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# Impact of Neuromuscular Rehabilitation and Accelerated Rehabilitation Program on Knee Pain and Quality of Life in ACL Reconstruction: A Comparative Analysis

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## ABSTRACT

**Context:** Anterior cruciate ligament (ACL) reconstruction using a hamstring tendon graft is a common surgical procedure for individuals with ACL injuries. However, there is a significant lack of comprehensive research comparing the effects of an accelerated rehabilitation program and a neuromuscular rehabilitation program on knee pain and quality of life in ACL reconstructed population.
**Objective:** To compare the impact of accelerated rehabilitation program with neuromuscular rehabilitation program on knee pain and quality of life in subjects after ACL reconstruction.
Subjects: 30 male individuals, between 35-50 years, who underwent ACL repair surgery.
Outcome measures: Visual analog scale (VAS) and Knee Injury and Osteoarthritis Outcome Score (KOOS) was used to examine the knee pain and quality of life respectively. The individuals in Group A underwent an accelerated rehabilitation program, whereas Group B received a neuromuscular rehabilitation program.
**Results:** The results of this study demonstrated a significant increase ($p < 0.001$) in both the visual analog scale scores and Knee Injury and Osteoarthritis Outcome Score scores in both the groups. While comparing the two groups, it was found that both groups exhibited similar improvements in VAS scores. However, the comparison of KOOS scores revealed that Group B showed a significantly greater improvement compared to Group A.
**Conclusion:** The result of current study indicates that neuromuscular rehabilitation program is equivalent to accelerated rehabilitation program in terms of improving knee pain, but better in terms of improving quality of life in subjects with ACL reconstruction.

***Keywords:*** Anterior cruciate ligament injury, Knee pain, Quality of life

## INTRODUCTION

Due to a surge in everyday injuries, particularly those sustained in industrial accidents and road traffic accidents (RTA), knee joint problems and injuries have become more prevalent. The relevance of the anterior cruciate ligament (ACL) has grown substantially, given that a considerable proportion of knee injuries result from ligament damage[1].

The surgical procedure is one aspect of a successful outcome after ACL

reconstruction; however, a scientifically based and well-designed rehabilitation program also plays a vital role[2–4]. Avoiding problems like as loss of range of motion (ROM) and quadriceps femoris weakness, which is linked to loss of knee extension, is a common goal of rehabilitation after anterior cruciate ligament repair[5,6].

Traditional rehabilitation methods typically impose constraints on the range of motion, avoid weight-bearing, and predominantly involve low-intensity exercises. In contrast, accelerated rehabilitation programs involve immediate and active rehabilitation exercises post-surgery, enabling a return to activities in approximately six months after ACL reconstruction[6]. The ACL rehabilitation protocol emphasized neuromuscular training during three months after surgery[7]. The primary goal of these training programs is to enhance the ability to generate a fast and optimal muscle firing pattern, to increase dynamic joint stability, and to relearn movement patterns and skills necessary during activities of daily living and sports activities[8].

## MATERIALS & METHODS

### Design

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

### Participants

The study involved a total of 30 male individuals, between the ages of 35 and 50, who had surgery to rebuild the anterior cruciate ligament after being diagnosed with a unilateral anterior cruciate ligament tear using hamstring tendon graft whereas the subjects who had undergone repeated ligament repairs, meniscectomy, chondral surgery, or substantial concurrent procedures including tibial osteotomy, meniscus autograft, or who had an active knee joint infection were excluded from the study.

### INTERVENTIONS

The participants were assessed for their knee pain and quality of life were evaluated using the Visual Analogue Scale (VAS) and Knee Injury and Osteoarthritis Outcome Score (KOOS) respectively. Further the subjects were divided into two groups, Group A (n=15) and Group B (n=15). The subjects in group A were administered accelerated rehabilitation program whereas the subjects in Group B received neuromuscular rehabilitation program. Three times a week for a total of twelve weeks, the treatment was administered, and after the course of treatment, the subjects were reassessed.

Accelerated rehabilitation program (Group A)

In Stage 1, lasting 3-7 days, participants will engage in passive knee extension (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), straight leg raise (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./5–1), 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).

Moving on to Stage 2, spanning the 2nd to 3rd week, all Stage 1 exercises are continued, and additional activities include 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) , passive range of motion 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).

In the subsequent Stage 3, spanning the 4th to 12th weeks, all previously mentioned exercises are continued, with the addition of wall squat (0°–30°) (10 times/3–5 sets), calf raises (15 times/3–5 sets), walking 10–20

minutes, standing balancing (tilt board) (5–10 minutes)[9].

Neuromuscular rehabilitation program (Group B)

In Phase 1, spanning 0-4 weeks, participants undergo a gradual progression in weight-bearing status from partial weight-bearing with 2 crutches (0-1 week) to full weight-bearing for normal gait mechanics (1-4 weeks) for the restoration of proprioceptive input. Exercises encompass ankle pump exercises , heel slides (0°-90° knee flexion), Neuromuscular electrical muscle stimulator 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 (3rd week).

