic ramus at the insertion of the rectus abdominis and/or conjoined tendon, (4) pain with resisted hip adduction at 0, 45 and/or 90 degrees of hip flexion, and (5) pain with resisted abdominal curl-up." Kachingwe (2008) here highlighted 5 good ways of finding out whether a SH is present, which are carried out in a clinical environment from your physician.

CHAPTER 3

TREATMENT & PREVENTION

3.1 Conservative treatment

Several studies including Demetrius (2011), Larson (2013) and Waryasz (2010) all found that not all patients with a SH require surgery, and that a trial of conservative therapy should be the first treatment plan. Demetrius (2011) believes that conservative treatment should be a priority measure, especially in professional athletes, suggesting a four week trial of rest and even selective steroid injections to the rectus abdominus insertion. Demetrius (2011) also feels this measure is sufficient during a season as a temporary measure to get the athlete through until the end of the season, at a time where surgical intervention would be more ideal due to the rest period before the following season.

In the majority of cases, Moeller (2007) believes conservative treatments are sufficient at relieving discomfort and an athlete's resumption to sport. Moeller (2007) agrees with Demetrius (2011) outlook of conservative content with programs of a therapeutic and functional nature, with stretching and analgesic medications (oral, topical, or in some

instances injected). The most crucial intervention would be activity modifications as Moeller (2007) adds which in some cases may lead to complete recovery, however stresses that most cases ultimately require surgical intervention. These modifications include gentle core exercises, adductor strengthening and flexibility training and a graduation of low impact cardio vascular exercise and eventual prolonged running as Larson (2013) suggested.

Polgase (1991) argues against using contemporary treatment to get an athlete to the end of a season with injections as Demetrius (2011), as it puts the athlete's body through unnecessary stress and could lead to further imbalances of the muscles. Polgase (1991) states that conservative treatment will always be limiting to the athlete as they could never really overcome the SH and will limit their season length, career and performance level. Knowledge of SHs has come a long way since Polgase in 1991 and research has come a long way since then. Demetrius (2011) does state that playing through the pain does not worsen the tear itself, however lacking evidence to back up the statement generally leaving it up to the athlete.

The content of the conservative treatment involves between 4+ weeks and 3 months of closed-chain lower intensity workouts through the resting stage (Demetrius, 2011). Once the resting stage is done (4 weeks), Larson (2013) a functional resumption to sport evaluation can be carried out to see whether the athlete is able to return to playing in the season. Suggestions of core stabilisation, postural retraining, and resetting of the dynamic relationship between hip and pelvis muscles are key according to Larson (2013). Although normalisation of the hip and pelvis range of motion is reasonable, Larson (2013) further stresses how forcible struggles at improving range of motion (ROM) or functional activities that present pain should be avoided as it could lead to increased hip pain.

Waryasz (2010) stresses avoidance of deep hip flexion with heavy weight bearing activities and instead do high repetitions with light weight to make the recovery as pain free and gradual as possible. In contrast, Larson (2013) believes after the 4 week rest period, resumption of sport can sometimes be possible, which is not recommended by both Waryasz (2010) and Demetrius (2011).

There is very little data recording the effectiveness of conservative treatment for athletic pubalgia/SH. However, Paajanen et al (2011) carried out a randomised study of athletes with chronic groin pain/SH analysing conservative treatment with laparoscopic mesh

repair. The results showed that 7 of 30 subjects who underwent just the conservative approach, only 50% returned to sport at 1-year follow-up with the rest having continued symptoms. Through surgical intervention 29 of 30 subjects resumed complete sporting activity and had no symptoms at 1-year follow-up. Paajanen and colleagues (2011) research suggested that conservative treatment can be effective for a small percentage of the athletes but the more successful method is through the path of surgery.

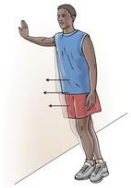
3.2 Prevention/ Prehabilitation

Current literature implies that conservative treatment is a good base to move on to surgery but also as a “prehabilitation” strategy perhaps which would be done in preparation for surgery. Conservative treatment will always be limiting Polgase (1991) believes, but agrees that conservative treatment is a good temporary measure to kick-start rehabilitation as do a majority of studies by Demetrius (1011), Larson (2013) and Waryasz (2010).

A cohort study on NHL players was carried out by Tyler et al (2002), involving a groin injury prevention program which looked at the effect of adductor strengthening and functional exercises. These resulted in a decrease of adductor injuries in at-risk players. A subject was deemed being “at risk” if the adductor-to-abductor strength ratio was less than 80%. The occurrence of groin injuries before the intervention programme was 3.2 per 1000 player-game exposures, in contrast with 0.71 per 1000 post intervention. From Tyler et al’s (2002) study it appears risk stratification of groin injuries is possible, however highlighting athletes at risk for an actual SH could be more difficult. In summary of the study, it discovered that prevention programs may decrease the possibility of muscular strain type injuries, but their prevalence in preventing SH is yet to be desired.

