Anterior cruciate ligament rehabilitation programme following anterior cruciate ligament reconstructive surgery: a pilot study

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Abstract

Rehabilitation following reconstruction of the anterior cruciate ligament (ACL) has changed dramatically over the past few decades. This includes leg immobilization for 12 weeks post-operation and the use of crutches for 16 weeks. These protocols have been developed because of the idea that intra-articular recovery is a long-term process. However, it is now well understood that as immobilization time increases, intra-articular ligament strength decreases. With increased scientific knowledge, current rehabilitation has begun to incorporate immediate post-operative range of motion as well as muscle power and strength, proprioceptive and control training. A specific ACL rehabilitation protocol was developed in January 2004, targeting patients with post-operative ACL reconstruction in RIPAS Hospital. Prior to this, there were no specific rehabilitation programmes adopted for these patients. A six-month ACL rehabilitation programme was developed based on three outstanding protocols adopted within the South East Asian region. The programme began with an initial intensive 10 week period, and empahsised mobility, strength, proprioception, control, plyometrics, agility, endurance and sport specific activities. Thirty-four out of 56 patients (61%) managed to complete the rehabilitation programme with 31 being able to return back to normal activities within six months. Twenty-two patients (39%) did not complete the programme, mostly owing to non-attendance or transfers to other centres. The ACL rehabilitation programme developed by the Physiotherapy Department of RIPAS Hospital managed to fulfil and cater the rehabilitative needs of patients following ACL reconstructive surgery in order to get them back to satisfying levels of activity.

Introduction

With the ever-increasing awareness on the importance of sport and physical activities for health and general well-being, more and more people are moving and involving themselves into the world of sport. Concomitant with this, there has been an increase in sports-related injuries, particularly to the lower limbs. Specifically, ligamentous injuries to the knee, rupture of the anterior cruciate ligament (ACL) has been the commonest [1-3], and has the greatest potential to cause both short term and long term disability [4].

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The ACL is a broad ligament inside the knee joint, joining the anterior tibial plateau to the posterior femoral intercondylar notch. The tibial attachment is to a facet, in front of, and lateral to the anterior tibial spine. The femoral attachment is high on the posterior aspect of the lateral wall of the intercondylar notch [4,5]. The biomechanical function of the ACL is complex for it provides both mechanical stability and proprioceptive feedback to the knee [6,7]. The most common cause of ACL rupture is a traumatic force being applied to the knee in a twisting moment [8,9]. This can occur with either a direct or an indirect force. Haim *et al.* reported that about 70% of ACL injuries do not result from direct contact i.e., while side-stepping, pivoting or landing from a jump [10].

Once the diagnosis of ruptured ACL is made, management can be divided into conservative and surgical. According to Cross [4], correct choice of treatment depends on assessment of factors such as age, functional disability

and functional requirements. If surgery is indicated, ACL reconstruction is the standard surgery, however, a wide variety of reconstruction procedures is available and a standard procedure has not been defined. In Brunei Darussalam, arthroscopic reconstruction with a hamstring tendon graft is commonly adopted. Rehabilitation, on the other hand, starts post-operatively and continues until the patient is able to get back to normal levels of activity.

Rehabilitation following ACL reconstruction has changed dramatically over the past few decades. This includes leg immobilization for 12 weeks post-operation and the use of crutches for 16 weeks. These protocols were developed because of the idea that intra-articular recovery was a long-term process. However, it is now well understood that as immobilization time increases, intra-articular ligament strength decreases. With increased scientific knowledge, current rehabilitation began to incorporate immediate post-operative range of motion as well as muscle power and strength, proprioceptive and control training. Hence, the major goals of rehabilitation following ACL surgery are: restoration of joint anatomy; provision of static and dynamic stability; maintenance of the aerobic conditioning and psychological well being; early return to work and sport. These have required the development of an intensive rehabilitation programme in which the patient has to take an active involvement [4]. At present, there is no specific and standard rehabilitation protocol available in RIPAS hospital for patients following ACL reconstructive surgery. Patients referred for rehabilitation are seen by different physiotherapists and were prescribed varying types of exercises and modalities, thus resulting in different outcomes.

