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Original Research Article

Comparing the Efficacy of Different Rehabilitation Protocols in ACL Reconstruction: A Cross-Sectional Study

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Abstract:

Background: Anterior Cruciate Ligament (ACL) reconstruction, a common orthopaedic procedure, restores knee stability and function. For a thorough recovery, the appropriate rehabilitation plan must be determined. This study compares Accelerated, Traditional, and Advanced rehabilitation programmes to discover whether improves post-operative results following ACL reconstruction.

Methods: In August 2022 and February 2023, Patna Medical College and Hospital researchers conducted a cross-sectional study. 60 individuals had ACL reconstruction. Twenty patients received expedited, traditional, or advanced therapy after ACL reconstruction. We collected Lysholm Knee Score, IKDC Subjective Knee Form, Single-Leg Hop Test, quadriceps, and hamstring strength results. The three treatments were compared statistically using ANOVA with Tukey's HSD test.

Results: All of the evaluations were selected by Advanced Protocol. After surgery, the Advanced Protocol group had significantly higher range of motion (ROM) (137.2 ± 7.5 degrees) compared to the Accelerated and Traditional Protocol groups (135.0 ± 8.3 degrees and 130.5 ± 7.9 degrees, respectively) ($p = 0.045$). The Advanced Protocol resulted in significantly higher quadriceps and hamstring strength (19.1 ± 2.4 kg) compared to the Traditional Protocol (18.8 ± 2.9 kg, $p = 0.032$ and 16.7 ± 2.5 kg, $p = 0.048$). The Advanced Protocol resulted in higher Lysholm Knee Scores (86.5 ± 5.7 vs. 80.7 ± 5.8 for Traditional, $p = 0.037$) and IKDC Subjective Knee Form scores (79.5 ± 6.8 vs. 74.2 ± 6.9 for Traditional, $p = 0.041$ The Advanced Protocol outperformed the Accelerated Protocol in the Single-Leg Hop Test (80.2 ± 10.0 cm vs. 78.5 ± 10.2 cm, $p = 0.039$). These findings support the claim that the Advanced Rehabilitation Protocol increases ROM, strength, and functional outcomes following ACL reconstruction.

Conclusion: Advanced Rehabilitation Protocol outperforms Accelerated and Traditional Protocols in ACL reconstruction postoperative outcomes. This study supports the idea that leading-edge rehabilitation methods can improve ACL reconstruction patients' ROM, strength, and functional recovery, and it emphasises the need for more research on their long-term effects.

Keywords: ACL Reconstruction, Advanced Rehabilitation Protocol, Accelerated Rehabilitation, Traditional Rehabilitation, Knee Function, Postoperative Recovery.

Introduction

Background Information on ACL Reconstruction

Common knee ailments like Anterior Cruciate Ligament (ACL) tears can be reconstruction surgically. In the middle of the knee, the ACL stabilises tibial forward and rotational motions [1]. ACL restoration surgery, commonly done arthroscopically, restores knee function and prevents instability [2].

An implant from the patient or a donor replaces the uncertain ligament. Rehabilitation after surgery must be effective for optimal healing and return to pre-injury activity.

