

# COMPARISON OF SHORT TERM ACCELERATED REHABILITATION PROTOCOL WITH TRADITIONAL REHABILITATION PROTOCOL FOLLOWING HAMSTRING TENDON GRAFT ON ACL RECONSTRUCTION

Miss. Ritika sunder notani<sup>1</sup>, dr. Rama ramdurkar<sup>2\*</sup>, dr. Amrutkuvar rayjade<sup>3</sup>, dr. Namrata bavalekar<sup>4</sup>, dr. Umiya pathan<sup>5</sup>, miss. Samrudhi upasak awhad<sup>6</sup>

<sup>1</sup>B.P.Th, D. Y. Patil College of Physiotherapy, D. Y. Patil Education Society (Deemed to be University), Kolhapur - 416006, Maharashtra, India

Email: [ritikanotani@gmail.com](mailto:ritikanotani@gmail.com)

<sup>2\*</sup> Assistant Professor, Department of Orthopedic Manual Therapy, D. Y. Patil College of Physiotherapy, D. Y. Patil Education Society (Deemed to be University), Kolhapur

Email: [rkarrama@gmail.com](mailto:rkarrama@gmail.com)

<sup>3</sup>H.O.D., Department of Orthopedic Manual Therapy, D. Y. Patil College of Physiotherapy, D. Y. Patil Education Society (Deemed to be University), Kolhapur - 416006, Maharashtra, India

Email: [dramrutkuvarrayjade@gmail.com](mailto:dramrutkuvarrayjade@gmail.com)

Email: [dramrutkuvarsrayjade@gmail.com](mailto:dramrutkuvarsrayjade@gmail.com)

<sup>4</sup> Assistant Professor, Department of Musculoskeletal Physiotherapy, D. Y. Patil College of Physiotherapy, D. Y. Patil Education Society (Deemed to be University), Kolhapur - 416006, Maharashtra, India

Email: [bavalekarnamrata@gmail.com](mailto:bavalekarnamrata@gmail.com)

<sup>5</sup> Professor and H.O.D., Department of Musculoskeletal Physiotherapy, D. Y. Patil College of Physiotherapy, D. Y. Patil Education Society (Deemed to be University), Kolhapur - 416006, Maharashtra, India

Email: [drumiyapathan@gmail.com](mailto:drumiyapathan@gmail.com)

<sup>6</sup>B.P.Th, D. Y. Patil College of Physiotherapy, D. Y. Patil Education Society (Deemed to be University), Kolhapur - 416006, Maharashtra, India

Email: [samrudhiawhad8@gmail.com](mailto:samrudhiawhad8@gmail.com)

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## ABSTRACT

**Background-** Anterior Cruciate Ligament (ACL) injuries are among the most common knee ligament injuries requiring surgical reconstruction. Rehabilitation following ACL reconstruction plays a crucial role in restoring knee stability, range of motion, and functional ability, following gold standard graft which is Hamstring tendon graft. Accelerated rehabilitation protocols emphasize early mobilization and weight bearing, whereas traditional rehabilitation follows a more conservative approach. However, there is limited evidence comparing their short term effectiveness.

**Aims of the study** – To compare the short term efficacy of accelerated rehabilitation protocol and traditional rehabilitation protocol following ACL reconstruction using hamstring tendon graft.

**Procedure** – Ethical clearance is obtained from the Institutional Ethical Committee. Participants undergoing ACL reconstruction are selected based on inclusion and exclusion criteria and randomly allocated into two groups. Group A received accelerated rehabilitation protocol and Group B received traditional rehabilitation protocol. The intervention are carried out over a period of follow up at day 1, day 5, day 15, 1 month, and 2 month post operatively.

**Outcome measures** – Visual Analogue Scale (VAS) for pain, Goniometer for range of motion (ROM), Double Limb Squat Test for strength assessment (DLST), Knee Injury And Osteoarthritis Outcome Score (KOOS) assess five outcomes: pain, symptoms, activities of daily living, sport and recreation function, knee related quality of life .

**Result** – The outcomes are analysed using appropriate statistical tests. It is seen that both groups will show improvement; however, the accelerated rehabilitation group demonstrate faster recovery in terms of pain reduction, range of motion, and strength than traditional rehabilitation group.

**Conclusion-** Both rehabilitation protocols are effective in improving functional outcomes after ACL reconstruction. However, accelerated rehabilitation provide earlier functional recovery and improved patient outcomes compared to traditional rehabilitation.