Gluteal stretch

Iliotibial band stretch (standing)



Iliotibial band stretch (side-leaning)

Straight leg raise

Prone hip extension

Side-lying leg lift

Limitations of the study are elements such as length of the study needing to be longer, as 6 weeks is a relatively short period of time to measure

Wall squat with a ball

Clam exercise

progress, perhaps a year would be better to give more data and reliability within the study. Consideration towards it being an effective intervention for groin injuries but not specifically SH injuries would be a stepping stone for targeting SH in the future to give further relevant data.

Figure 4. Larson's (2013) recommended conservative/ rehabilitation exercises for core and stabilisation.

Farber & Wilckens (2007) builds on that by recommending conservative treatment as not only a treatment, but also as a preventative measure so it does not happen again to the athlete or incidence not occurring in the first place. Farber & Wilckens (2007) believed similar core stability exercises and hip strengthening to that of Larson's (2013) could be utilised post rehabilitation too, suggesting core, flexibility (see figure 4), strengthening and gradual implementation of cardiovascular exercise. This was to prevent an imbalance of strength in the hips as the injured hip could potentially recover stronger, which Farber & Wilckens (2007) suggested could cause injury to the other side. So these strengthening, flexibility and improvements in rotation around the hip are also recommended for maintenance even when fully recovered.

CHAPTER 4

SURGICAL INTERVENTION

As emphasised previously by the works of Polgase (1991) and Paajanen et al (2011), conservative treatment is not enough on its own to recover from a SH. The importance of surgical intervention is crucial for full rehabilitation without any lingering symptoms suggests Garvey (2010) and that the presence of a SH is a clear indication for reconstructive surgery to happen. Garvey (2010) does however stress the importance of how physiotherapy (conservative treatment) and surgery should go hand in hand in the

rehabilitation process and how not only one should be used.

4.1 Two most common types of surgery

After analysis of literature involving the current range of surgical operations it suggests that the two most common types of surgery are open and laparoscopic surgery.

Brown et al (2013) defines open surgery techniques as often varied but mainly modifications of the classic Bassini repair technique which aims to reinforce the abdominal muscles or fascia near the inguinal ligament. Compared to the alternative laparoscopic approach which is suggested by Brown et al (2013) to be the preferred technique amongst surgeons using a form of mesh to reinforce the posterior abdominal wall.

The method of open repair surgery consisted of an incision on the external oblique muscle to open the inguinal ring. This enabled examination of the ring and whether an indirect hernia was present, the repair was then to reconstitute the inguinal ring, refer to Hackney (1993) for more depth on the procedure. Hackney (1993) suggests that the findings at examination depend on duration of symptoms with abnormalities becoming more obvious with time and stress on the site. There is indication from Hackney (1993) that there were few reports of similar procedures but this could be due to the age of the study.

Larson (2014) shows the currently used types of surgical repair that can be carried out on a sports hernia (see table 1). The table summarises the successful resumption of sport from each method and the different researchers who have investigated them. From observing table 1 it is evident that the most studied types of repair so far is open and laparoscopic surgery, with those including mesh repair being the most successful. The table below summarises the four studies that were carried out on different surgical repair types, primarily open and laparoscopic techniques as they are seen to be the most successful.

Table 1. Outcomes after surgical management of athletic pubalgia/ sports hernia

Reference/	Repair	Sample	Sport	Gender (M/F)	Outcome

Study	type	Size	(Majority)		
Hackney (1993)	Open/no mesh	15	Runners, Rugby,	14/1	87% return to sports
Kluin et al (2004)	Laparoscopic/ mesh	14	-	14/0	93% return to sports
Gentisaris et al (2004)	Laparoscopic/ mesh	131	Soccer	131/0	100% return to sports
Jakoi et al (2013)	Various types	43	Hockey	43/0	80% return to sports

4.2 Discussion of studies of sports hernia surgery (table 1)

The review will now examine a few of these studies in more detail to fully understand the best surgical method for repair of a SH. Starting with Gentisaris et al (2004) which is suggested to be the most successful study of laparoscopic mesh repair. 131 professional athletes were operated on with 114 of those being soccer players and all athletes being male over a period of nine years between 1993 and 2002. In critique of the study, there could have been more variation in gender and also the sports the athletes took part in just to get a wider more applicable sample. In fact, between all five studies there has only been one female involved which was in Hackney (1993) study. This could be because the majority of sports hernias tend to occur in males as Nyland (2008) found, so could have been the reasoning behind the focus on males in these studies.

