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Effect of Accelerated Rehabilitation Program and Neuromuscular Rehabilitation Program on Knee Range of Motion and Knee Function in Patients with ACL Reconstruction

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Abstract: ***Context: There is lack of information related to the comparison of the effect of accelerated rehabilitation program with neuromuscular rehabilitation program on knee range of motion and knee function in subjects after anterior cruciate ligament reconstruction using hamstring tendon graft. Objective: To investigate the comparison of the effect of accelerated rehabilitation program with neuromuscular rehabilitation program on knee range of motion and knee function in subjects after anterior cruciate ligament reconstruction and to document the changes pre and post treatment. Methodology: Thirty male subjects, aged 35 to 50 years, who underwent ACL reconstruction surgery after being diagnosed with a full unilateral anterior cruciate ligament tear, were included as per the selection criteria. The subjects were assessed for knee range of motion and knee function with Universal Goniometer and International Knee Documentation Committee Questionnaire (IKDC - questionnaire), respectively. The individuals in Group A received an accelerated rehabilitation program, whereas Group B received a neuromuscular rehabilitation program. Results: There was significant increase in the (p<o. oo1) knee range of motion and IKDC score in both the groups. There was improvement in the Knee flexion range and IKDC scores (p <.05) but there was no difference found between the groups in respect to knee extension (p >.05). Conclusion: The result of current study indicates that neuromuscular rehabilitation program is equivalent to accelerated rehabilitation program in terms of knee extension, but better for knee flexion and knee function in subjects with anterior cruciate ligament reconstruction.***

Keywords: Anterior cruciate ligament injury, Knee function, Knee Range of motion

1. Introduction

Anterior cruciate ligament (ACL) rupture is one of the most common traumatic injuries among physically active individual[1]. ACL ruptures are common in adults, especially in younger populations[2]. Because of its intricacy and weight - bearing role, the knee joint is prone to damage and are often associated with concomitant meniscus and chondral lesions in the knee.

In order to decrease excessive anterior tibial movement in the sagittal plane following an ACL tear, the torn ligament may be surgically replaced with a graft[3]. ACL reconstruction patients must undergo rehabilitation in order to resume their prior level of activity[4–6]. In today's scenario, there is emphasis on functional exercises, immediate mobility, immediate partial weight bearing (WB), and full passive knee extension[7].

Although experts in exercise prescriptions have recently been examining the effects of accelerated rehabilitation exercises after anterior cruciate ligament reconstruction, no study has been conducted on its comparison with neuromuscular rehabilitation program. Therefore, aim of the present study was to evaluate and compare the effectiveness of two different rehabilitation programs: an accelerated rehabilitation program and a neuromuscular rehabilitation program on knee range of motion and knee function.

2. Methods

Design
The study design of the current study was quasi - experimental in nature.

Participants
A total of thirty male subjects, aged 35 - 50 years, diagnosed with unilateral anterior cruciate ligament tear followed by anterior cruciate ligament reconstruction surgery using hamstring tendon autograft were included in the study. The patients who had multiple ligament reconstruction, had meniscectomy/chondral surgery or have major concomitant procedures like tibial osteotomy, meniscusautograft and with active knee joint infection were excluded from the study.

Interventions
The subjects were divided into 2 groups i. e., Group A (n=15) and Group B (n=15) and were assessed for knee range of motion and knee function using Universal Goniometer and International Knee Documentation Committee Questionnaire (IKDC - questionnaire) respectively. The individuals in group A were administered accelerated rehabilitation program whereas, Group B received neuromuscular rehabilitation program [8, 9]. The treatment was given three times per week for a total of twelve weeks and were reassessed on completion of treatment program.