The main aim of this pilot study was to evaluate the effectiveness of a developed ACL rehabilitation programme on patients following ACL reconstructive surgery in RIPAS Hospital.

Methods

Development and Standardization of Protocol

An ACL rehabilitation programme was developed based on three outstanding protocols from different hospitals within the South East Asian region: Jerudong Park Medical Centre, Brunei Draussalam; Intan Gleneagles Medical Centre, Malaysia; Singapore General Hospital. These three protocols were chosen because they are currently being used by physiotherapists in the physiotherapy department of RIPAS Hospital. The general outline of the developed programme encompasses the three above protocols. It was a six-month graduated programme with an initial intensive 10-12 week period emphasizing range of motion, strength, proprioception, control, plyometrics, agility, endurance and sport specific activities.

The developed rehabilitation programme was divided into phases. The first initial phase involved seeing the patient one or two days post-operatively when the patients were taught general lower limb exercises with emphasis on static contraction of both quadriceps and hamstrings muscles, and to continue after discharge from the ward. They were also taught non-weight-bearing mobilization with crutches, and a post-operative knee brace was supplied by the orthotist and prosthetist. The patient will be given physiotherapy outpatient appointments two to three times a week for the next 10 weeks.

On their first initial physiotherapy outpatient appointment, the patients were assessed in terms of knee range of motion, muscle power and functional status. Any pain and knee swelling was also addressed according to the usual physiotherapy modalities. During the first one to three weeks the aims of therapy were to decrease pain and swelling, and increase the range of motion of the knee. The Continuous Passive Motion (CPM) machine may have been used in the earlier phase mainly to increase knee flexion. Passive knee mobilization techniques were performed to reduce any flexion deformity. Quadriceps and hamstrings strengthening exercise programme were also be continued to prevent muscle atrophy. Most patients graduated from non-weight-bearing crutch-walking to partial weight-bearing. The post-operative brace used until there was adequate control of the quadriceps.

The second phase from three to ten weeks post-operatively, continued to emphasize increasing the range of motion, increasing weight-bearing and gaining hamstring and quadriceps control, gradually progressing to general muscle strengthening activities. Only closed chain

exercises were adopted in this programme. Proprioceptive work was introduced and progressed from static to dynamic techniques including balance exercises on the wobble board and eventually jogging on a mini-tramp. The patient should have had a full range of motion during this stage and gentle resistance work e.g. gym work could be added. By the end of this period the patient should have been able to walk with a normal gait pattern without any walking aid, and have good muscular and proprioceptive control. Progress was determined by the achievement of specific functional goals rather than by simple time frames. Hence, the phase maybe extended to twelve weeks depending on the patient's progress in terms of range of motion, muscle power, pain and swelling.

The fourth phase of rehabilitation from ten weeks to six months involved the gradual re-introduction of sports specific exercises aimed at improving agility and reaction times and increasing total leg strength. At the very start of this phase, patients were brought to the hydrotherapy pool, where they were taught patterns of jogging and swimming, paying particular attention to the knee stability. Once the patients were able to do this, only then were they allowed to try jogging and running on land. Patients were advised to continue their exercise regime and to take up gym work to build up on their muscle power and bulk. They were reviewed monthly until fit for discharge; usually six to nine months post surgery.

Patients

A total of 56 patients (55 males and 1 female) who had had ACL reconstructive surgery between January 2004 and September 2005 were recruited. All these patients had their surgery performed by the orthopaedic surgeons in RIPAS Hospital using the hamstring tendon as the graft of choice and a closed loop endobutton fixation technique. Exclusion criteria included patients who had the surgery outside Brunei; presence of concomitant ligament damage e.g. posterior cruciate tear, collateral tears; patients who were put on cylinder cast or plaster of Paris for immobilization for some time following reconstructive surgery.

A return to normal activities in 6 months after reconstructive surgery, coupled with the following indicated a successful rehabilitation: full active knee range of movement; 85 - 90%, or more, muscle power compared to the unaffected side; no joint instability, with good proprioception and control.

Results

The general outline of the developed programme is given in Table 1. Thirty-four out of the 56 patients (61%) taking part in this pilot study managed to complete the six-month programme. The other 22 patients (39%) did not complete the programme, mostly due to non-attendance or transfer to other centres.