However, conservative treatment was used appropriately over the first 2-8 months which agrees with Moeller (2007) suggestions for being a good method to see if a SH is actually present. Physical examination revealed 123 of the 131 athletes showing signs of a SH such as a dilated external ring of the inguinal canal which meant operational intervention was needed. Mesh (polypropylene, 12 × 15 cm) was implanted in the posterior wall of the inguinal canal for reinforcement which is also known as laparoscopic surgery, for full procedure refer to Gentisaris et al (2004). Overall, the study showed good protocol with diagnosis, procedure and 100% success as table 1 shows. However it could have been made more widely applicable with more varied subjects regarding gender and sport.

The least successful type of surgery was from Hackney's (1993) study (see table 1) with 87%, which still seems to be a high success rate but with only studying 15 subjects it does not transfer that great compared to Gentisaris et al's (2004) work on 131 subjects. Although, Hackney (1993) does try to get a range of sports persons in the selection with not only soccer players but runners, rugby and netball players with different genders which is more widely applicable.

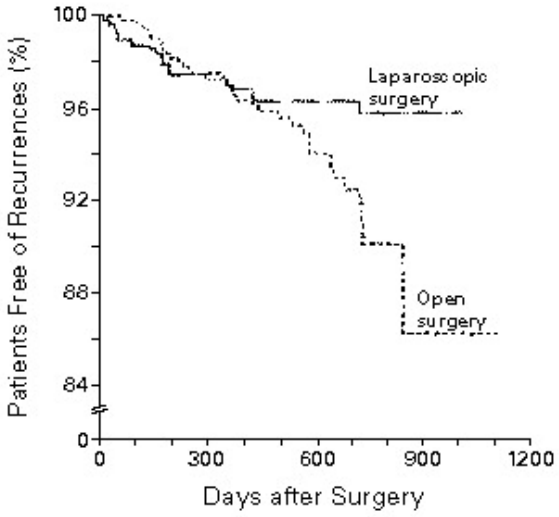
4.3 Open vs Laparoscopic methods

Liem et al (1997) carried out a study comparing the two surgical procedures with 487 patients being treated laparoscopically and 507 patients treated through open repairs. At this point in time, laparoscopic surgery was only just developed, providing a need for such a study. Liem et al (1997) shows good study design due to the large sample size used and comparing the different techniques correctly.

The results of this study showed that athletes with inguinal hernias rehabilitate more quickly and less recurrences occur post laparoscopic surgery than post open repair. The length of the procedure was only five minutes longer with laparoscopic repair, catering little support for the general belief that this procedure consumed more time than open surgery. The majority of the laparoscopic operations were carried out with general anaesthesia, though 60 percent of the open operations were reportedly performed with spinal anaesthesia.

Using general anaesthesia may be seen as a disadvantage of laparoscopic repair as sickness and vomiting has been seen to occur. Factors such as heart rate, blood pressure, heart rhythm, body temperature, breathing and need for fluid or blood replacement will be monitored which could also complicate the procedure so Cambridge university hospital (2012) suggests. Nonetheless, the laparoscopic surgery group were released from hospital sooner and had less postoperative discomfort than patients in the open-surgery group.

Clinically it is very important to examine the differences of reoccurrence between the two groups (see figure 5). Figure 5 displays how much more quickly laparoscopic patients are free from recurrences than those who underwent open repair surgery. The longer the follow up, the more recurrences are expected in the open-surgery group as these late recurrences may be only prevented by supporting the groin region like the laparoscopic mesh repair provides. Therefore a late recurrence post laparoscopic repair may be not so common as mesh is used in routine to reinforce and stabilise the groin region internally.



It would seem based on Liem et al (1997) and several other studies that laparoscopic surgery is the preferred method of repair for SH and is proved to be the more effective and durable type for optimal rehabilitation. However, other variables apart from the surgery itself of course depend on how well an individual recovers from a SH. Post-operative rehabilitation protocol and programming must be optimal to ensure the surgery is justified and utilised to its full potential.

Figure 5. Kaplan–Meier Curves for Recurrence-free Survival in the Open-Surgery and Laparoscopic-Surgery Groups.

CHAPTER 5: POSTOPERATIVE REHABILITATION

5.1 Postoperative approach

Both post-operative and non-operative conservative treatments have similar stages and steps to recovery according to Ellsworth et al (2014). The process and type of exercises that are involved in the recovery process from surgery are those similar to that of conservative treatment, (Garvey 2010). There is a lack of research on what regime to follow post operation of a SH, so the review will now focus on if there are any common concepts amongst surgeons that stand out in current literature. With the understanding that individual surgeons will have their own specific recommendations, it would useful to research to see if there are any trends in aspects such as speed of recovery, stages, type of exercises and how soon after surgery they can start physiotherapy. Five studies, Ellsworth (2014), Nyland (2008), Demetrius (2011), Rabe (2010) and Garvey (2010) describe surgical rehabilitation in a variety of ways but more detailed descriptions are generally lacking. Table 2 summarises the five studies and their recommendations that they each proclaim to be the best method of rehabilitation from a SH. Considerations such as what type of exercises, when the exercises are introduced, periods between progression and the time taken for the resumption of sport will be taken into account.