Group A

Table 1: Accelerated Rehabilitation Program

Stage	Rehabilitation exercise
Stage 1 (3−7 days)	• Passive knee extension (over press) (10 sec. /10 times/3–5 sets) • Ankle pump (10 times/5 sets) • Passive and active knee joint flexion (10 sec. /10 times/5–10 sets) • SLR (hip joint flexion, adduction, abduction) (10 times/5 sets) • Isometric setting of the quadriceps muscle of thigh (10 sec. /10 times/3–5 sets) • Hamstring stretching (10 sec. /5–10 sets) • Multi - angle isometric exercises under maximum force between 90° and 60° (knee joint extension) • Standing hamstring curl (10 times/3–5 sets) • Mini squat (10 times/2–3 sets)
Stage 2 (2nd−3rd weeks) 2nd week 3rd week	• All stage 1 exercises • Leg press (10 times/2–3 sets/0–30°/ weight bearing) • Leg extension 10 times/2–3 sets/90°–40° • Half squat 0–40° (10 times/3–5 sets) • Hamstring curl in a prone position (10 times/3–5 sets) • Cycling (10 minutes) • Patella mobilization (5 minutes) • All the above exercises • Passive ROM exercise 0–115° • Cycling (5–10 minutes) • Leg extension emphasizing extending exercises (40°–90°) (10 times/3–5 sets) • Side stair climbing (10 times/2–3 sets) • Front stair climbing (10 times/2–3 sets) • Proprioceptive sense training (5 minutes)
Stage 3 (4th−12th weeks) 4th −7th weeks 8th −9th weeks 10th −12th weeks	• All the above exercises • Wall squat (0–30°) (10 times/3–5 sets) • Calf raises (15 times/3–5 sets) • All the above exercises • Walking 10–20 minutes • Standing balancing (tilt board) (5–10 minutes)

Group – B

Table 2: Neuromuscular Rehabilitation Program

Phase	Rehabilitation program
Phase 1 (0 - 4 weeks)	Weight bearing status • Partial weight bearing with 2 crutches (0 - 1 week) • Partial weight bearing progressing to full weight bearing for normal gait mechanics (1 to 4 weeks) and for restoring proprioceptive input Exercises • Ankle pump exercises • Heel slides (0 - 90 knee flexion) • NMES for vastus medialis obliques muscle • Single leg raises with brace (0 - 2 weeks) • Gastro/soleus stretching (0 - 4 weeks) • Patellar mobilization (4 directions) • Quadriceps and hamstring sub - maximal stabilization exercises with 60˚ and 90˚ knee flexion by using exercise ball (2 - 4 weeks) • No active quadriceps and hamstring concentric contraction for 4 weeks. • Very gentle hamstring stretching (3th week) • Prone hang for knee extension at bed end (3th week)
Phase 2 (4 - 8 weeks)	Criteria for progressed to phase 2 • At least 90˚ knee flexion • Full extension • Minimal swelling/inflammation • No pain or minimal pain during full weight - bearing and closed kinetic chain exercise • Weight bearing status • Full weight - bearing Exercises • Begin use of the stationary bicycle mild to moderate resistance • Initiate Closed kinetic chain quad strengthening and progress as tolerated (wall sits, step - ups, mini squats, Leg

	press 90˚ - 30˚, lunges) and progress to closed chain exercises on unstable surfaces • Continue hamstring, gastro/soleus stretching • Single leg raise exercise with resistance • Patellar mobilization • 4 - way hip strengthening with elastic band • Initiate open kinetic chain exercise for hamstrings with lower limb weight (4th week) • Core stability exercises (abdominal draw in, supine bridge, clam exercise for gluteal muscles, abdominal crunches) and progress on unstable surfaces • Gait training
Phase 3 (8 - 12 weeks)	• Criteria for progressed to phase 3 • Minimum of 120˚ degrees of flexion • Normal gait on level surfaces • Good quadriceps and hamstring setting during CKC exercises • No pain during exercises Exercises • Stationary cycle - intervals • Initiate eccentric quadriceps and hamstring exercises with Closed kinetic chain exercises (for exp. step up and down exercises) • Open kinetic chain exercises for hamstrings with free weights • Advance Closed kinetic chain strengthening • Advanced proprioceptive exercises with perturbation training • Continue core stability exercises with resistance on unstable surfaces

3. Results

Knee range of motion

There was significant improvement in knee flexion and extension in both the groups (p>0.05) pre and post treatment. On comparison between both the groups revealed that there was significant improvement (p>0.05) in the knee flexion in group B as compared to group A.