Thirty-one out of the 34 patients (91%) that completed the programme were able to return back to normal activities in six months after their reconstructive surgery. The remaining three (9%) were able to return back to normal activities within nine months of surgery.

Table 1. ACL Rehabilitation Programme

Prior to discharge

Home Exercise Programme

- Ankle Exercises
- Heel Slides
- Static Quadriceps/Hamstrings
- Straight leg raise/vastus medialis oblique

None weight bearing mobilisation mobilisation
Knee brace
Advice

(NB: Knee brace supplied and monitored by the orthopaedic team)

0 - 3 weeks

Exercise Programme

- Straight leg raise/vastus medialis oblique
- Theraband exercises
- Ankle Weights exercises
- Knee exercises in prone
- Tiptoe exercises
- Gentle stretches

Passive mobilisation

Patellar mobilisation

Ant-Post mobilisation

Electrophysical Modalities

Cryotherapy

Pulsed Ultrasound

Pulsed short wave diathermy

None-weight bearing and partial-weight bearing mobilisation

(N.B. Knee flexion range of motion should reach 100° before progressing to next phase)

3 - 10 weeks

Exercise Programme

Cycling

Wobble board activities

Trampoline activities

Half-squats

Hamstring exercises

Lunges

Steps exercises

Stretches

Gym Work

Passive Mobilisation

Patellar mobilisation

Ant-Post mobilisation

Electrophysical Modalities

Cryotherapy

Pulsed Ultrasound

Pulsed short wave diathermy

Partial And Full-weight Bearing Mobilisation

(NB: Time line can be extended up to 12 weeks according to patient's progress and development in terms of knee active range of motion, muscular power and strength, pain, swelling)

After 10 weeks

Hydrotherapy

Jogging

Hopping

Swimming

Stretches

Jogging/Patterns of Running

Gym Work

Sport-Specific Activities

Discussion

The result of this study shows that all recruited patients who managed to complete the programme were able to return to activities prior to injury, although three of them completed it within nine months, three months later than the targeted six months. This was attributed to a number of factors such as degenerative changes, severe muscle atrophy prior to surgery and low compliance to exercise regime. Some of the patients recruited for the programme also had partial menisectomy performed together with ACL reconstruction. This may or may not have affected their rate of recovery during their rehabilitation phase.

Thirty-one of the 34 patients who completed the programme managed to return to normal activities in six months after their surgery. However, it is noted that, while conducting the study, that although the final outcome was more or less the same, there were variations in terms of patients' progress at certain stage of the rehabilitative phase. Hence it can be concluded that due to individual variation, it would not be prudent to develop specific protocols that detail each step of the rehabilitation programme following ACL reconstruction. It is possible, however, to establish guidelines for protocols that are based upon scientific research.

Factors determining the successful return to normal activities after surgery and intensive rehabilitation appeared to be too subjective. The use of reliable outcome measures before and after surgery and rehabilitation would benefit in concluding the effects of rehabilitation on symptomatic

and functional factors. Outcome measures such as the Lysholm Tegner Knee scale and the International Knee Documentation Committee Subjective Knee Form would offer the study a much more valid and reliable result [11,12].

It is concluded that many factors must be considered when designing a protocol for a given patient, as they will all have a role in the success or failure of the programme. These factors include conservative versus accelerated approach, surgical considerations such as graft type and source, sex differences, and perhaps most importantly the motivation of the athlete to return to competition. It should be noted that every patient is different, with different rehabilitative needs. Hence, designing a tailor-made ACL rehabilitative programme, based upon scientific research, for each individual patient will hopefully produce a better outcome. With a good understanding and knowledge-based on the need of proper rehabilitation, coupled with evidence-based practice, the ACL rehabilitation protocol developed by the Physiotherapy Department of RIPAS Hospital managed to fulfil and cater for the rehabilitative needs of patients with post-operative ACL reconstruction in order to return them to satisfying levels of activity. Nevertheless, this protocol should only be used as a guideline. Physiotherapists and clinicians alike should always be open and exposed to new ideas and ground breaking research and scientific studies in this area.

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