**Keywords** – ACL Reconstruction, Accelerated Rehabilitation, Traditional Rehabilitation, Hamstring Tendon Graft, Visual Analogue Scale, Range of Motion, Double Limb Squat Test

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PROTOCOL WITH TRADITIONAL REHABILITATION PROTOCOL FOLLOWING HAMSTRING TENDON GRAFT ON ACL RECONSTRUCTION. Int J Drug Deliv Technol. 2026;16(82s):1027-1036. DOI: 10.25258/ijddt.16.82s.112.

## INTRODUCTION

The knee's most common, reconstructed ligament is often the anterior cruciate ligament with ligamentous injuries representing a significant portion of musculoskeletal disorders.<sup>1</sup> The ACL functions primarily to prevent anterior translation of the tibia relative to femur while also contributing to rotational stability during dynamic movements, structurally the ACL consists of two primary bundle – the anteromedial (AM) bundle and posterolateral (PL) bundle which work synergistically to provide stability throughout the knees range of motion.<sup>2</sup> The tibial plateau largely determines their functional characteristics and nomenclature.<sup>2</sup>

Anatomically, ACL is a dense band of Type 1 collagen fibre.<sup>2</sup> ACL is a strong band of fibrous tissue that extends diagonally from the anterior intercondylar regions of tibial plateau to the posteromedial side of the lateral femoral condyle, this orientation enables the ligament to resist complex multidirectional forces encountered during activities such as walking running jumping.<sup>3</sup>

Epidemiological studies indicate that ACL injuries are highly prevalent with an estimated incidence of approximately 68.6 incidence per 100,000 persons-years in the United States.<sup>4</sup> ACL injuries frequently happen during physical activity that primarily require jumping, twisting and stopping motion<sup>5</sup>.

Understanding the mechanism underlying ACL injury is essential for both prevention and treatment, Non-contact mechanism are especially important when discussing ACL damage, notably a large portion of ACL injuries occur through non-contact mechanisms.<sup>6</sup> When performing activities, moves that involve abrupt dynamic loading of the knee joint, as loading from a leap, cutting, bending and decelerating the majority of non-contact injuries occur.<sup>7</sup>

Contact type injuries although less frequent, usually result from high energy injuries such as traumatic knee dislocations or sudden changes in knee direction due to abrupt deceleration such as direct blow to the knee or sudden forced displacement of the joint.<sup>8</sup>

Advancements in surgical techniques have significantly improved the outcomes of ACL reconstruction, modern approaches emphasize anatomical reconstruction aiming to restore native structure and function of the ligament as closely as possible.<sup>9</sup> Various techniques have been developed which include fixation method, open surgery, intra v/s extra-articular reconstruction, femoral tunnel replacement, number of graft strands, single v/s double and arthroscopic.<sup>10</sup> A tendon graft is utilised to repair the ruptured ACL during anterior cruciate

ligament (ACL), reconstruction (ACLR).<sup>11</sup> Around the world, orthopaedic surgeons have become significantly more familiar with hamstring auto graft.<sup>12</sup>

The process of ACL reconstruction involves several critical steps including removal of damaged ligament, harvesting and preparation of graft, the tibial and femoral tunnels are drilled, the graft is positioned anatomically comparable to or different from the original ACL and the graft is fixed.<sup>13</sup>

Postoperative rehabilitation plays a vital role in the success of the procedure with early mobilization and weight bearing strategies being key components of recovery.<sup>14</sup> Accelerated rehabilitation defined as weight bearing within two weeks post-surgery is associated with faster recovery of knee function and an earlier return to daily and high level activities often within six months.<sup>15</sup> In contrast delayed weight bearing beyond two weeks is a more conservative approach used to protect healing structures but may slow functional recovery, two weeks weight bearing is considered accelerated, while weight bearing beyond two weeks is considered delayed / traditional rehabilitation.<sup>16</sup>

Understanding the effects of early versus delayed weight bearing is important for optimizing rehabilitation outcomes and guiding clinical practice.<sup>16</sup>

## MATERIALS AND METHODOLOGY

**An Experimental Study, Randomised Clinical trial,** conducted on Patients with ACL reconstruction with Hamstring graft at D.Y. Patil Medical College Hospital and Research Institute, Kolhapur. Simple Random Sampling Method was used. Study conducted for a duration of 6 Months. Sample Size – 82

**Materials-** Written informed consent, Data collection sheet, Questionnaire sheets, Plinth Goniometer, Tape.

**Inclusion criteria-** Diagnosed ACL tear, Recent ACL reconstruction surgery, patient with HT graft, Age group 20-40 years, Physical capacity to participate in rehabilitation activities and exercise, Patients willing to participate in study.