Advancing to Phase 2, covering 4-8 weeks, full weight-bearing status is maintained. Exercises involve the introduction of a stationary bicycle with mild to moderate resistance, initiate CKC 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, spanning 8-12 weeks, introduces stationary cycle intervals, initiates 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[7].

## RESULT

### Knee pain

There was significant improvement in severity of knee pain in both the groups ($p<0.05$) pre and post treatment. When comparing both groups, it was evident that there was a nearly equivalent and statistically significant improvement ($p<0.05$) in the Visual Analog Scale (VAS) scores in both groups.

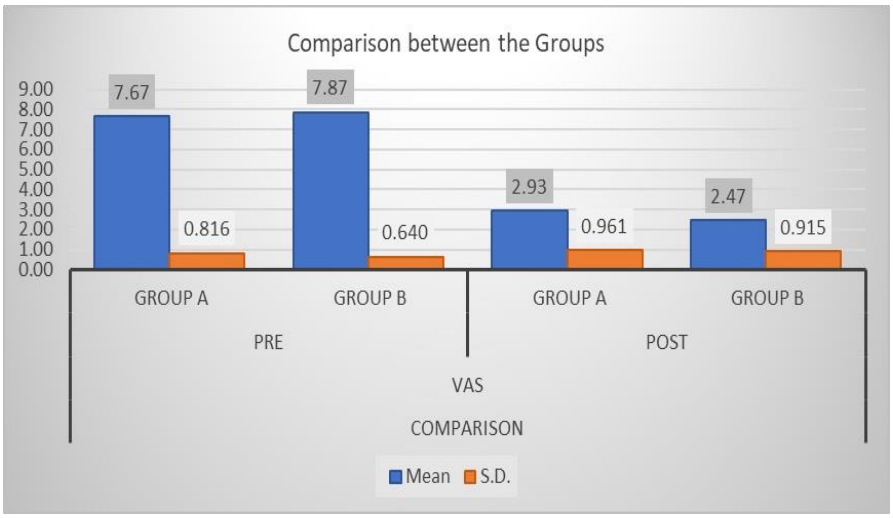
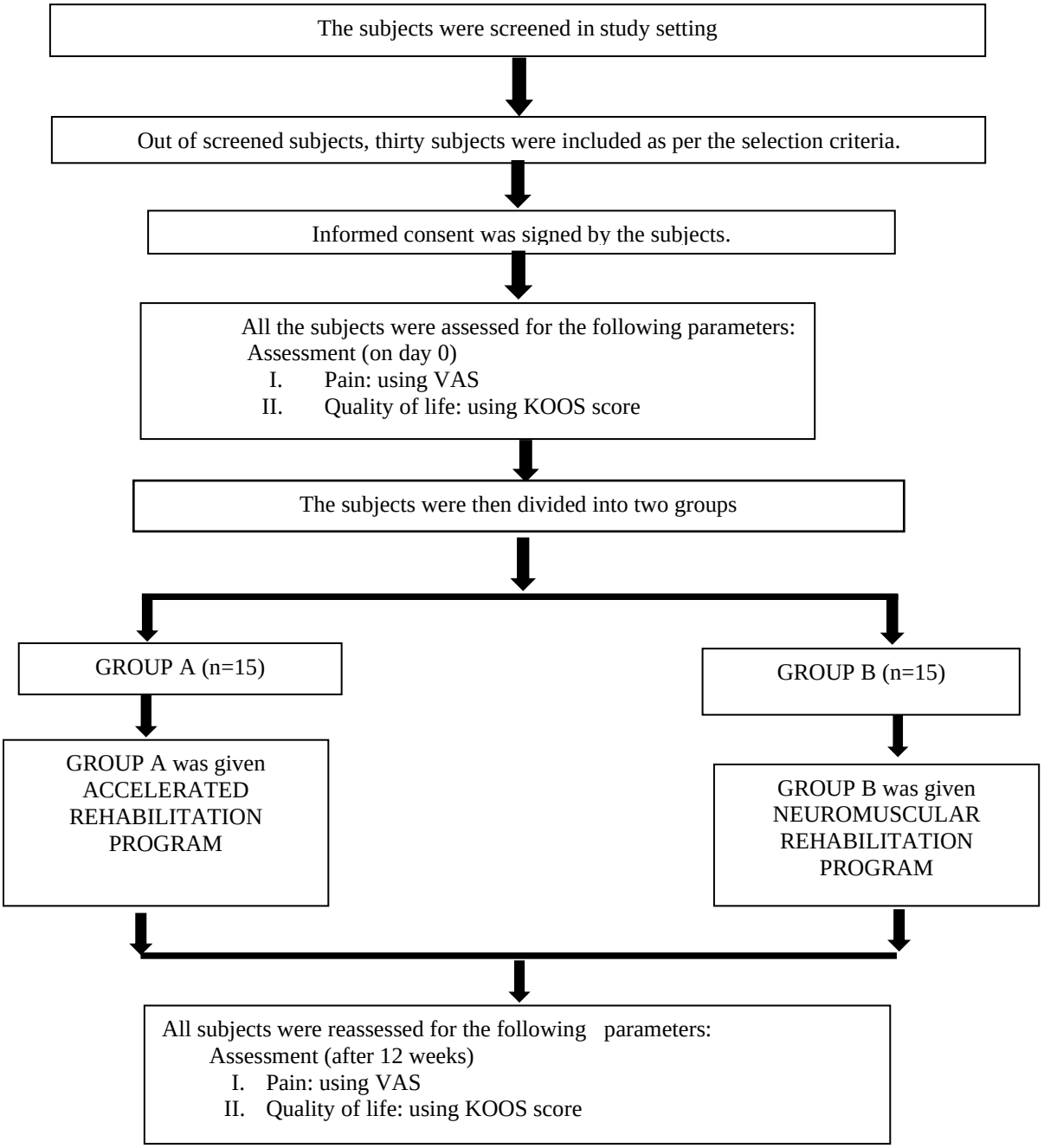



