Effectiveness of Blood Flow Restriction Training on Increasing Strength in Post Surgery Rehabilitation of Anterior Cruciate Ligament (ACL) Compared with Traditional ACL Rehabilitation Protocol

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Abstract

Background: Patients who have anterior cruciate ligament restoration surgery endure a severe loss of strength in their lower limbs as a result of muscle atrophy and arthrogenic inhibition. A relatively novel method for either preventing muscle atrophy or maybe inducing muscular growth is blood flow restriction (BFR) training.

Purpose: The Purpose of the study is to determine effectiveness of blood flow restriction training in post-surgery rehabilitation of anterior cruciate ligament compared with traditional ACL rehabilitation protocol.

Materials and Methods: Total of 50 samples was selected based on inclusion and exclusion criteria. The subjects were separated as Group A and Group B where group A (n=25) is provided with blood flow restriction training and group B (n=25) is provided with strengthening exercise. Results were statistically analysed and tabulated.

Result: The study found that there is significant improvement on anterior cruciate ligament surgery in post rehab using NPRS and Range of motion. The results concluded that the improvement in blood flow restriction training was extremely statistically significant.

Conclusion: Blood flow restriction training was found to be more effective than strengthening exercise for the treatment of post rehabilitation of anterior cruciate ligament surgery.

Keywords: Anterior cruciate ligament, blood flow restriction training, Numeric pain rating scale, Range of motion, strengthening exercise

Introduction

Patients who have anterior cruciate ligament restoration surgery endure a severe loss of strength in their lower limbs as a result of muscle atrophy and arthrogenic inhibition 1 The anterior cruciate ligament (ACL) is the knee ligament that is most frequently injured and one of the orthopaedic injuries that is most extensively investigated, postoperative rehabilitation strategies have developed over the years. Over this time, medical professionals have switched from their previous strategy of complete immobilization and little muscle activity to one that emphasizes enhanced muscle activation and range of motion (ROM)

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immediately after surgery\(^2\). Patients who undergo anterior cruciate ligament repair (ACLR) surgery significantly lose strength in their lower limbs as a result of muscle atrophy and arthrogenic inhibition. After surgery, there is significant knee flexor and extensor muscle weakness for the first 12 weeks, which affects quality of life and lower limb function. After ACLR surgery, muscle weakness can linger for years and is linked to persistent function decreases, a high risk of re-injury, and joint deterioration \(^3\). The restricted weight bearing and unloading environment of ACL rehabilitation, the consequences of muscular atrophy are unavoidable. This is particularly apparent following surgery due to Tendon strains, cartilage damage, bone bruising, and meniscal injury are all signs against using excessive loads to increase strength and muscle hypertrophy\(^4\). The exercise programme for recovering from an ACL injury moves slowly and includes ROM, weight-bearing, isokinetic muscle activation, proprioception, and functional exercises. It is done in conjunction with physical therapy. However, in those with weak quadriceps and muscular function, using high-intensity loads or completing challenging workouts for speedy recovery may increase the risk of re-injury and arthritis. Therefore, even at modest intensities, there is a need for effective treatments\(^5\). The management of this problem depends on an early diagnosis of ACL injury, extensive rehabilitation programs, and preventative strategies. The literature is well aware of the associated repercussions, including recurring bouts of knee instability, injury to related knee structures such as the menisci, cartilage, and bone, following degenerative changes, and a reduced capacity to recover to pre-injury levels of activity\(^6\). A relatively novel method for either preventing muscle atrophy or maybe inducing muscular growth is blood flow restriction (BFR) training \(^7\). Evidence suggests that this method of training can offer an exceptional, advantageous form of exercise, even in therapeutic settings, since it results in favourable training adaptations that are comparable to daily physical activity (10–30% of maximum work capacity). Recent research has revealed that modest vascular restriction during exercise can cause muscle hypertrophy at intensities as low as 20% of one’s maximum heart rate\(^8\). BFR therapy prevents the usual muscle atrophy that is frequently seen after reconstructive knee operations by allowing physicians and patients to operate in a low-load bearing setting while still being able to achieve the essential musculoskeletal strengthening\(^9\). Over the past 20 years, it has been shown that resistance training at low loads (20–30% 1-RM) in combination with blood flow restriction (BFR) to the working muscle can enhance muscular strength and growth\(^10\).