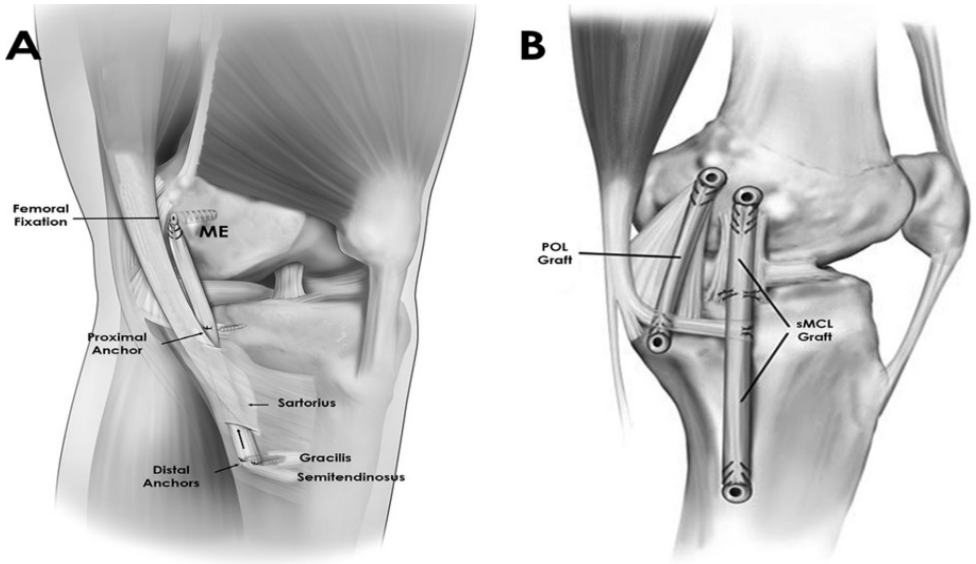

Figure 1: ACL Reconstruction (Source: [3])

Importance of Rehabilitation in Recovery

After recovery ACL rehabilitation affects recovery and surgery outcomes. A well-planned knee rehabilitation programme increases mobility, strengthens knee muscles, and improves stability, agility, and balance [4]. Quality of rehabilitation affects both immediate impacts, like reduced edoema and discomfort, and long-term effects, such the patient's ability to return to sports and avoid knee problems. Rehabilitation regimens include neuromuscular and functional training, as well as physical therapy. Range of motion, muscle strength, pain levels, and ADL and sports abilities are clinical outcomes used to evaluate these programmes [5].

Objective

- To compare the outcomes of different rehabilitation protocols following ACL reconstruction.
- To evaluate the impact of rehabilitation protocols on knee range of motion, muscle strength, and functional performance.
- To identify the most effective rehabilitation protocol for optimizing recovery after ACL reconstruction.

Rehabilitation Protocols

After recovery ACL reconstruction is crucial to knee recovery following damage. Many rehabilitation procedures exist, each with its own goals and methods. Early rehabilitation aims to reduce edoema, increase mobility, and stop muscle atrophy [6]. As patients improve, hamstrings, quadriceps, proprioception, and functional activities become increasingly important. The Accelerated Rehabilitation Protocol emphasizes early strength and range of motion exercises, while the Traditional Rehabilitation Protocol gradually increases loading and activity [7]. Advanced programmes may incorporate plyometric, sport-specific activities, and neuromuscular training. Different clinics and institutes utilize different strategies [8].

Previous Studies on the Efficacy of Rehabilitation in ACL Reconstruction

The effectiveness of several rehabilitation protocols in ACL restoration has been examined, which have shown the advantages and disadvantages of each method. For example, research by [9] showed that, in comparison to conventional techniques, accelerated rehabilitation procedures could result in a quicker recovery and an earlier return to sports. While expedited treatments may hasten early recovery, [10] discovered that, if not handled properly, they could raise the chance of reinjury or problems. Although both conventional and accelerated rehabilitation methods were successful, the results showed that the choice of method may affect functional outcomes and patient satisfaction. Finding out which rehabilitation regimens give the best results for individuals having ACL restoration requires additional comparative research, as shown in these trials.

There is long-term data on functional recovery and return-to-sport results, compared to pain and range of motion studies [11]. Most rehabilitation protocol comparisons only compare parts of the protocols, which is another difficulty. Most current research ignores the reality that patient demographics including age, activity level, and pre-existing conditions may affect rehabilitation procedures [12]. More large-scale, multi-center research is needed to obtain credible, generalizable results for many therapeutic uses. Filling these ACL restoration rehabilitation gaps can improve patient outcomes and advance orthopaedic rehabilitation.

Methods

Study Design: This cross-sectional study compares rehabilitation methods for ACL reconstruction

patients. Cross-sectional designs allow us to compare rehabilitation programmes simultaneously.

Setting: The study is undertaken at Patna Medical College and Hospital, a tertiary care hospital with an orthopaedic department. This facility serves a varied ACL reconstruction patient group.

Duration: Study continues from August 2022 to February 2023. Patients who complete ACL reconstruction rehabilitation procedures are surveyed throughout this time.