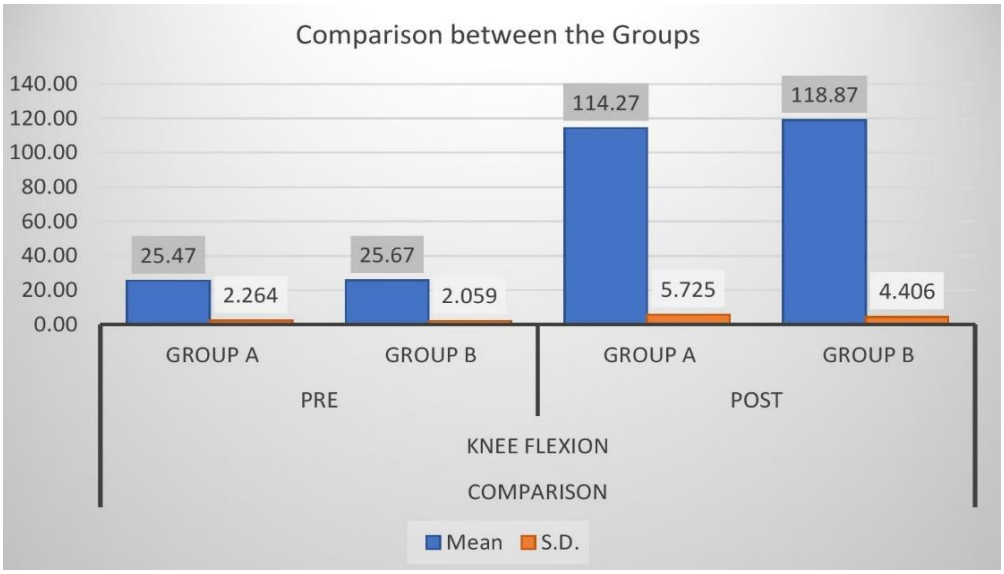

Figure 1: Graphical Representation of Comparison of Mean and SD of Pre - test and Post - test of knee flexion between Group A and Group B

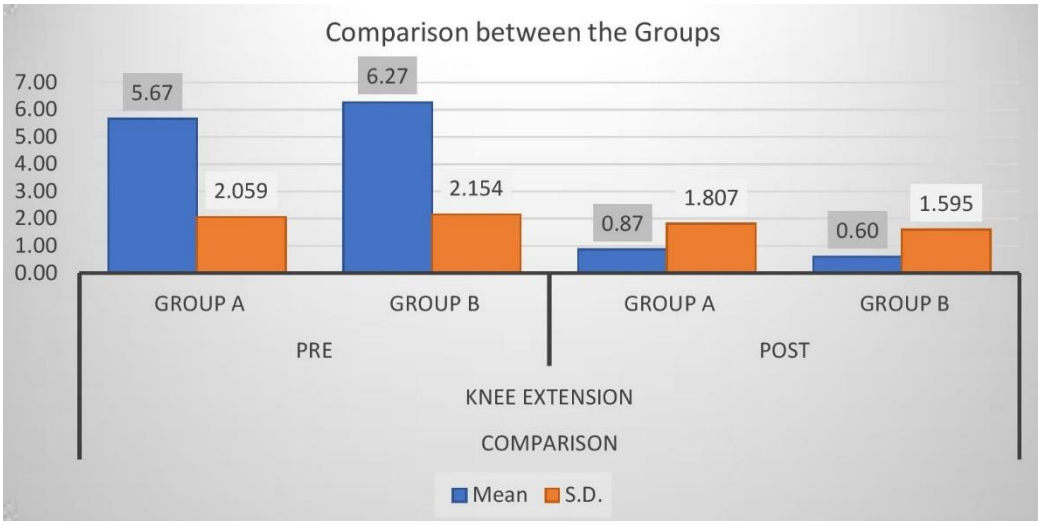

Figure 2: Graphical Representation of Comparison of Mean and SD of Pre - test and Post - test of knee extension between Group A and Group B

Knee function

There was significant improvement in knee function in both the groups ($p>0.05$) pre and post treatment. On comparison between both the groups revealed that there was significant improvement ($p>0.05$) in the knee function in group B as compared to group A.