**Exclusion criteria-** Subjects are excluded if they have a previous injury or operation to same knee, simultaneous fracture, concurrent injury to the posterior cruciate ligament, injury to the posterolateral corner or lateral collateral ligament, a grade II or III medial collateral ligament tear Evidence of osteoarthritis on radiograph, Patients with meniscal tears that required repair will be excluded, Active infection.

## PROCEDURE

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The ethical clearance will be obtained from the Institutional Ethical Committee.

All the subjects will be screened and then recruited as per the inclusion and exclusion criteria.

The subjects included in the study will be explained about the research protocol, a written consent will be taken from the subjects.

Immediately after surgery, each subject will be randomized into either the accelerated or traditional (non-accelerated) rehabilitation treatments using computer generated random sampling method

Once the randomization is done, based on the group the treatment protocol is initiated. In 1<sup>st</sup> Group (A) (accelerated rehabilitation group) subjects are started with accelerated protocol and early weight bearing and subjects with 2<sup>nd</sup> group (B) are started with non-accelerated traditional knee rehabilitation protocol.

Pain(VAS), range of motion, and double limb squat test, all these outcome measures are taken at day 1 of post operation, day 5<sup>th</sup>, day 15<sup>th</sup> of post operation, one month of post operation and 2<sup>nd</sup> month of post operation for both group A and B.

## RESULT

Comparison of short term accelerated rehab protocol with traditional rehab protocol following hamstring tendon graft on ACL reconstruction shows that the tools used for assessing pain, range of motion, and quadriceps strength are valid and consistent. Therefore, the observed changes between accelerated and traditional rehabilitation groups can be considered reliable and meaningful.

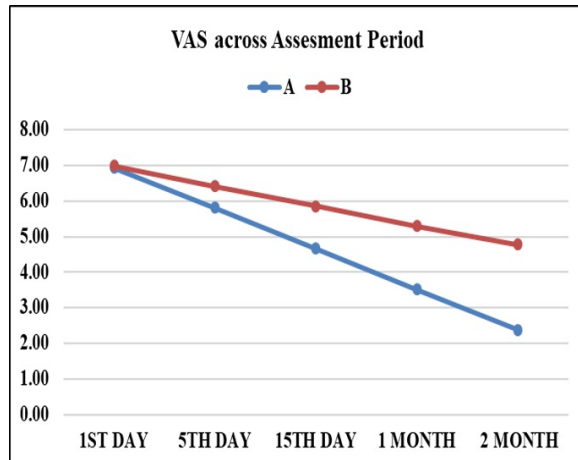
### • VISUAL ANALOUGE SCALE

| VAS                | GR<br>OU<br>P | M<br>ea<br>n | Std.<br>Devia<br>tion |
|--------------------|---------------|--------------|-----------------------|
| <b>1ST<br/>DAY</b> | A             | 6.<br>94     | 0.59                  |
|                    | B             | 6.<br>99     | 0.53                  |
|                    | Tot<br>al     | 6.<br>96     | 0.56                  |
| <b>5TH<br/>DAY</b> | A             | 5.<br>81     | 0.61                  |
|                    | B             | 6.<br>42     | 0.55                  |
|                    | Tot<br>al     | 6.<br>11     | 0.65                  |

|                          |           |          |      |
|--------------------------|-----------|----------|------|
| <b>15T<br/>H<br/>DAY</b> | A         | 4.<br>67 | 0.61 |
|                          | B         | 5.<br>85 | 0.57 |
|                          | Tot<br>al | 5.<br>26 | 0.84 |
| <b>1<br/>MO<br/>NTH</b>  | A         | 3.<br>52 | 0.65 |
|                          | B         | 5.<br>29 | 0.62 |
|                          | Tot<br>al | 4.<br>41 | 1.09 |
| <b>2<br/>MO<br/>NTH</b>  | A         | 2.<br>38 | 0.64 |
|                          | B         | 4.<br>77 | 0.63 |
|                          | Tot<br>al | 3.<br>57 | 1.36 |

| Sour<br>ce         | p-<br>val<br>ue |
|--------------------|-----------------|
| Time               | <0.<br>001<br>* |
| Grou<br>p          | <0.<br>001<br>* |
| Time<br>*Gro<br>up | <0.<br>001<br>* |