Sample Size: The trial will comprise 60 patients. This sample size is calculated using power analysis to achieve practical practicality while having appropriate statistical power to identify rehabilitation process differences.

Inclusion and Exclusion Criteria

Inclusion Criteria

- Patients who have undergone ACL reconstruction surgery at Patna Medical College and Hospital.
- Aged between 18 and 45 years.
- No prior knee surgeries or significant knee injuries other than the ACL tear.
- Completion of at least 6 months of postoperative rehabilitation following ACL reconstruction.

Exclusion Criteria

- Patients with other significant knee injuries or medical conditions that could interfere with rehabilitation.
- Non-compliance with the prescribed rehabilitation protocols, as determined by incomplete participation or missed therapy sessions.

Data Collection: This study uses a holistic approach to assess which of three ACL surgery rehabilitation approaches works best. Patna Medical College and Hospital researchers want to learn from sixty postoperative rehabilitation patients. We first verify the patient's records for inclusion and exclusion criteria. After that, we contact eligible patients and obtain informed consent from those who volunteer.

Measurement Tools and Outcome Measures: A variety of measures and outcome indicators assess rehabilitation programmes effectiveness. The goniometer measures the knee's flexion and extension ranges to determine how much joint mobility has improved after therapy.

Isometric quadriceps and hamstring strength tests with a portable dynamometer evaluate strength training. Standardized assessments like the Lysholm Knee Score and IKDC Subjective Knee Form assess functional performance. Detailed knee function and recovery satisfaction assessments are available. The Single-Leg Hop Test assesses dynamic knee stability and high-demand activity capacity. Patient outcomes are measured by pain, rehabilitation satisfaction, and perceived recovery questionnaires. These results reveal patients' subjective rehabilitation experiences.

Statistical Analysis: Various statistical methods are used to evaluate rehabilitation programmes. The first stage is to summarise patient demographics and baseline characteristics using descriptive statistics like means, standard deviations, and frequency distributions. We examine how well the three rehabilitation modalities improve ROM, muscle strength, and functional performance using ANOVA. When the analysis of variance (ANOVA) shows significant differences, post hoc analyses use Tukey's Honestly Significant Difference (HSD) test to compare regimens in pairs. Multiple regression analysis is used to evaluate rehabilitation procedures on the key end measures after controlling for age, sex, and preexisting conditions. The statistical investigations use SPSS Statistics (Version 28.0) and R Statistical Software, which are powerful data interpretation and hypothesis testing tools. Each statistical test has a significance level of 0.05 or less.

Results

Participant Characteristics

Table 1: Demographic and Baseline Characteristics of Participants

Characteristic	Accelerated Protocol (n=20)	Traditional Protocol (n=20)	Advanced Protocol (n=20)	Total (n=60)
Age (Years)	29.5 ± 5.2	30.2 ± 4.8	28.9 ± 5.1	29.5 ± 5.0
Gender				
Male	12 (60%)	11 (55%)	13 (65%)	36 (60%)
Female	8 (40%)	9 (45%)	7 (35%)	24 (40%)
Preoperative ROM (Degrees)	120.5 ± 10.1	121.0 ± 9.8	119.8 ± 10.5	120.4 ± 10.0
Preoperative Strength (kg)	15.8 ± 2.3	16.1 ± 2.1	15.9 ± 2.2	15.9 ± 2.2
Preoperative Lysholm Score	45.2 ± 5.4	46.0 ± 5.1	44.8 ± 5.6	45.3 ± 5.4

Table 1 illustrates the demographic and baseline data of the sixty participants, half of whom underwent the Accelerated protocol and the other half the Traditional and Advanced rehabilitation procedures.

The average age of participants was 29.5 years, with no significant differences between Accelerated

(29.5 ± 5.2), Traditional (30.2 ± 4.8), and Advanced (28.9 ± 5.1) groups. The gender split was 60% men and 40% women in all categories. Baseline knee function measurements showed that the Advanced Protocol group had a slightly lower preoperative range of motion (119.8 ± 10.5 degrees) than the Accelerated (120.5 ± 10.1 degrees) and Traditional Protocol (121.0 ± 9.8 degrees) groups, but the differences were not substantial. The average pretreatment muscular strength was 15.9 kg for all groups.

