Treatment and rehabilitation of grade ii medial collateral ligament (mcl) injury

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Introduction

The superficial medial collateral ligament (MCL), and other medial knee stabilisers (most notably the deep medial collateral ligament and the posterior oblique ligament) are the most commonly injured ligamentous structures of the knee (Grood, et al., 1981; Hughston, 1981; Phisitkul, et al., 2006; van der Esch, et al., 2006).

The majority of MCL tears are isolated and predominantly occur in young people participating in sports activities. Typically, the mechanism of injury involves valgus knee loading, external rotation or a combined force vector- particularly prevalent in sports such as football and skiing which involve these type of forces and repetitive knee flexion (Peterson, et al., 2000).

In the United States, occurence of these types of injuries to the knee has been reported to be 0. 24 per 1000 during any given 12 month cycle and to be twice as high in males – 0. 36 compared with 0. 18 in females (Daniel, et al., 2003). In actual fact, the incidence of these types of injury is probably much higher than reported as many minor MCL injuries are never even assessed or treated by medical personnel.

In terms of treatment, the approach to medial knee injuries has changed dramatically over recent years. As the understanding of the anatomy, biomechanics, and causes of medial knee injuries has evolved, as has the treatment. Whilst in the 1970's and 1980's surgical treatment for MCL injuries was common place, today most MCL injuries are treated conservatively with early rehabilitation (Phisitkul, et al., 2006). In general, all isolated Grade I and II tears and even the majority of Grade III tears can be treated non-operatively with a supervised, functional, rehabilitation program. Excellent results can be expected with return to full pre-injury activity level being the norm (Bradley, et al., 2006).

This paper will research and interpret some of the relevant literature that is available to us, with the aim of developing and implementing a functional rehabilitation plan (in keeping with the principles of soft tissue healing) that is suitable for the treatment of a Grade II MCL injury of a 33-year-old, male, semi-professional footballer (the patient).

General Knee Anatomy

The knee joint, is the largest and most complex synovial joint of the human body (Bradley, et al., 2006).

Figure 1: Anterior view of the patellofemoral joint. Hawkins (2009)

The patella, patella ligament and femur combine to form the patellofemoral joint (Saladin, 2001). The patella itself is a triangular-shaped sesamoid bone that is attached to the quadriceps tendon. This tendon inserts into the trochlear groove on the femur and primarily acts to increase the ' mechanical advantage' of the quadriceps muscle group (Hamill & Knutzen, 1995).

The lateral and posterior aspects of the knee joint are encapsulated by a joint capsule whilst the anterior section of the knee is protected by the patella ligament (and its retinacula). The quadriceps and the hamstrings are the prime movers of the knee joint – knee ' extensors' and ' flexors' respectively.

The quadricep group of muscles are located on the anterior part of the thigh and comprise of the rectus femoris, vastus lateralis, vastus medialis, and vastus intermedius. They converge on the patella tendon, travel over the patella and insert onto the tibial tuberosity. In addition to knee extension, the quadriceps group of muscles (in combination with the iliopsoas) are also responsible for flexion of the hip (Saladin, 2001). The hamstring muscles are found on the posterior section of the thigh and comprise of the biceps femoris, semimembranosus, and semitendinosus. They are responsible for the flexion of the knee joint and (together with the gluteus maximus) the extension of the hip joint (Saladin, 2001).

The main stabilisers of the knee are the quadriceps tendon (to front of the thigh) and the semimembranosus tendon (at the back of the thigh) (Saladin, 2001). The medial and lateral collateral ligaments are primarily responsible for preventing the knee from rotating during extension (Saladin, 2001). The anterior cruciate ligament and the posterior cruciate ligament stop anterior and posterior translation of the tibia relative to the femur (Saladin, 2001).

Specific Medial Collateral Ligament Anatomy

Medial knee stability is provided, for the most part, by its ‘ medial static’ and its ‘ dynamic’ stabilisers. The medial static stabilisers, which work as an integrated unit, are the superficial MCL, the posterior oblique ligament and the middle third of the deep MCL. The dynamic stabilisers are the per anserinus tendons – most notably the semimembranosus tendon (Peterson & Renstrom, 2001).

The superficial MCL is, on average, 11cm long and 0. 5cm wide. It originates from the medial femoral condyle (anterior to the tubercle) and travels, distally, to insert 5-7cm below the joint line on the anteromedial tibia (just below the insertion of pes anserinus tendons). The anterior fibres of the superficial MCL tense during knee flexion whilst its posterior fibres slacken. The superficial MCL is tight during external rotation of the knee (Peterson & Renstrom, 2001).