**Aim**

To find the effectiveness of blood flow restriction training in post-surgery rehabilitation of anterior cruciate ligament compared with traditional ACL rehabilitation protocol.

**Materials and Methods**

Requirements of material in the study are BFR cuff, Goniometer. This research is an experimental study. The study was conducted with a sample size of 50 participants. The participants were selected from Saveetha college of physiotherapy outpatient department OPD according to inclusion and exclusion criteria. Participants received an extensive overview of the method, and a formal informed consent form was acquired. The study was done between December 2022 to March 2023.

**Inclusion criteria:**
- subject of the age group of 18 to 40,
- Females > Males.
- Post-ACL reconstruction surgery,
- stable and controlled knee

**Exclusion criteria:**
- pain more than 8 in NPRS scale,
- severe cardiovascular disease,
- congenital deformity,
- patients who are not willing to participate.

**Outcome measure:**
- Numerical pain rating scale (NPRS)
- Range of motion using goniometer

**Procedure**

This study was conducted as an experimental study, randomly selecting patients selected based on
inclusion and exclusion criteria. Subjects between 18 to 40 years of age, both male and female volunteers, non-smokers, patients with no neurological impairment and were free of cardiac, pulmonary or metabolic conditions were included in the study. Patients were informed about the rehabilitation program prior to the surgery. Patients were taken from Saveetha College of physiotherapy (scpt) OPD, Saveetha medical college and hospital Thandalam Chennai. Subjects were randomly divided into two groups; group A patients were given blood flow restriction training and group B patients were provided with strengthening exercise. Before and after intervention patients were assessed using the NPRS scale to identify the intensity of pain, and analysed ROM using a goniometer. Patients who were getting rehabilitation in our Physiotherapy department between February to March 2023 were prospectively enrolled in the study. The informed consent was given to the patient before the treatment began and explained about the procedure.

Traditional Rehabilitation Protocol

Traditional post-operative management mainly consist of restoring tibiofemoral joint PROM, passive glides of patella, control of enema, hamstring & quadriceps isometrics, ankle strengthening, progressive weight bearing of the operated leg given for 8 weeks, where treatment started on day 2 postoperatively till week 8\textsuperscript{11,12}.

1. Quadriceps isometrics:

Patients were instructed to lie in supine position. Underneath the affected knee, a small rolled towel was placed. Ask the patient to push the back of the knee into the rolled towel and encourage them to tense the quadriceps muscle on top of the leg. The patients were told to contract for five seconds, and then relax gradually.

2. Straight leg raises:

To effectively strengthen the quadriceps, the Straight Leg Raises (SLR) exercise can be done under certain duration constraints. Incorporating duration into the activity can be done in the following ways.

Procedure:

- Lie on a mat or other solid surface on your back to start.
- Extend the opposite leg straight out in front of you while bending one knee and keeping the foot flat on the ground.
- Tighten the quadriceps muscle (front of the thigh) of the extended leg.
- Hold the raised position for a predetermined amount of time, usually 2-3 seconds to begin with.
- Slowly elevate the extended leg off the ground, keeping it straight, until it is at the same height as the bent knee or as high as comfortable.
- Remain in the raised position for the allotted time, which is usually 2-3 seconds at first.
- Back to the beginning position, gently lower the leg.
- Follow your physical therapist’s advice and carry out the exercise for the prescribed number of repetitions, such as 10-15.
- The exercise should be done again on the other side by switching legs.

Blood Flow Restriction Training Protocol:

Blood flow restriction training protocol consists of isometric contraction of quadriceps which progresses to extension of leg over the bolster and straight leg raise, half squat, resistance to walking with elastic tube given 8 weeks, where treatment started on postoperative week 2 and ends on week 8. 20 reps given for 5 set with rest period of 3 minutes per day, external load was low.

1. Straight leg raising with blood flow restriction

The subject is in supine lying position legs laid out comfortably on the floor. Bend the knee of your non-injured leg at a 90-degree angle, planting the foot flat on the floor. Stabilize the muscles on your straight leg by contracting your quadriceps (the group of muscles on the front of your thigh). Inhaling slowly, lift the straight leg six inches off the ground. Hold for three seconds. Exhaling slowly, lower the leg to the floor with control. Relax and repeat 10 times.