Table 2: 5 different post-operative rehabilitative processes

Study	Type	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7-8
Ellsworth (2014)	Review	- No lifting. - Gentle walking (flat)	-Palpation assessment -Light resistive activities	-Standing hip exercises -Gentle stretches -Jogging	-Bilateral balancing. -Begin core exercises.	-Pain monitor levels. -Increase core exercise load. -Running	- Use all planes of core mobility. -Weight progression -Sprints	-Agility drills -jog/sprints -Plyometrics -Resume 2-3 months
Nyland (2008)	Review	-Gentle stabilisation exercises -Walking.		-Progression from walking to jogging/running. -Straight line running		-Coordination and stabilising exercises progressed.	- Resumption of sport.	
Demetrius (2011)	Review	-Weight bearing as tolerated.	-Wound evaluation.	-Gentle hip range exercises. -Jogging	-Light abdominal core exercises	-Sport specific activity as tolerated. -Running	-Resumption of sport	
Rabe (2010)	Review	-Daily living -Walking	-Incr walking -Stretches	-Stationary cycling. -Jogging	-Core exercises, lower back & abductors	-Progress previous. -Massage.	-Functional activities (turns).	-Return to sport
Garvey (2010)	Review	-Build walking patterns -Regular squeeze test measures throughout.	-Safe core stability exercises. -Light jogging	-Running progressed into straight line speed.	-Progress Core exercises	-Running in different directions.	-Typically rehabilitation takes 3 months after surgery to resume to sport.	

5.2 Comparison of recommendations between the five studies (see table 2)

In general, they all follow the same principles where there is a focus on minimising pre-existing risk factors, encouraging core stability exercises, motor control, strengthening around the pelvis and increasing range of motion around the hip. Furthermore, table 2 shows a clear progression from walking to jogging, to sprinting, and then more functional sport specific movements. The reviews vary slightly in where these stages are implemented such as jogging is only introduced at week 3 by Ellsworth (2014), Rabe (2010) and Demetrius (2011), whereas running is started at that stage by Garvey (2010) and Nyland (2008).

A few more notable differences are evident between the 5 reviews, Demetrius (2011) urges that the athlete starts weight bearing activities as soon as possible after surgery whereas the other four studies suggest starting between weeks 2 and 3. Interestingly, although Garvey (2010) seems to push the stages sooner than the rest, resumption of sport is said to be as long as 3 months compared to the generic 6-8 weeks of the rest who take a more tentative approach to the stage progression. With all reviews considered, an individual's response will vary to each programme of rehabilitation and the body is expected to recover at different rates (Ellsworth, 2014). To help measure such variants, Garvey (2010) highlights the use of a squeeze test which is used as a measure of strength of the adductors which can help judge progress and dictate when to move on to the next stage.

Walking is encouraged early in the recovery process so Nyland (2008) suggests and it should be built up gradually into jogging and straight line running, usually around 3-4 weeks post operation. The Straight-line running should avoid cutting movements and sport-specific functional activities may commence around postoperative day 21. However, Ellsworth (2014) believes that sprinting with no cutting should be started by the fifth postoperative week and runners subsequently would return to full competition within 2- 3 months (same as Garvey 2010), suggesting a longer recovery period. Nyland (2008) states how recovery after laparoscopic repair usually takes between six and eight weeks before full resumption of activity is permitted.

Strengthening of the core muscles, lower back and groin region are generally carried out

with stretching and massage in the third week, Rabe (2010). Two of the other studies agree with the timing of core exercises except Ellsworth (2014) and Demetrius (2011) who both seem to take a more tentative approach by engaging core stability exercises in the 4th week.

It is evident that there are differences in preference when it comes to designing a post-operative rehabilitation programme for an athlete but all follow a similar stage progression system. Rabe (2010), Demetrius (2011) and Ellsworth (2014) go for a more cautious approach with the first week being more treating to wound an initial primary attention. Whereas Nyland (2008) and Garvey (2010) believe it is best to start physiotherapy right away with daily activities and basic movements. However, progress should be judged by the patient's fitness and strength around the injury not the week that they are on after surgery due to the different recovery rates in individuals Demetrius (2011) proposed. Garveys (2010) adductor squeeze test could be used as mentioned previously to judge the progress of recovery, for example if there was limited response to surgery early on, you would not progress the athlete yet.