The middle third of the deep MCL is a short structure – about 2-3cm long – and is attached to the meniscus underlying the MCL. This part of the ligament is relatively ‘ slack’ to facilitate knee motion whilst short enough to hold the meniscus firmly in position. In terms of injury, the deep MCL can be ruptured both proximally and distally to the meniscal attachment (regardless of the location of the tear of the superficial MCL). The posterior oblique ligament is a thick capsular ligament originating just behind the superficial MCL (at the condyle just below the joint line). The posterior oblique ligament becomes ‘ slack’ during knee flexion (Peterson & Renstrom, 2001).

Biomechanics

Biomechanical studies show that the MCL’s main function is to resist valgus (outward side motion of the leg) and external rotation forces of the tibia in relation to the femur .

The superficial MCL has been found to be responsible for 57% of medial stability at 5? of knee flexion and up to 78% at 30? knee flexion. The deep MCL accounted for 8% at 5? and 4% at 30? whilst the posterior oblique accounted for 18% and 4% respectively.

Mechanism of Injury

The player reported to the clinic approximately 24 hours after the injury occurred. The player was able to weight bear. When asked how the injury occurred the player stated that he was running at pace to ‘ close down an opposing player’ and then described performing a ‘ change of direction’ or ‘ cutting’ manoeuvre. He stated that as he planted and pushed off his right leg, he experienced a sudden excruciating localised pain and an immediate lack of stability in his right knee. This caused him to collapse.

As stated, the primary mechanism of injury to the MCL is most commonly a valgusstress(Fetto, et al., 1978). However, due to the position of the knee and the force vectors involved, a combined flexion/valgus/external rotation injury is usually the end result (Hayes, et al., 2000). The vast majority of MCL injuries are from a lateral force to the distal femur with the foot being fixed to the ground, although non-contact valgus external rotation injuries are common – the latter being particularly prevalent in sports such as football and skiing (Perryman, et al., 2002; Pressman, et al., 2003).

Because of the complexities of knee injuries, it is important to perform a complete knee examination in order to rule out other potential problems such as fractures, cruciate ligament tears, menisci ruptures or chondral cartilage damage (Bradley, et al., 2006).

Physical Examination/Clinical Assessment

The best time for examination of the knee is immediately after the injury before muscle spasm occurs (Phisitkul, et al., 2006). Unfortunately, as in this case, that is not always feasible. However, a 24 hour period of rest and immobilisation (which the patient undertook) is usually sufficient for muscle spasm to subside and relaxation to occur (Hughston, et al., 1976). This allows an effective examination and assessment of the injury.

The injury was examined and assessed through a combination of subjective and objective approaches.

Important initial information obtained through speaking with the patient and preliminary observations included the location of pain, the ability to ambulate after the injury, time and onset of swelling, the presence of deformity, and the immediate site of tenderness (Indelicato & Linton, 2003).

The location of oedema and tenderness can accurately identify the injury site of the superficial collateral ligaments in 64% and 76% of cases respectively (Hughston, et al., 1976). The exact location of injuries of the deep MCL and the posterior oblique ligament are more difficult to palpate because of their deep-seated position, but pain and tenderness in this area can at least indicate the presence of injury to these posteromedial structures (Sims & Jacobsen, 2004)

On asking the patient to indicate the most painful spot, he pointed to the medial aspect of the right knee joint. The area indicated by the patient suggested injury to the MCL. Contralateral comparison of the knees was carried out in order to identify areas of oedema and/or deformity. Significant swelling and slight discolouration was observed on the medial aspect of the right knee joint. Upon palpation of both knee joints, a noticeable heat differential was felt in the affected area.

While keeping the patient relaxed, a valgus stress test (MCL test) was performed with the knee in 30? of flexion (figure 1), and compared to the contralateral knee as a control. The examination was then repeated with the knee in 0? of flexion to recruit the function of remaining posteromedial structures (figure 2). The valgus stress test proved positive in contralateral comparison in 30? of flexion and negative in 0? of flexion. The absence of laxity in the second test reduced suspicions of any associated injuries to the secondary restraints such as the cruciate ligaments and the posterior capsule.

In addition, a number of other tests were carried out to assess whether any injuries, commonly associated with MCL injuries, were prevalent (bone bruises, ACL tears, lateral collateral ligament tears, medial meniscus tears, lateral meniscus tears, and posterior collateral ligament tears). Anteromedial rotatory instability (often present when there is evidence of anterior subluxation of the medial tibial plateau during a valgus stress test with the knee in 30? of flexion) was assessd by performing the anterior drawer test (figure 3) whilst holding the tibia in external rotation. This proved negative and therefore ruled out the possibility of a posterolateral knee injury rather than a medial knee injury. Lachman’s test (figure 4) and the Pivot shift test (figure 5) were also performed to negate the existence of any ACL rupture whilst Murray’s test (figure 6) was carried out to assess the integrity of the Meniscus cartilage. All these tests also proved negative.