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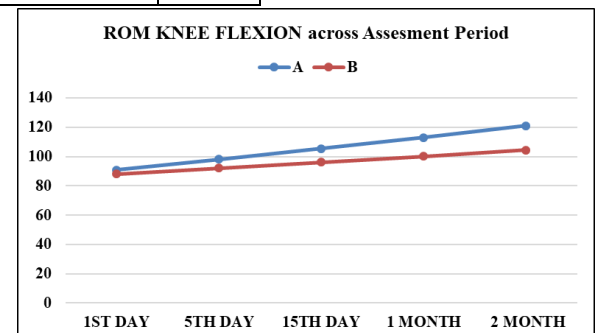
Accelerated rehabilitation leads to earlier and greater pain reduction, suggesting that early mobilization and progressive loading do not increase pain but rather help in quicker recovery.

**RANGE OF MOTION KNEE FLEXION**

| ROM KNEE FLEXION | GRO UP | Mean   | Std. Deviation |
|------------------|--------|--------|----------------|
| 1ST DAY          | A      | 90.77  | 6.65           |
|                  | B      | 88.06  | 6.04           |
|                  | Total  | 89.41  | 6.46           |
| 5TH DAY          | A      | 98.21  | 6.82           |
|                  | B      | 92.19  | 6.29           |
|                  | Total  | 95.20  | 7.19           |
| 15TH DAY         | A      | 105.40 | 7.10           |
|                  | B      | 96.13  | 6.53           |
|                  | Total  | 100.76 | 8.23           |
| 1 MONTH          | A      | 113.04 | 7.58           |

|         |       |        |       |
|---------|-------|--------|-------|
|         | B     | 100.27 | 6.52  |
|         | Total | 106.65 | 9.52  |
| 2 MONTH | A     | 120.97 | 7.45  |
|         | B     | 104.40 | 6.74  |
|         | Total | 112.68 | 10.92 |

| Source     | p-value |
|------------|---------|
| Time       | <0.001* |
| Group      | <0.001* |
| Time*Group | <0.001* |
|            |         |



Accelerated protocol promotes early restoration of joint mobility, preventing stiffness and improving functional knee movement more effectively than the traditional approach.

**RANGE OF MOTION KNEE EXTENSION**

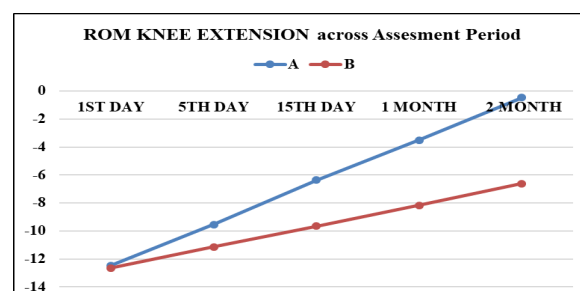
| ROM KNEE EXTENSION | GRO UP | Mean   | Std. Deviation |
|--------------------|--------|--------|----------------|
| 1ST DAY            | A      | -12.47 | 1.64           |
|                    | B      | -12.47 | 1.64           |

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|                 |       |                |      |
|-----------------|-------|----------------|------|
|                 | B     | -<br>12.6<br>4 | 1.45 |
|                 | Total | -<br>12.5<br>5 | 1.54 |
| <b>5TH DAY</b>  | A     | -<br>9.53      | 1.74 |
|                 | B     | -<br>11.1<br>4 | 1.43 |
|                 | Total | -<br>10.3<br>4 | 1.78 |
| <b>15TH DAY</b> | A     | -<br>6.37      | 2.03 |
|                 | B     | -<br>9.66      | 1.42 |
|                 | Total | -<br>8.02      | 2.40 |
| <b>1 MONTH</b>  | A     | -<br>3.50      | 2.15 |
|                 | B     | -<br>8.16      | 1.37 |
|                 | Total | -<br>5.83      | 2.95 |
| <b>2 MONTH</b>  | A     | -<br>0.47      | 2.28 |
|                 | B     | -<br>6.62      | 1.46 |
|                 | Total | -<br>3.55      | 3.63 |

| Source | P-value |
|--------|---------|
|--------|---------|

|            |             |
|------------|-------------|
| Time       | <0.00<br>1* |
| Group      | <0.00<br>1* |
| Time*Group | <0.00<br>1* |



Accelerated protocol promotes early restoration of joint mobility, preventing stiffness and improving functional knee movement more effectively than the traditional approach.