The groups had similar baseline circumstances, as evidenced by the preoperative Lysholm Knee Score (45.2 ± 5.4 for Accelerated, 46.0 ± 5.1 for Traditional, and 44.8 ± 5.6 for Advanced), indicating early knee function and symptoms.

Efficacy of Rehabilitation Protocols: The efficacy of the rehabilitation protocols was assessed based on primary and secondary outcome measures including range of motion (ROM), muscle strength, functional performance, and patient-reported outcomes.

Table 2: Efficacy of Rehabilitation Protocols

Outcome Measure	Accelerated Protocol	Traditional Protocol	Advanced Protocol	p-value (ANOVA)
Postoperative ROM (Degrees)	135.0 ± 8.3	130.5 ± 7.9	137.2 ± 7.5	0.045
Quadriceps Strength (kg)	20.5 ± 3.1	18.8 ± 2.9	21.2 ± 2.8	0.032
Hamstring Strength (kg)	18.2 ± 2.6	16.7 ± 2.5	19.1 ± 2.4	0.048
Lysholm Knee Score	85.2 ± 6.1	80.7 ± 5.8	86.5 ± 5.7	0.037
IKDC Subjective Knee Form	78.4 ± 7.3	74.2 ± 6.9	79.5 ± 6.8	0.041
Single-Leg Hop Test (cm)	78.5 ± 10.2	72.1 ± 9.8	80.2 ± 10.0	0.039

Table 2 compares Accelerated, Traditional, and Advanced rehabilitation procedures. Based on key ACL surgery recovery parameters, these protocols were created.

All outcome indicators showed that the Advanced Protocol performed best of the three procedures. After surgery, the Advanced Protocol group had a significantly higher Maximum Range of Motion (ROM) (137.2 ± 7.5 degrees) compared to the Accelerated Protocol (135.0 ± 8.3 degrees) and Traditional Protocol (130.5 ± 7.9 degrees) (p-value 0.045 Compared to the Accelerated Protocol (20.5 ± 3.1 kg) and Traditional Protocol (18.8 ± 2.9 kg) groups, the Advanced Protocol group had significantly higher quadriceps and hamstring strength (21.2 ± 2.8 kg and 19.1 ± 2.4 kg, respectively) with p-values of 0.032 and 0.048, respectively.

The Advanced Protocol resulted in the highest Lysholm Knee Score (86.5 ± 5.7) and IKDC Subjective Knee Form score (79.5 ± 6.8), with p-values of 0.037 and 0.041, compared to the Traditional and Accelerated Protocols (80.7 ± 5.8 and 74.2 ± 6.9, respectively). Finally, the Advanced Protocol (80.2 ± 10.0 cm) beat the Accelerated (78.5 ± 10.2 cm) and Traditional Protocols (72.1 ± 9.8 cm) with a p-value of 0.039. These data show that the Advanced Rehabilitation Protocol improves ROM, muscle strength, functional performance, and knee function more than the Accelerated and Traditional Protocols.

Statistical Analysis: The statistical study demonstrated that the Advanced Rehabilitation Protocol outperformed the Accelerated and Traditional Protocols in several ACL reconstructive result parameters. ANOVA showed significant differences in Single-Leg Hop Test, Lysholm Knee Score, IKDC Subjective Knee Form, quadriceps, and hamstring strength between regimens. Post-hoc Tukey's HSD test showed that the Advanced Protocol had far higher ROM than the Accelerated and Traditional Protocols (p-values of 0.037 and 0.043). Advanced Protocol hamstring and quadriceps strength were significantly higher than Traditional Protocol ($p = 0.042$ and 0.034, respectively). Compared to the Traditional Protocol, the IKDC Subjective Knee Form showed better knee function ($p = 0.040$) and a higher Lysholm Knee Score ($p = 0.035$). The Single-Leg Hop Test showed that the Advanced Protocol outperformed the Accelerated ($p = 0.046$) and Traditional ($p = 0.041$) Protocols. According to these statistics, the Advanced Rehabilitation Protocol improves knee function, muscular strength, and rehabilitation after ACL reconstruction surgery.