5.3 Testing/ monitoring progression

In order to have safe progression through the different stages in the recovery from the SH, Garvey (2010) believes it requires the monitoring of objective measures like the adductor squeeze test and hip flexibility (see figure 6). Garvey (2010) adds that pubic symphysis shear tests have now been created to guide the start and development of running and has shown to be more reliable than pubic bone palpation. Nevin and Delahunt (2013) explored adductor squeeze test normative data for healthy rugby players and those with a groin injury and found that healthy norms were 269 ± 25 mmHg and those with groin injuries to be lower at 202 ± 36 mmHg. This normative data would be a good indicator as to how far off the athlete is onto optimal groin strength. Garvey (2010) emphasises the importance of clinical outcome measures as they can guide recovery, this is done by exercise being encouraged to the point of pain tolerance with modification of

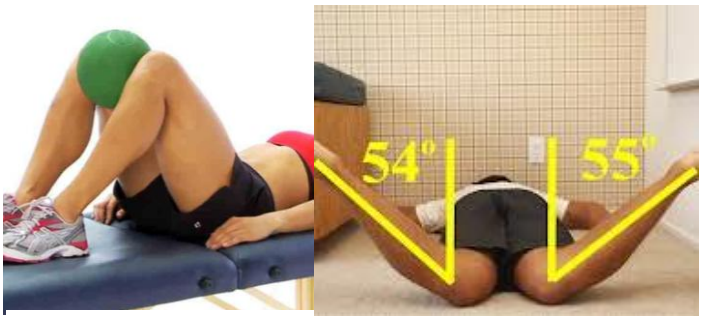


Figure 6. Adductor squeeze test (left). Hip flexibility test (right)

activity in relation to clinical indicators.

5.4 Core exercises

Gretchen et al (2010) studied the importance of a strong core and functional posture in relation to injury and found an extremely strong relationship between the two. "A strong and stable core allows one to transfer energy effectively as well as reduce undue stress" (Gretchen et al, 2010). A weak core therefore supposedly results in other parts of the body being under stress and compensating for the lack of force production which leads to injury. Garvey (2010) mentions that progressions are made in the form of adding limb movements in stable positions in order to make it more difficult, eventually into functional more sport specific movements. A large amount of focus is shown to the development of a solid and strong single-leg position, with external loads being added for progression onto cables for example, Hemingway (2003). Functional and dynamic are eventually progressed into which use controlled lateral movement such as a slide board which Garvey (2010) suggests with emphasis given to the strengthening of the adductors.

5.5 Hip stabilisation/ Stretching

Witvrouw et al (2004) researched the relationship between having good flexibility and the occurrence of muscle strains and injury and found that stretching does help prevent and increase the success rate of recovery. However stresses that there is a deficiency of research supporting the role of stretching in footballers so the assumption should be accepted with caution. Although there is a large amount of general agreement that stretching is beneficial for injury prevention and recovery, there is a lack of statistical evidence as it is rarely systematically observed so Witvrouw et al (2004) states. Shrier (2008) agrees with the fact stretching is beneficial to health but again questions the research behind it and says there is not enough done as to *when* an athlete should stretch and how long before or after exercise. These are all small considerations that should be taken into account when devising a rehabilitation programme such as timing and length of stretching as it could ultimately affect the speed of recovery. Stretching as regards to the adductors, Garvey (2010) trusts that it is a clinical criteria that would determine the return of an individual to sprinting, for this it should be pain-free and provide a strong squeeze test.

5.6 Sport specific rehabilitation

Hemingway (2003) mentions how a player will begin with a walk/run pattern every other day and build the players capability under stress. Monitoring of the player is done closely and any unexpected occurrences within the two days of rest then the programme will recommence to the previous level of activity. Larson (2014) proposes this is carefully judged with pain tolerance of the athlete as they gradually run further/faster. Meyers (2002) recommends this be done in the form of “Box Runs” to gradually improve time and speed of 12 laps of a football field. So jogging moves to running and then running into straight line sprinting, sudden changes of direction and then accelerative drills. Hemingway (2003) expresses how this is done to build the strength and durability of the hips and groin before sudden changes of direction is added. Mullens (2012) states how the pain will occur immediately after hyperextension of the injury, so strengthening the inguinal region before sudden twists and kicking will avoid disrupting the healing process. So, Ellsworth (2014) agrees that during the last week of rehabilitation, kicking and other power activities consisting of direction and speed are built in, with sport specific drills to ease the player to a competitive environment.

Table 3. Recommended post-operative rehabilitation programme based on literature.