**Fig.1: Graphical representation of comparison of Mean and SD of Pre-test and post-test of VAS between Group A and Group B**

**Treatment Plan**




**Quality of life**

There was significant improvement in KOOS scores within both groups, with a statistically significant improvement ($p<0.05$) observed from pre- to post-treatment. Upon comparing the two groups, it became evident that the quality-of-life improvement in Group B was significantly higher ($p<0.05$) than that in Group A.

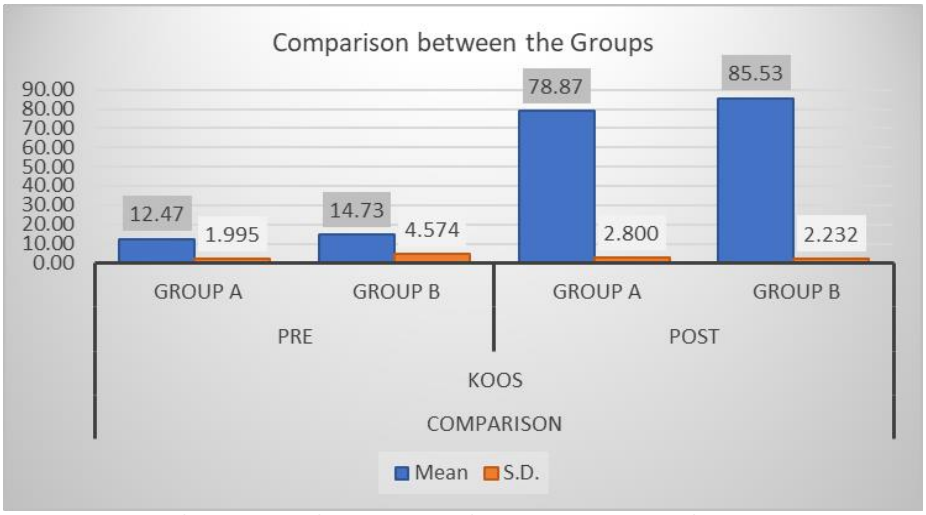



**Fig.2: Graphical representation of comparison of Mean and SD of Pre-test and post-test of KOOS between Group A and Group B**

## DISCUSSION

This study aimed to assess the effectiveness of accelerated and neuromuscular rehabilitation protocols post-ACL reconstruction concerning knee pain and quality of life. The results indicated improvements in both knee pain and quality of life for patients in both groups. However, when comparing the two groups, there was a nearly equivalent and statistically significant enhancement in Visual Analog Scale (VAS) scores. Notably, the quality-of-life improvement in Group B was significantly higher than that in Group A.

In a comparative investigation between accelerated and conventional rehabilitation protocols, it was observed that the accelerated rehabilitation protocol played a more significant role in pain reduction and improvement in functional activities. This can be attributed to the accelerated rehabilitation protocol's focus on enhancing the quality of life by reinstating functional activities after ACL reconstruction. This comprehensive approach involved a combination of balancing, proprioceptive, agility, and plyometric exercises, coupled with Range of Motion and strengthening exercises[10].

These findings align with a study comparing neuromuscular physical therapy to strength training post-ACL reconstruction. The results underscored the statistical significance of neuromuscular training in reducing pain ($p<0.001$), improving function ($p<0.001$), enhancing power and strength ($p<0.001$), and improving quality of life ($p=0.001$). The study concluded that, compared to strength training, neuromuscular training demonstrated significantly superior outcomes across various parameters[11].

Similarly, another study comparing a 6-month neuromuscular training (NT) program with a traditional strength training (ST) program post-ACL reconstruction revealed that the NT group exhibited significantly enhanced Cincinnati Knee Scores and VAS scores for global knee function at the 6-month follow-up. These results suggest that incorporating exercises from the neuromuscular training program into rehabilitation protocols following ACL reconstruction can contribute to improved patient outcomes[12].

## CONCLUSION

The findings of the current study suggest that, in terms of reducing knee pain, neuromuscular rehabilitation program is similar to accelerated rehabilitation program, but it does a better job in enhancing the quality of life in patients who have had their anterior cruciate ligaments repaired.

### *Declaration by Authors*

**Ethical Approval:** Approved
**Acknowledgement:** None
**Source of Funding:** None

**Conflict of Interest:** The authors declare no conflict of interest.

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