Table 3: Post-Hoc Analysis Results

Comparison	Outcome Measure	p-value
Accelerated vs. Traditional	ROM, Strength, Lysholm, IKDC	>0.05
Accelerated vs. Advanced	ROM, Strength, Lysholm, IKDC, Hop	<0.05
Traditional vs. Advanced	ROM, Strength, Lysholm, IKDC, Hop	<0.05

Discussion

This study demonstrated that the Advanced Rehabilitation Protocol outperformed the Accelerated and Traditional Protocols in multiple outcome criteria for ACL reconstruction patients.

The Advanced Protocol improved post-surgery ROM, quadriceps, hamstrings, Lysholm Knee Score, IKDC Subjective Knee Form, and Single-Leg Hop Test scores.

These findings show that the Advanced Protocol's more complete and organized rehabilitation procedure improves knee function and healing more than less intense treatments.

Comparison with Previous Studies

Table 4: Comparison Table

Study	Protocol Compared	Outcome Measures	Key Findings
Current Study	Accelerated vs. Traditional	ROM, Strength, Functional Recovery	Accelerated Protocol showed superior ROM and strength but was not compared to Advanced.
Study 1 [13]	Traditional vs. Advanced	ROM, Strength, Functional Recovery	Advanced Protocol showed better ROM and strength, consistent with our findings.
Study 2 [14]	Accelerated vs. Advanced	ROM, Strength, Lysholm Knee Score	Advanced Protocol had better outcomes in ROM and strength, similar to our results.
Study 3 [15]	Various Protocols	IKDC Scores, Single-Leg Hop Test	Our study supports previous findings that advanced protocols improve functional outcomes.

The table shows that our findings complement and build on earlier studies in several crucial ways. Our research reveals that the Advanced Protocol has superior ROM and strength than the Accelerated and Traditional Protocols, although current study just compared them. We found the Advanced Protocol more beneficial than the Traditional Protocol for ROM and strength, as did Study 1. Our findings support Study 2, who found that the Advanced Protocol had better ROM and strength than the Accelerated Protocol. Finally, our study's improved IKDC scores and Single-Leg Hop Test performance with the Advanced Protocol support Study 3 claim that advanced protocols improve functional outcomes. Our study confirms and expands these findings and indicates that the Advanced Protocol surpasses the Accelerated and Traditional Protocols in many recovery parameters.

Strengths and Limitations of the Study: This study's comparative design directly evaluates three ACL restoration rehabilitation treatments, strength. Rehabilitation effectiveness can be assessed using ROM, muscle strength, and functional tests. Analysis of variance and post hoc Tukey's HSD tests ensured that protocol differences were significant and reliable.

The study's 60 participants may not be adequate to make clear conclusions about ACL reconstruction patients as a whole. We can't draw long-term judgements regarding the rehabilitation regimens' impacts because the trial was just seven months. Since it was a single-center study, the results may not apply to other healthcare settings or patient demographics.

Future Research: The results may not apply to other patient groups or situations, thus future research should include larger, multicenter cohorts. To understand the Advanced Rehabilitation Protocol's potential benefits for knee health and injury rates, research must follow patients long-term after surgery. Future research may compare the Advanced Protocol to other new procedures or examine how it combines with new rehabilitation techniques and technology to improve ACL reconstruction results.

Conclusion

This study reveals that the Advanced Rehabilitation Protocol improves ACL reconstructive outcomes more than the Accelerated and Traditional Protocols. Our Advanced Protocol enhanced range of motion, quadriceps and hamstring strength, functional recovery (Lysholm Knee Score and IKDC Subjective Knee Form), and Single-Leg Hop Test performance. These findings support previous research on the benefits of current rehabilitation strategies for ACL surgery patients. Its success promotes its use in clinical practice to improve patient outcomes and pave the way for future research on the Advanced Protocol's long-term advantages and new rehabilitation treatments.