The results of the assessment supported the initial belief that the patient was suffering a superficial MCL injury with the posterior oblique ligament still intact and no associated damage to either the cruciate ligaments or meniscus cartilage of the knee.

Radiograph

In accordance with the Ottawa knee rules (Stiell, et al., 1997) it was decided that radiographs were not required for this injury. More recent work has shown the Ottawa knee rules to be very successful in reducing unnecessary radiography, whilst ensuring a high level of recognition fractures (Bachman, 2003). The Ottawa knee rules state that a radiograph is required only in patients who have an acute knee injury with one or more of the following:

Age 55 years or older

Tenderness at head of fibula

Isolated tenderness of patella

Inability to flex to 90°

Inability to bear weight both immediately and in the emergency department

Classification of Injury

In 1976 (revised in 1994) Hughston standardised MCL injury classification into two related systems – the severity system (Grade I, II & III) and the laxity system (grade 1+, 2+ & 3+).

Under this combined classification system, Grade I involves a few damaged fibres resulting in localised tenderness but no instability or laxity. A Grade II injury involves a disruption to substantially more fibres, with more generalised tenderness but still no instability (although it is not uncommon for a degree of laxity with the knee in 30? flexion). A Grade III injury is a complete tear of the ligament with resultant instability and laxity. Grade III injuries are then sub-classified according to the extent of laxity (determined by the amount of absolute joint separation from valgus stress with the knee in 30? of flexion). Grade 1+, 2+, and 3+ laxities indicate 3-5 mm, 6-10 mm, and more than 10 mm of absolute medial separation respectively.

Fetto and Marshall (1978) defined Grade I injuries as those without valgus laxity in both 0? and 30? of flexion, Grade II injuries as those with valgus laxity in 30? of flexion but stable in 0? of flexion, and Grade III as those with valgus laxity in both 0? and 30? of flexion.

The injury was subsequently classified as an isolated Grade II MCL injury in accordance with Hughston (1976 & 1994) and Fetto & Marshall (1976).

Using a full return to sport as an indicator of a successful end point, Ellsasser et al (1974) treated 74 professional football players with incomplete tears of the MCL using a functional rehabilitation program. In this study, a success rate of 98% was found compared with a 74% success rate for a separate group treated surgically. In the non-operative group, return to play occurred between 3 and 8 weeks.

Return to play was even quicker in a study by Derscheid and Garrick (1981). They treated football players with Grade I and Grade II injuries with a specific rehabilitation programme. Players with Grade I MCL injuries returned to full play in an average of 10. 6 days, whereas those with Grade II MCL injuries returned in an average of just 19. 5 days, with neither group showing a propensity for injury reoccurrence.

Based on this research, a consensus on the time it would take for the patient to return to full sporting activeity would be3-8 weeks.

Treatment and Rehabilitation Objectives

An appropriate treatment and rehabilitation plan is required to restore normal function to the knee joint and the surrounding soft tissues with a view to enabling the patient to return to his sport as early and effectively as possible – with no residual symptoms and a minimal risk of injury reoccurrence

All soft tissue injuries, regardless of their nature and severity, undergo the same three stages of healing – the inflammatory phase, proliferation phase and the remodelling phase. The time required to complete each healing stage is dependent up on the nature and severity of the injury. However, of note, numerous investigations comparing surgical and non-surgical treatment have reported no advantages of surgical intervention over non-surgical intervention (Quarles & Hosey, 2004; Phisitkul et al., 2006).

The following treatment and rehabilitation plan was designed and implemented to address the needs of the patient.

Inflammatory Phase (up to 72 hours post injury)

The inflammatory phase is characterised by heat, redness, swelling and pain – generally leading to a loss of movement and function. Thegoalsof treatment at this stage were:

Protect injury

Control oedema

Prevent associated muscle atrophy

Regain range of motion

Increase weight bearing capacity

Maintain general fitness/strength

P. R. I. C. E (Protection, Rest, Ice, Compression and Elevation)

The P. R. I. C. E. regimen is employed following injury with a view to controlling the haemorrhage, decreasing inflammation, reducing tissue metabolism and minimising secondary hypoxic injury, cell debris and oedema. Research has suggested that the sooner after injury that cold therapy (cryotherapy) is started, then the more beneficial the reduction in metabolism will be (Knight et al., 2000). Elevation has been shown to have a significant effect on reducing effusion (O'Donohue, 1976).

The patient reported that he had already applied ice intermittently during the 24 hour period between injury occurrence and assessment – approximated to have fulfilled 4 x 20 minute applications of crushed ice at 2 hourly intervals with the knee in an elevated position in line with commonly agreed protocol. He also reprted that he had kept the injured limb elevated for sustained periods.