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7-8
- No lifting. - Gentle walking (flat)	-Palpation assessment (ongoing) -Light resistive activities (high reps, light weight build)	-Standing hip exercises -Gentle stretches (Progress) -Jogging (straight lines)	-Bilateral balancing. -Begin core exercises. -Adductor strength machines (progress)	-Pain monitor levels. -Increase core exercise load. -Running (straight lines)	- Use all planes of core mobility. -Weight progression -Sprints	-Agility drills -Sprints (changes of direction) -Using lateral more functional movements. -Plyometrics -Resume sport

CHAPTER 6: SUMMARY OF REVIEW

6.1 Summary of review

Sports hernias occur primarily in males and those who participate in sports that contain cutting, pivoting, twisting and turning such as football, hockey and rugby as Nyland (2008) proposes. It is further described by Demetrius (2011) as a distinct syndrome of lower abdomen and groin pain that is also found predominantly in high-performance athletes. There is huge variety in the number of terms used for a sports hernia as Farber (2008) identified in the literature such as “Gilmores Groin”, “Athletic Pubalgia” and “Hockey groin”.

The anatomy of the injury has been described by a number of studies which have been drawn upon by this review. A SH involves a weakness/tearing of the transversals fascia, which results in posterior inguinal wall incompetency (Demetrius 2011). This incompetency in the inguinal wall created a reliance on other muscles to compensate for the stress (Garvey 2010). The literature has stressed how a sports hernia is difficult to diagnose and Swan (2006) believed it to be due to its misconception of being a regular groin strain. Garvey (2010) states unlike a groin strain the symptoms are only present for a couple of days resting but as soon as sport is resumed, the symptoms come back and worsen the injury site. This leads to difficult diagnosis because the symptoms are only clear for a few days and are often hard to pinpoint in the physical examination process which Brown et al (2013) described.

It is not currently known what the exact sequence of events leading up to sports hernia occurrence are but imbalances in abdominal/ hip adductor muscle strength, endurance and coordination along with poor hip range of movement could be a primary indicator. A series of repetitions at high intensity going through pelvic attachments could play a large part so Morelli (2005) implies. That’s why more focus in strengthening and stretching these areas around the hip joint has been found in literature to be an effective rehabilitation recommendation. Poorly planned off-season training programmes that concentrate on leg strength–power improvement while abandoning synergistic abdominal and core muscle group strength, endurance and coordination may be connected to the growing number of sports hernias that are being conveyed (Fricker,1997).

Having reviewed the current literature, it is apparent that sports hernia surgery is significantly more effective than conservative treatment alone. Although conservative treatment should play a part while the athlete is waiting for surgery or to use as a

prevention tactic to avoid further hernias arising. Polgase (1991) is one of several researchers that agreed with the surgery pathway in the review but also stressed conservative treatments importance alongside surgery. Two main types of surgery found to be best are open repair and laparoscopic repair surgery, identified by Brown et al (2013). Laparoscopic repair, as well as being a minimally intrusive approach, it also enables a quicker rehabilitation progression and possibly a faster resumption of sporting activities than open repair (Brown et al, 2013).

Rehabilitation recommendations vary slightly in the literature in regards to recovery time, stage progression, when to involve weight bearing activities, when to start core and deep abdominal muscle work and finally begin more functional training. However, the type of exercises that were suggested were all very similar but discrepancies in when to introduce them was the main difference. All studies followed the same principles by which cardiovascular level was built up slowly from walking to jogging to running in straight lines to then functional side to side and twisting drills. A focus on core exercises was another main theme usually brought in around 3 weeks after the operation alongside hip mobility exercises.

Demetrius (2011) stated that progression would be judged by the athlete's stability and strength around the adductors and not the week that they were on after surgery due to the different recovery rates in individuals. Garvery (2010) suggests an adductor squeeze test would be ideal as a measure of progress. Gradual squeeze pressure would gradually improve towards the healthy norm of 269 ± 25 mmHg, judging when would be best to move onto the next stage. A table of recommendations based on the reviewed literature has been created that can be used as a template for future cases of sports hernia incidence by physiotherapists and athletes.

6.2 Table 4. Step by step recommendations on dealing with a sports hernia

Step	Recommendations
1	**Self-recognition:** If lower abdomen/adductor pain is present (sometimes bulge) see physician immediately as sports hernia symptoms quickly cease after day or so until disrupted again, especially after sharp twisting and lateral movements, (Malycha & Lovell, 1992).

2	**Physical examination/ Diagnosis:** 'Direct Stress' test (figure 3) is issued, involving: Feeling over the superficial inguinal ring while person is lay down in a supine positon causes distress. Further continuing to apply the same pressure over the superficial ring and getting the patient to a straight-leg raise causes increased pain, (Brown et al, 2013).
3	**Trial Conservative treatment:** Conservative treatment should be used as an initial measure as the hernia may not be critical enough to require surgery, Moeller (2007). Some cases, 4 weeks rest and a programme of core stabilisation, flexibility, strength and ROM exercises around hip & pelvis along with building levels of cardiovascular activity into functional activity could result complete recovery, (Farber & Wilckens, 2007).
4	**Surgery:** If conservative treatment fails then surgery is the only option and usually is the only way to ensure complete recovery with no return of symptoms, (Polgase, 1991). The Laparoscopic surgical repair technique using mesh showed to be the most effective and quicker to recover as Liem et al's (1997) study showed.
5	**Post Operative rehabilitation:** Table 3 presents an up to date template of the post rehabilitation process. Very similar to activities highlighted by Farber & Wilckens (2007). Monitor progression through adductor squeeze test as mentioned on the previous page suggested by Garvey (2010).