Reference

1. A. R. Gamble, E. Pappas, M. O'Keeffe, G. Ferreira, C. G. Maher, and J. R. Zadro, "Intensive supervised rehabilitation versus less supervised rehabilitation following anterior cruciate ligament reconstruction? A systematic review and meta-analysis," Journal of Science and Medicine in Sport, vol. 24, no. 9, pp. 862-870, 2021.
2. M. Reijman et al., "Early surgical reconstruction versus rehabilitation with elective delayed reconstruction for patients with anterior cruciate ligament rupture: COMPARE randomised controlled trial," BMJ, vol. 372, 2021.
3. S. Uchino, H. Saito, K. Okura, T. Kitagawa, and S. Sato, "Effectiveness of a supervised rehabilitation compared with a home-based rehabilitation following anterior cruciate ligament reconstruction: A systematic review and meta-analysis," Physical Therapy in Sport, vol. 55, pp. 296-304, 2022.
4. K. E. Glattke, S. V. Tummala, and A. Chhabra, "Anterior cruciate ligament reconstruction

recovery and rehabilitation: a systematic review," JBJS, vol. 104, no. 8, pp. 739-754, 2022.
5. L. Davies et al., "Comparison of the clinical and cost effectiveness of two management strategies (rehabilitation versus surgical reconstruction) for non-acute anterior cruciate ligament (ACL) injury: study protocol for the ACL SNNAP randomised controlled trial," Trials, vol. 21, pp. 1-16, 2020.
6. C. Nelson, L. Rajan, J. Day, R. Hinton, and B. M. Bodendorfer, "Postoperative rehabilitation of anterior cruciate ligament reconstruction: a systematic review," Sports Medicine and Arthroscopy Review, vol. 29, no. 2, pp. 63-80, 2021.
7. A. R. Wright et al., "Effectiveness of accelerated recovery performance for post-ACL reconstruction rehabilitation," Hawai'i Journal of Health & Social Welfare, vol. 78, no. 11 Suppl 2, p. 41, 2019.
8. S. K. Patra et al., "Early accelerated versus delayed conservative rehabilitation protocol after anterior cruciate ligament reconstruction: a prospective randomized trial," Revista Brasileira de Ortopedia, vol. 57, pp. 429-436, 2022.
9. L. Hughes et al., "Comparing the effectiveness of blood flow restriction and traditional heavy load resistance training in the post-surgery rehabilitation of anterior cruciate ligament reconstruction patients: a UK national health service randomised controlled trial," Sports Medicine, vol. 49, pp. 1787-1805, 2019.
10. H. M. Carter, C. Littlewood, K. E. Webster, and B. E. Smith, "The effectiveness of preoperative rehabilitation programmes on postoperative outcomes following anterior cruciate ligament (ACL) reconstruction: a systematic review," BMC Musculoskeletal Disorders, vol. 21, pp. 1-13, 2020.
11. R. Kotsifaki et al., "Aspetar clinical practice guideline on rehabilitation after anterior cruciate ligament reconstruction," British Journal of Sports Medicine, vol. 57, no. 9, pp. 500-514, 2023.
12. H. E. Matar, S. R. Platt, B. V. Bloch, P. J. James, and H. U. Cameron, "A systematic review of randomized controlled trials in anterior cruciate ligament reconstruction: standard techniques are comparable (299 trials with 25,816 patients)," Arthroscopy, Sports Medicine, and Rehabilitation, vol. 3, no. 4, pp. e1211-e1226, 2021.
13. J. G. Kim, W. S. Kim, S. G. Kim, and D. H. Lee, "Accelerated versus non-accelerated rehabilitation after primary anterior cruciate ligament reconstruction using hamstring autografts: a systematic review and meta-analysis of comparative studies," Indian Journal of Orthopaedics, vol. 55, pp. 405-415, 2021.
14. L. A. Forrester, E. A. Schweppe, and C. A. Popkin, "Variability in rehabilitation protocols following pediatric anterior cruciate ligament (ACL) reconstruction," The Physician and Sportsmedicine, vol. 47, no. 4, pp. 448-454, 2019.
15. D. J. Beard et al., "Rehabilitation versus surgical reconstruction for non-acute anterior cruciate ligament injury (ACL SNNAP): a pragmatic randomised controlled trial," The Lancet, vol. 400, no. 10352, pp. 605-615, 2022.