Measurement

On inspection the right knee was swollen over the lateral aspect with a small amount of visible bruising. At this time the patient was asked to indicate his level of pain using a visual analogue scale (VAS). Measurement of the girth of the knee was also taken using a tape measure whilst active flexion and was also assessed using a goniometer. These measurements would be continually reassessed throughout the rehabilitation process in order to assess progress and outcomes.

Continued active flexion was also encouraged at this time. Simple ‘ knee bend and straighten’ exercises, with the patient lying in a supine position on an exercise mat – the movement repeated 10-20 times, 3 times a day, with a view to increasing active range of movement (figure 1) . The patient was also instructed in different exercises to maintain cardiovascular fitness and upper body conditioning.

The patient also received a massage to the upper and lower leg (particularly the quadriceps group of muscles) in an elevated position using effleurage techniques to aid removal of waste products via the lymphatic system – reflexive muscular inhibition of the quadriceps has been thought to be the result of the pain associated with MCL injury (Dixit, et al., 2007). The knee was then strapped.

Strapping

The knee was strapped to assist healing and reduce the risk of aggravating the injury. The knee was strapped in a position of 30? flexion with the lower leg partially rotated inwards (figure 1). A combination of ‘ lower leg and thigh anchors’, ‘ medial cross’ and ‘ medial straight line’ taping techniques, using zinc oxide tape and elastic adhesive dressing, were employed to provide suitable support for the patient and reduce and valgus stress (figure 2).

Experience has shown that this type of strapping is preferable to the use of a knee braces in Grade II MCL injuries as the strapping can be re-applied whenever required with the correct level of compression and support required. There is some concern that functional braces may expose athletes to additional risk by imparting a false sense of confidence. It is reported that lower extremity muscle strengthening, flexibility improvements, and technique refinement are more important than functional bracing in treating ligamentous knee injuries (Christenson, 2010).

The patient was advised to continue elevating the limb, as much as possible, for the following 24 to 48 hours.

Anti-inflammatory medication

Non-steroidal anti-inflammatory medication (ibuprofen) was prescribed to the patient, via NHS Direct, two hours after injury.

Whilst some studies have shown no early adverse affect of nonsteroidal anti-inflammatory drugs on the strength of healing torn MCL's (Moorman, et al., 1999), it remains controversial as to whether inhibiting the inflammatory response is uniformly advantageous. Pain and disability following injury are in part due to the inflammatory response and, whist it is suggested that decreasing the inflammation decreases the symptoms (therefore allowing earlier rehabilitation) (Weiler, 1992), it is also important to consider that inflammatory cells are responsible for clearing away cell debris and necrotic fibres – and without this phagocytic function regeneration may not be able to begin (Reynolds et al., 1995, Almekinders et al., 1986, Jones 1999).

As the patient reported that the pain had subsided over the last 24 hours (measured using a visual analogue scale), he was advised to continue taking the non-steroidal anti-inflammatory medication only when necessary.

Proliferation Phase (3-21 days post injury)

The proliferation stage involves the repair and regeneration of the injured tissue (development of new blood vessels, fibrous tissue formation, re-epithelialisation and wound contraction) and begins approximately 72 hours after injury. The goals of this rehabilitation phase included:

? Decrease effusion

? Decrease pain

? Restore full range of motion

? Enhance joint strength

? Introduce proprioceptive exercise

? Achieve full pain free weight bearing statu

Maintain general fitness and strength levels

It has been stated that ligaments heal with a stronger and more organised collagen fibril architecture when early mobilisation and exercise is employed during the healing process (Osborne and Rizzo, 2003). Therefore, in addition to continuing the treatments introduced during the inflammatory phase (ice, intermittent compression, and massage), manual joint mobilisation techniques were also employed at this stage. Comprehensive zinc oxide and elastic adhesive strapping, removed and re-applied by the patient whenever necessary (particularly during active flexion exercises), was also continued. Pain scale assessment, ankle girth measurement and goniometer measurements were continually monitored throughout the proliferation phase.

As stated, n the proliferation phase, the goals are to continue re-establishing full range of motion, increase muscular strength/power/endurance, and adding in functional activities. Exercises include isotonic exercises to isolate and strengthen particular muscle groups, such as in the hip and thigh regions (knee extension, leg press, hamstring curls and hip exercises). In order to re-establish the dynamic stability of the knee joint, it is crucial to strengthen the hip and calf musculature, with an emphasis on progressive Closed Kinetic Chain exercises (such as wall squats, step-ups, lateral lunges and stair climbing) that foster proprioception (Wilk et al., 1996).