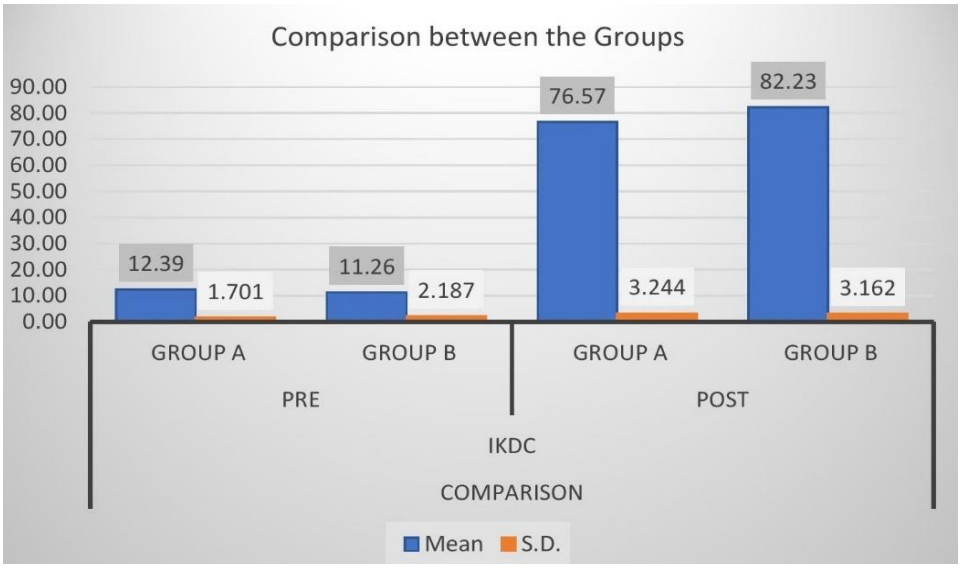

Figure 3: Graphical Representation of Comparison of Mean and SD of Pre - test and Post - test of International Knee Documentation Committee Questionnaire (IKDC - questionnaire) between Group A and Group B

4. Discussion

The result of the present study revealed that there was an improvement in the knee ROM and knee function of patients receiving accelerated rehabilitation protocol and neuromuscular rehabilitation protocol. Hence, both the groups showed statistically significant improvement in knee ROM and knee function score.

One of the study compared the accelerated protocol to conservative patients in both elite athletes and non - athletes and found that accelerated rehabilitation decreased disability and pain; increased functionality; and improved quality of life[10]. The result of the present study revealed that on comparison between both the groups, there was significant improvement ($p>0.05$) in the knee flexion and knee function in group B as compared to group A. Whereas, knee extension improvement was similar in both the groups. These results were supported by a randomised controlled trial on neuromuscular training to improve knee function more than traditional strength training following anterior cruciate ligament (ACL) reconstruction was done. The study concluded that neuromuscular rehabilitation results in superior knee function at 6 months after ACL reconstruction compared with standard strength training[11]. Another study conducted on the effectiveness of neuromuscular physical therapy as compared to strength training following anterior cruciate ligament reconstruction in terms of pain, function, quality of life, strength and power of participants revealed that compared to strength training, neuromuscular training was significantly more effective in reducing pain; improving function, quality of life, strength and power[12].

Compared to standard rehabilitation techniques, which limit range of motion, forego initial weight - bearing, and only include low - intensity exercises, accelerated rehabilitation

programmes feature immediate and active exercises after surgery. These programs were designed to speed up the healing process and promote early recovery, allowing patients to regain full range of motion, strength, and function sooner than traditional methods. Contrarily, Neuromuscular training typically involves a combination of exercises such as strength training, balance training, rapid expansion and contraction compound training, and agility training. The training begins with static control and gradually progresses to dynamic control, with the aim of restoring limb symmetry and normal movement patterns.

There is strong evidence supporting the effectiveness of neuromuscular training in modifying risky neuromuscular patterns in both healthy athletes and athletes who have undergone ACL reconstruction. In addition, this type of training has been shown to increase knee function after ACL reconstruction.

Overall, neuromuscular training is an important component of rehabilitation following ACL reconstruction and can help individuals regain strength, balance, and stability, reduce the risk of future injuries, and improve overall physical performance.

5. Conclusion

The present study has concluded that both the accelerated rehabilitation program and neuromuscular rehabilitation program are effective in improving the range of motion and knee function of the subjects after ACL reconstruction. However, on comparing both the groups, the neuromuscular rehabilitation program is equivalent to accelerated rehabilitation program in terms of knee extension but better in terms of knee flexion and knee function after anterior cruciate ligament reconstruction.

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