2. Knee extension exercise with blood flow restriction

Subject is sitting on a chair or bench. Lifting one leg up, extending at the knee to the fullest range tolerable hold briefly at the top of the movement, squeezing the
muscles at the front of the thigh before lowering your leg back down for 5-7 seconds. Gently lower the leg by bending the knee to complete a repetition. Ensure the movement is slow and controlled. Ensuring full knee extension (leg completely straight). Repeat for the 10 repetitions.

3. Half squat with blood flow restriction

Subject is in standing position place the feet about shoulder-width apart, pointing ahead with a slight angle outward Create an arch in your foot, pressing down with your heel, the base of your first toe, and the base of your 5th toe to create a sort of tripod—this will provide stability and even distribution of your weight. Drive your hips back into a hip hinge, bringing your chest forward, engaging your glutes and hamstrings. Descend to the desired position, either to parallel or just above, keeping balanced with your weight evenly distributed in your feet. For a half squat, your shins should be as vertical as possible. Drive your hips up and back, pulling in your shins to vertical as you return to standing.

Data Analysis

Using descriptive and inferential statistics, the acquired data was tabulated and evaluated. The mean and standard deviation (SD) were applied to all parameters. The significant differences between pre-test and post-test measures were analysed using a paired t-test. The significance level of p <0.0001 was judged statistically significant when using the unpaired t-test to examine significant changes between two groups.
Result

- The data acquired were statistically significant between pre-test and post-test values of NPRS scale in the blood flow restriction training group, with a mean value of 9.10 in before testing and 4.40 after the test and a standard deviation of 0.88 in before the test and 0.97 in after the test.

- Pre-test and post-test values of NPRS scale in the strengthening group, with a mean value of 9.10 in before testing and 7.1 after the test and a standard deviation of 0.88 in before the test and 0.89 in after the test.

- Pre-test and post-test of goniometric measurements in the blood flow restriction training, with a mean value of 15 in before testing and 43 after the test and a standard deviation of 4.08 in before the test and 5.37 in after the test. Pre-test and post-test of goniometric measurements in the strength training, with a mean value of 15 in before testing and 43 after the test and a standard deviation of 4.08 in before the test and 5.37 in after the test according to the statistical analysis performed on the quantitative data.

- Blood flow restriction training was therefore shown to be helpful in reducing pain and enhancing range of motion in knee joints following ACL surgery.

Discussion

The current study’s objective is to evaluate the effectiveness of the anterior cruciate ligament strengthening exercise and blood flow restriction technique in post-rehabilitation. Additionally, with anterior cruciate ligament surgery, access the pain and work on enhancing the strength and range of motion. Within the span of 5 weeks, the comparison is shown. Before and after the treatment, the NPRS and range of motion were used to measure the outcomes. When the responses from the two groups were compared, the blood flow restriction training group performed much better than the strengthening exercise group.

This study is to find out the effectiveness of blood flow restriction training exercise and conventional exercises for patients with ACL injury. This study has a sufficient level of evidence that highly recommends the blood flow restriction training exercises to the patients with ACL injury. During this experimental study some stretches and strengthening exercises were given to strengthen the muscles around the knee with blood flow restriction, which is effective in pain reduction and increases the range of motion of the knee.

It was preferred that blood flow restriction training According to many writers, including Rosenblatt et al., BFR-RT can dramatically lessen knee joint discomfort and effusion while skeletal muscle strength and hypertrophy are increased to a identical degree as with High load resistance training. positive effects on general physical performance. Thus, during the increasing limb loading phase of recovery following surgery, BFR-RT may be better suitable for the NHS’s ACLR patient groups.

BFR-RT can increase skeletal muscle development with a greater deduction in knee joint discomfort and outflow. This results in greater overall gains in physical function was preferred by many authors like Luke Hughes et al., The National Health Service may therefore find that BFR-RT is better suitable for early rehabilitation in ACLR patient populations.

In 89% of patients who were checked at least two years after surgery, four-strand hamstring tendon autograft eradicated anterior tibial subluxation. 11% of attempts failed total. At the time of the follow-up, the functional knee scores had greatly increased, but the results did not match those of the knee arthrometric testing.

Conclusion

According to the study’s conclusions, blood flow restriction training was found to be more beneficial than strengthening exercise for the treatment of post-rehabilitation of anterior cruciate ligament.

Ethical committee: This research work has been approved by the ISRB committee.11 ISRB number -03/010/2022/ISRB/SR/SCPT.

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References