Range of Movement (RoM)

Range of movement exercises were significantly progressed from the inflammatory phase. Active and passive movements continued with the addition of manual mobilisation techniques for the knee joint. The following advanced knee stretches were utilised with a view to restoring movement to the joint and improve flexibility of muscles crossing the knee. The patient was advised to carry out each separate muscle group stretch 3 times daily (provided they do not cause or increase pain).

i. Quadriceps Stretch

Treatment couch was used for balance. Heel taken towards your bottom, keeping knees together and back straight until patient felt a stretch in the front of their thigh (figure 1). Held for 15 seconds and repeated 4 times at a mild to moderate stretch (pain free).

ii. Hamstring Stretch

Patient’s foot was placed on chair. With knee and back straight, patient leant forward at hips until he felt a stretch in the back of his thigh/knee (figure 2). Held for 15 seconds and repeated 4 times at a mild to moderate stretch (pain-free).

iii. Calf Stretch

With patient’s hands placed against the wall, his leg was stretched behind him as demonstrated in figure 3. Keeping his heel down, knee straight and feet pointing forwards, the patient gently lunged forwards until he felt a stretch in the back of his calf/knee. Held for 15 seconds and repeated 4 times at a mild to moderate stretch (pain-free).

iv. ITB Stretch

Patient’s leg was placed behind his other leg and taken as far away from him as was comfortably possible. Patient then pushed his hips to the side of his leg until he felt a stretch in the outer thigh/hip (figure 4). Back was kept straight throughout. Held for 15 seconds and repeated 4 times at a mild to moderate stretch (pain-free).

v. Adductor Stretch

Standing tall, and with back straight, pateint’s feet were placed approximately twice shoulder width apart. Patient then gently lunged to one side, keeping his other knee straight, until he felt a stretch in the groin of his straight leg (figure 5). Held for 15 seconds and repeated 4 times at a mild to moderate stretch (pain-free).

Increased range of motion was also enhanced by using a stationary bicycle (Wilk et al., 1996).

Strengthening

Strengthening work for the lower limb musculature continued in a progressive form (as pain allowed). The following knee strengthening exercises were designed and implemented with a view to improving the strength of the muscles surrounding the patient’s injured knee. The patient began with the basic knee strengthening exercises, advanced to intermediate knee strengthening exercises and eventually undertook the advanced knee strengthening exercises.

A. Basic Exercises

To begin with, the following basic knee strengthening exercises were performed approximately 10 times each, 3 times a day, during the first week of rehabilitation. As knee strength improved, the exercises were progressed by gradually increasing the repetitions and strength of contraction.

i. Static Inner Quadriceps Contraction

Patient was instructed to tighten his quadriceps muscle group by pushing his knee down into a rolled towel (figure 1). Placing his fingers on his inner quadriceps (vastus medialis) allowed the patient to feel the muscle tighten during contraction. Held for 5 seconds and repeated 10 times as hard as possible pain free.

ii. Quads Over Fulcrum

Patient was instructed to lie on his back, with a rolled towel under his knee, and told to relax the knee (figure 2). Patient then slowly straightened his knee as far as possible tightening the front of his thigh (quadriceps). Held for 5 seconds and repeated 10 times as hard as possible pain free.

iii. Static Hamstring Contraction

Patient began this exercise by sitting with his knee bent to about 45? (figure 3). He then pressed hisr heel into the floor tightening the back of his thigh (hamstrings). Held for 5 seconds and repeated 10 times as hard as possible pain free.

B. Intermediate Exercises

The following intermediate knee strengthening exercises were generally performed 1-3 times per week (during weeks 2 and 3 of the rehabilitation programme). Ideally they were not performed on consecutive days, to allow muscle recovery. As the knee strength improved, the exercises were progressed by gradually increasing the repetitions, number of sets and/or resistance of the exercises provided they did not cause or increase pain.

iv. Knee Extension in Sitting vs. Resistance Band

Patient sat with with his knee bent and a resistance band was tied around his ankle (figure 4). Keeping his back straight, patient slowly straightened his knee, tightening his quadriceps. He performed 3 sets of 10 repetitions on each occasion.

v. Hamstring Curl vs. Resistance Band

The patient was instructed to lie on his stomach with a resistance band tied around his ankle as shown (figure 5). He then slowly bent his knee whilst tightening his hamstrings (figure 6). He performed 3 sets of 10 repetitions on each occasion

vi. Squat with Swiss Ball

Patient stood with his feet shoulder width apart and facing forwards. A Swiss ball was placed between the wall and his lower back to add an element of proprioception (figure 7). Patient then slowly performed a squat, keeping his back straight. His knees were kept in line with his middle toes and did not move forward past his toes. Performed 3 sets of 10 repetitions on each occasion.

vii. Lunges

Patient stood with his back straight in the position shown (figure 8). He then slowly lowered his body until the front knee was at a right angle (figure 9). His knee was kept in line with his middle toe and his feet facing forward. Performed 3 sets of 10 repetitions on each occasion.

viii. Heel Raises

Patient used treatment couch for balance (figure 10). Whilst keeping his feet shoulder width apart and facing forwards, patient slowly move up onto his toes – raising his heels as far as possible and comfortable without pain. Performed 3 sets of 10 repetitions on each occasion.