6.3 Future directions

A review has been made on what the current literature says about what a sports hernia is, including the anatomy, diagnosis, types of treatment, surgery and the exercises required to rehabilitate from the injury. From the review, a table of recommendations were constructed in order to guide individuals on how to deal with a sports hernia. Having done this, it is important to acknowledge that there is a need for further research on sports hernias in a few areas that were picked up throughout the review of current literature.

For instance, Table 1 had shown four studies that investigated surgical options for a sports hernia and almost all of the participants included in the studies were male. This suggests that there is a need to get more data regarding female athletes and to see how they

compare in the success rate of the different types of surgery perhaps. Another possible limitation to the current literature is the lack of diverse sport types that the athletes investigated took part in, could be interesting to see how different sports effect the injury site on an anatomical basis and to see if any trends occur. Also, a lack of sample size from most studies seem to be apparent with most being around 15 subjects. It would be useful to have a higher number of studies looking at sports hernias on a larger scale with a purpose to look at gender, sports types, somatotypes, age and ethnicity to again register any trends that may occur. Finally, with a further understanding of trends, more attention can be paid to rehabilitation programmes and potentially evolve them and adapt them to certain populations if needed with more novel interventions.

CHAPTER 7: CASE STUDY

7.1 Case study description

Case studies are defined as in depth investigations of a single person/ group, which can enable a pathway to challenge theory and its assumptions through observing behaviors of a person where new sources of ideas may be developed (Mcleod, 2008). Limitations of using a case study may include not being able to generalise results to the wider population, time consumption and its difficulty to replicate.

Bhamra (2012) used a case study approach on a 32 year old rugby player who sustained a cervical spine injury on the field. He used the approach to explain the short term

treatment and management of the injury and what barriers that had to be considered and overcome. Using the case study method Bhamra (2012) was able to properly show the experiences of the rugby player and focus in on a scenario that others could relate to and how to prevent it from happening in the future.

A case study approach is useful and appropriate for this review because a comparison can be made from what literature suggests and to what has actually been prescribed to an athlete with a SH. The comparison will be made against the table of recommendations generated as a template in the review (table 4), the scenario will first be described.

7.2 Scenario

A 20 year old male semi-professional football player.

1) Injury sustained in the final football match of the season from a sharp twist/ change of direction. Injury on hip/adductor gradually worsened in match until the athlete could not even jog/sprint two yards without pain. Difficult to get in and out of cars for a few days. (June 2013)
2) Injury eases off through off season rest
3) Injury reoccurs upon return from around 8 week break still. (August 2013)
4) See GP, referred to a physiotherapist. Direct stress test utilised (Consultation August 2013).

5) Adductor stretches (figure 6) and strengthening exercises (figure 7) recommended 4-6 weeks to see if temporary measures cease injury. Gradual progression of adductor strength weight with max repetitions of 15.

6) Reoccurs, so proper diagnosis of *sports hernia* is given, PREHAB before surgery is continuing current stretches and strengthening. (Pre-op appointment December)

7) Undergo Laparoscopic Surgery with general anaesthetic, out of hospital same day, walking extremely difficult. (January 2014)
8) Post-operative rehab exercise starts immediately after surgery with minor movements for first week whilst taking prescribed medication.
9) After 4 days of surgery, walking for 20 mins on treadmill and gentle cycling on spin bike.
10) Second/third week, very light core work such as side plank and plank and knee touches, strengthen with adductor machine. Progress walking to light jogging and slight increase in intensity on spin bike pain tolerance.
11) Fourth week, more core exercises added with further progression of straight line cardiovascular work on the treadmill as tolerated.
12) Progress cardiovascular and core exercises with duration and repetitions until 5-6 week. Cardiovascular exercise transferred from treadmill onto football pitch doing Field box running (figure 8) and box to box runs (figure 9).
13) Resume kicking activity and incorporate agility runs on 8th post-operative week.
14) Resume light football training with squad. (Feb/March2014)

Figure 7. Adductor stretch prescribed. Developmental stretch, hold on pain threshold.

Figure 8. Adductor strength machine prescribed.