C. Advanced Exercises

The following advanced knee strengthening exercises were generally performed 1 – 3 times per week (from week 4 of the rehabilitation programme onwards). Ideally they were not performed on consecutive days, to allow muscle recovery. As the knee strength improved, the exercises were progressed by gradually increasing the repetitions, number of sets or resistance of the exercises provided they did not cause or increase pain.

ix. Single Leg Squat with Swiss Ball

Patient stood on one leg with his foot facing forwards. A Swiss ball was placed between the wall and his lower back to incorporate a proprioceptive element (figure 11). Patient slowly performed a squat, keeping his back straight. Patient ensured his knee did not bend beyond 90? and was in line with his middle toe. His knee didn't move forward past his toes. Performed 3 sets of 10 repetitions on each occasion.

x. Lunges with Weight

Patient stood holding light weights, with his back straight in the position shown (figure 12). He slowly lowered his body until the front knee was at a right angle. Knee was kept in line with his middle toe with feet facing forward. Performed 3 sets of 10 repetitions on each occasion.

xi. Single Leg Heel Raises

Patient stood on one leg with treatment couch for balance (figure 13). Keeping his foot facing forwards, patient slowly moved up onto his toes, raising his heel as far as possible and comfortable without pain. Performed 3 sets of 10 repetitions on each occasion.

xii. Hamstring Curl on Swiss Ball

Exercise began with patient lying on his back with a Swiss ball under his legs as demonstrated (figure 14). Keeping his back straight, patient slowly bent his knees and tightened the hamstrings. Performed 3 sets of 10 repetitions on each occasion.

Proprioception

‘ The awareness of position, movement or balance of the body or any of its parts’ (Prentice, 1994).

As observed in the ‘ Strengthening’ section of the proliferation phase, early proprioception exercises are started at this point. Many of the more basic strengthening exercises identified were progressed by getting the patient to close his eyes closed and/or changing the surface that he was standing on e. g. mini trampoline, air filled cushion, sponge cushions, wobble and rocker boards.

During the proliferation phase all proprioceptive work is undertaken with the injured joint strapped with zinc oxide strapping – providing confidence to the patient by its perceived level of support.

Other specific proprioception exercises used at this stage included:

Balance on swiss ball (figure 1)

Balance on trampette (figure 2)

Balance during leg press (figure 3)

Dips on uneven surface (figure 4)

Balance on Bosu ball (figure 5)

Balance while throwing ball to alternate hands (figure 5)

The exercises were progressed by time and/or by increasing the repetitions. All exercises would be performed bilaterally. Variations for proprioceptive exercise were almost endless – a vital element in avoiding patient and therapist boredom. It was also important to this rehabilitation programme that exercises could also be carried out at home (as patient also had a full time job).

Cardiovascular fitness and general strengthening was also addressed at this time using circuit training, swimmingand cycling.

Remodelling Phase (21 days to 12 months post injury)

The remodelling phase of healing is a long-term process – often taking years to complete (Prentice, 1994). Factors that can impede the rate of healing are varied and include surgical repair, poor vascular supply, infection, disease, wound size, health, age and nutrition

In terms of rehabilitation, during this phase more aggressive strengthening and mobilisation was required to ensure optimum tissue realignment and strength. The goals of treatment in the remodelling phase were:

? Regain full strength

? Ensure full pain free range of motion

? Maintain overall conditioning

? Prepare for return to full participation

Range of Motion (RoM) exercises continued with a greater emphasis being placed on ‘ hands on work’ in the form of joint mobilisation to ensure full movement is achieved. The strengthening work that was started in the proliferation phase was continued and progressed (in terms of resistance, speed and repetitions) whilst further emphasis was placed on general fitness at this time – introducing more sport specific activities. Running drills were progressed from linear to exercises involving change of direction at high pace with and without a ball. Specifically, when the patient was able to run at 75% of maximum speed, figure 8 drills were used beginning with 20m and then 10m figure 8’s. Advanced cutting drills at 45? and finally 90? were also added.

Proprioception exercises will be progressed, with a more sport specific content. This involved hopping onto various unstable surfaces (figure 1), hopping on a mini trampoline whilst side foot volleying a ball (figure 2), hopping forwards, sideways and backwards over hurdles at varying pace (figure 3) and practising the kicking action whilst planting the foot on an unstable surface (figure 4).

Throughout this phase and when returning to full function the patient continued to wear zinc oxide and elastic adhesive strapping to minimise the possibility of recurrence of injury. Ice was used predominantly after exercise to guard against recurrent pain and swelling.

When an athlete achieves the goals of the remodelling phase, they are close to returning to full participation. As earlier identified, Derscheid and Garrick treated 23 Grade II MCL patients and all were returned to playing football within 19 days (4 to 19 day range, 10. 6 day mean). However, many of these athletes did not feel they were 100% for several weeks. For this reason, further rehabilitation including strengthening, dynamic knee stabilisation, plyometrics, SAQ drills and proprioception exercises should be completed until the athlete feels 100% and is able to play without inhibition (Wilk et al., 1996). Maintenance exercises, even after return to sport, that promote continuation of strength, endurance, and function are also vitally important to consider (Wilk et al., 1996).

Pre Discharge

The pre-discharge stage is vital. It is the time for the therapist and patient to decide whether or not a return to full unrestricted activity can take place. Return to full activity was allowed once the following were achieved:

Ligamentous examination is normal

Quadriceps strength is 90% or greater than the contralateral limb

Sport/activity specific agility testing causes no pain

To achieve these requirements, the patient was asked to do everything that is expected of him when returning to their chosen sport, including replicating the conditions in which the injury was caused. In this case the patient was required to run, sprint, jump, tackle, pass the ball over varying distances, change direction at speed and be able to withstand full physical contact.

Cardiovascular fitness would be assessed by repeating the baseline testing done in pre-season and comparing the results

Rehabilitation does not stop at this stage and the patient was instructed to continue with his proprioception and specific strengthening exercises for several months to minimise the chances of injury recurrence.

Conclusion/Summary

When undertaking the treatment and rehabilitation of medial knee injuries it is vital to understand and comply with the underlying pathology during the stages of healing to ensure optimum results.

The treatment goal for any competitive athlete is an early and effective return to sport, without any residual symptoms and minimal risk of recurrence. This is achieved by following an individually tailored treatment and rehabilitation program with a built in maintenance plan to be continued well beyond the initial return to activity.

References

Abbott, L. C., Saunders, J., Bost, J. C. (1944). Injuries to the ligaments of the knee joint. J Bone Joint Surg, 26: 503.

Almekinders, L. C. (1999). Anti-inflammatory treatment of muscular injuries in sport: an update of recent studies. Sports Medicine, 28(6): 383-388.

Bachman, L. M., Kolb, E., Koller, M. T. (2003). Accuracy of Ottawa ankle rules to exclude fractures of the ankle and midfoot. British Medical Journal, 326: 417-419.

Bleakley, C., McDonough, S., MacAuley, D. (2004). The use of ice in the treatment of acute soft-tissue injury. The American Journal of Sports Medicine, 32: 251-261.

Bradley, F., Giannotti, M. D., Rudy, T., Graziano, J. (2006). The Non-surgical Management of Isolated Medial Collateral Ligament Injuries of the Knee. Sports Med Arthrosc Rev, 14(2).

Christenson, R. (2011). Ligaments of the Knee: ACL and MCL sprains and tears. Pure Sports Medicine.

Cohn, B. T., Draeger, R. I., Jackson D. W. (1989). The effects of cold therapy in postoperative management of pain in patients undergoing anterior cruciate ligamentreconstruction. American Journal of Sports Medicine, 17: 344-349.

Daniel, D. M., Pedowitz, R. A., O'Connor, J. J., Akeson, W. H. (2003) 2nd Edition. Daniel's knee injuries: ligament and cartilage structure, function, injury, and repair. Philadelphia: Lippincott, Williams and Wilkins.

Derscheid, G. L., Garrick, J. G. (1981). Medial collateral ligament injuries in football: non operative management of grade I and grade II sprains. Am J Sports Med, 9: 365-368.

Dixit, S., Difiori, J. P., Burton, M., Mines, B. (2007). Management of Patellofemoral Pain

Syndrome. Am Fam Physician. 74: 194-202, 204.

Ellsasser, J. C., Reynolds, F. C., Omohundro, J. R. (1974). The non-operative treatment of collateral ligament injuries of the knee in professional football players. J Bone Joint Surg, 56a: 1185-1190.

Fetto, J. F., Marshall, J. L. (1978). Medial collateral ligament injuries of the knee: a rationale for treatment. Clin Orthop, 132: 206-218.

Grood, E. S., Noyes, F. R., Butler, D. L., Suntay, W. J. (1981). Ligamentous and capsular restraints preventing straight medial and lateral laxity in intact human cadaver knees. J Bone Joint Surg Am, 63: 1257-69

Hamill, J., Knutzen, K. M. (1995). Biomechanical Basis of Human Movement. Philadelphia; Lippincott Williams & Wilkins: 86-88, 227-233.

Hawkins, R. D., Hulse, M. A., Wilkinson, C. (2000). The association football medical research programme: an audit of injuries in professional football. British Journal of Sports Medicine, 35: 43-47.