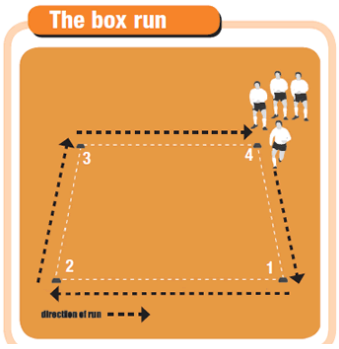


Figure 9. Box runs. 12 laps. Improve time each time.

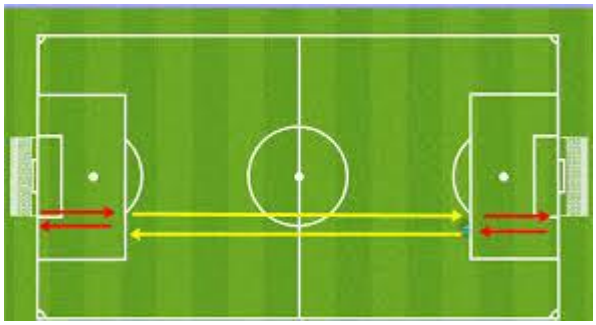


Figure 10. Box to box runs. Progress from 5-12 times. Fast jogging/Sprinting in yellow area, walking/very slow jogging in red.

7.3 Case study & literature recommendations discussion

The case study's order of events are very similar to those that the literature recommends with only a few slight differences. The outline of agreement between the subject's experience and the literature's suggestions is shown in table 5 below. At the very first stage of incidence of the SH it was a twisting motion that seemed to cause it which is what Farber & Wickens (2007) suggested was the suspected action that prompted the injury. Self-recognition of the injury prompted 4 weeks rest but symptoms returned after a few days of resumption justifies Paajanen et al's (2011) study who found conservative treatment to only resume 50% of its athletes to sport, suggesting conservative treatment on its own is not enough to recover.

Table 5. Table showing agreement between the case study events and the literature recommendations on the rehabilitation process.

Step	Title	Recommendations met? "Yes"/ "No"/ "Somewhat"
1	Self-recognition	Yes
2	Physical examination/ Diagnosis	Somewhat

3	Trial Conservative treatment	Somewhat
4	Surgery	Yes
5	Post-Operative rehabilitation	Yes

The case subject is referred to a physiotherapist by a GP (general practitioner) who then diagnoses the injury as a sports hernia using the direct stress test and palpation techniques as suggested by Brown et al (2013), agreeing with the recommendations. However, this was done a bit late after having thought 4 weeks rest would have extinguished the injury but of course did not. Conservative treatment was then issued by the physiotherapist using just one stretching exercise and one strengthening exercise on the adductors. The recommendations show research by Farber & Wicker (2007) that there are more elements to focus on such as core and hip mobilisation techniques. This shows that the prescription of conservative treatment by the physiotherapist lacked detail and could have supported it with more exercises.

In the case study laparoscopic surgery was opted for which agrees with the recommendations from literature for its superior results in studies shown by Liem et al (1997). The delay in the initiation of surgery was due to a two month waiting list by the NHS for non-private patients, otherwise recovery would have been sooner overall. This was the implementation of a general anaesthetic and the insertion of a piece of mesh as support which meant the patient could be out the same day and as Liem et al (1997) found, a quicker recovery to every day activity.

Post rehabilitation shows a general similarity however there showed a lack of variety of exercises prescribed by the physiotherapist for after surgery. Although the main components were covered such as gradual building of straight line cardiovascular, core and adductor strength work. Not enough focus was put on flexibility, ROM of the hip, and monitoring of progress through the adductor squeeze test (figure 6). The adductor strength machines were introduced at week 2/3 for the case study where as literature suggests week four. Plyometrics were not used in the later stages either by the case study where literature template suggests it should be on week 7.

7.4 Conclusion

In summary to the comparison between the case study and the formulated table of recommendations, they both follow a similar stage pattern. However, the case study's prescribed exercises for pre and post-operative rehabilitation programmes were lacking detail which could have reduced recovery time. The use of box to box runs in the case study on grass to introduce the athlete back to a sport specific environment was a good way of progressing jogging instead of being on a treadmill as literature guide suggests. Additionally, the adductor squeeze test was not used as an ongoing guide of progress which could have told to push the subject to push harder or ease off, benefiting recovery efficiency. The total time from the initial occurrence of the sports hernia to the return to sports was around 7 months. This of course would have been shortened if surgery was immediately available rather than the subject having to be put on a long waiting list of around 3/4 months. The total time of recovery would have been also reduced if the subject immediately sought a physiotherapist rather than self-initiated rest which used up 4 weeks. Overall, the case study could have included more variety of exercises and a tool for measuring progress which could have shaved a week or so off recovery time. If the recommendations were exactly followed and there was no delay in the delivery of surgery, then the subject could have recovered within 9/10 weeks of the injury occurring.

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