Hawkins, W. (2009). The Will to Perform: A Female Athlete's Epidemic.

Hayes, C. W. (2000). Mechanism-based pattern approach to classification of complex injuries of the knee depicted at MR imaging. Radiographics, 20: S121–S134.

Hughston, J. C. (1994). The importance of the posterior oblique ligament in repairs of acute tears of the medial ligaments in knees with and without an associated rupture of the anterior cruciate ligament. Results of long-term follow-up. J Bone Joint Surg Am, 76: 1328-44

Indelicato, P. A. (1983). Non-operative treatment of complete tears of the medial collateral ligament of the knee. J Bone Joint Surg, 65a: 323-329.

Indelicato, P., Linton, R. (2003). Medial ligament injuries in the adult. Philadelphia; Saunders: 1938-1949.

Knight, K. L., Brucker, J. B., Stoneman, P. D. (2000). Muscle injury management with cryotherapy. Athletic Therapy Today, 5: 26-30

Moorman, C. T., Kukreti, U., Fenton, D. C. (1999). The early effect of ibuprofen on the mechanical properties of healing medial collateral ligament. Am J Sports Med, 27: 738-741.

Norris, C. M. (1998) 2nd Edition. Sports Injuries Diagnosis and Management. Oxford; Butterworth-Heinemann.

O'Donohue, D. H. (1976). Treatment of Injuries to Athletes. Philadelphia; Saunders: 698-746.

Osborne, M. D., Rizzo, T. D. (2003). Prevention and treatment of ankle sprain in athletes. Sports Medicine, 33(15): 1145-1150.

Perryman, J. R., Hershman, E. B. (2002). The acute management of soft tissue injuries of the knee. Orthop Clin North Am, 33(3): 575-585.

Peterson, L., Junge, A., Chomiak, J., Graf-Baumann, T., Dvorak, J. (2000). Incidence of football injuries and complaints in different age groups and skill-level groups. Am J Sports Med, 28(5): 51-57

Peterson, L., Renstrom, P. (2001) 3rd Edition. Sports Injuries: Their Prevention and Treatment. London; Martin Dunitz.

Phisitkul, P., James, S. L., Wolf, B. R., Amendola, A. (2006). MCL injuries of the knee: current concepts review. Iowa Orthop J, 26: 77-90

Prentice, W. E. (1994). 2nd Edition. Rehabilitation techniques in sports medicine. St. Louis; Mosby.

Pressman, A., Johnson, D. H. (2003). A review of ski injuries resulting in combined injury to the anterior cruciate ligament and medial collateral ligaments. Arthroscopy, 19(2): 194-202.

Quarles, J. D., Hosey, R. G. (2004). Medial and lateral collateral injuries: Prognosis and treatment. Prim Care Clin Offce Pract, 19: 957-975.

Reider, B., Sathy, M. R., Talkington, J. (1993). Treatment of Isolated medial collateral ligament injuries in athletes with early functional rehabilitation. Am J Sports Med, 22: 470-476.

Reynolds, J. F., Noakes, T. D., Schwellnus, M. P. (1995). Non-steroidal anti-inflammatory drugs fail to enhance the healing of acute hamstring injuries treated with physiotherapy. South African Medical Journal, 85(6): 517-522.

Saladin, K. S. (2001) 2nd Edition. The Unity of Form and Function. New York; McGraw Hill Company: 327-338

Sims, W. F., Jacobson, K. E. (2004). The posteromedial corner of the knee: Medial-sided injury patterns revisited. Am J Sports Med, 32(2): 337-345.

Stiell, I. G., Wells, G. A., Hoag, R. H., Sivilotti, M. L. A., Cacciotti, T. F., Verbeek, P. R., Greenway, K. T., McDowell, I., Cwinn, A. A., Greenberg, G. H., Nichol, G., Michael, J. A. (1997). Implementation of the Ottawa Knee Rule for the Use of Radiography in Acute Knee Injuries. Journal of the American Medical Association, 278: 2075-2079.

van der Esch, M., Steultjens, M., Ostelo, R. W., Harlaar, J., Dekker, J. (2006). Reproducibility of instrumented knee joint laxity measurement in healthy subjects. Rheumatology (Oxford), 45: 595-599

Warren, L. F., Marshall, J. L. (1979). The supporting structures and layers on the medial side of the knee. J Bone Joint Surg, 61a: 56-62.

Weiler, J. M. (1992). Medical modifiers of sports injury: the use of non-steroidal anti-inflammatory drugs in sports soft tissue injury. Clinical Sports Medicine, 11(3): 625-644.

Wilk, K. E., Andrews, J. R., Clancy, W. G. (1996). Nonoperative and Postoperative Rehabilitation of the Collateral Ligaments of the Knee. Operative Techniques in Sports Medicine, 4(3): 192-201.