**KNEE INJURY AND OSTEOARTHRITIS OUTCOME SCORE (KOOS)**

| KOOS SCALE | Group | Mean | Standard Deviation |
|------------|-------|------|--------------------|
|            | A     | 47.  | 4.26               |

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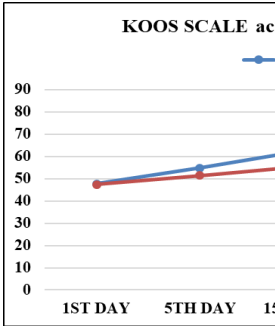
|                     |               |                   |          |
|---------------------|---------------|-------------------|----------|
| <b>1ST<br/>DAY</b>  |               | 7<br>3            |          |
|                     | B             | 4<br>7.<br>4<br>5 | 4.2<br>5 |
|                     | T<br>ot<br>al | 4<br>7.<br>5<br>9 | 4.2<br>3 |
| <b>5TH<br/>DAY</b>  | A             | 5<br>4.<br>8<br>9 | 4.2<br>0 |
|                     | B             | 5<br>1.<br>5<br>4 | 4.6<br>0 |
|                     | T<br>ot<br>al | 5<br>3.<br>2<br>2 | 4.6<br>9 |
| <b>15TH<br/>DAY</b> | A             | 6<br>2.<br>6<br>5 | 4.5<br>3 |
|                     | B             | 5<br>5.<br>7<br>6 | 5.0<br>1 |
|                     | T<br>ot<br>al | 5<br>9.<br>2<br>1 | 5.8<br>8 |
| <b>1<br/>MO</b>     | A             | 7<br>0.           | 4.8<br>3 |

|                    |               |                   |          |
|--------------------|---------------|-------------------|----------|
| <b>NT<br/>H</b>    |               | 5<br>5            |          |
|                    | B             | 5<br>9.<br>8<br>0 | 5.0<br>3 |
|                    | T<br>ot<br>al | 6<br>5.<br>1<br>8 | 7.3<br>0 |
| <b>2<br/>MONTH</b> | A             | 7<br>8.<br>3<br>9 | 5.2<br>8 |
|                    | B             | 6<br>3.<br>9<br>6 | 4.8<br>4 |
|                    | T<br>ot<br>al | 7<br>1.<br>1<br>8 | 8.8<br>4 |

| <b>Sou<br/>rce</b> | <b>p-<br/>v<br/>al<br/>u<br/>e</b> |
|--------------------|------------------------------------|
| Time               | <<br>0.<br>0<br>0<br>1<br>*        |
| Gro<br>up          | <<br>0.                            |

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|       |   |
|-------|---|
|       | 0 |
|       | 0 |
|       | 1 |
|       | * |
| Time* | < |
| Group | 0 |
|       | 0 |
|       | 1 |
|       | * |



Patients undergoing accelerated rehabilitation achieved better knee related quality of life, symptoms, and functional performance indicating superior overall recovery

| DOUBLE LIMB SQUAT TEST |       |      |                    |
|------------------------|-------|------|--------------------|
| DOUBLE LIMB SQUAT      | GROUP | Mean | Standard Deviation |
| 1ST DAY                | A     | 47   | 4.46               |

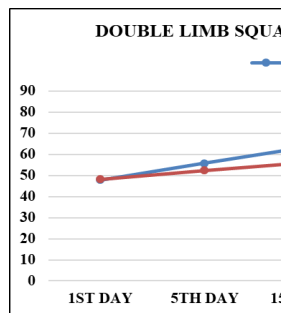
|          |       |       |      |
|----------|-------|-------|------|
|          |       | .91   |      |
|          | B     | 48.21 | 4.61 |
|          | TOTAL | 48.06 | 4.51 |
|          | A     | 55.89 | 4.89 |
| 5TH DAY  | B     | 52.42 | 4.75 |
|          | TOTAL | 54.15 | 5.10 |
| 15TH DAY | A     | 63.57 | 5.62 |
|          | B     | 56.3  | 5.03 |

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|                |                       |                       |          |
|----------------|-----------------------|-----------------------|----------|
|                |                       | 3<br>1                |          |
|                | T<br>o<br>t<br>a<br>l | 5<br>9<br>.<br>9<br>4 | 6.4<br>3 |
| 1<br>MON<br>TH | A                     | 7<br>0<br>.<br>8<br>8 | 6.4<br>3 |
|                | B                     | 6<br>0<br>.<br>2<br>8 | 5.1<br>0 |
|                | T<br>o<br>t<br>a<br>l | 6<br>5<br>.<br>5<br>8 | 7.8<br>5 |
| 2<br>MON<br>TH | A                     | 7<br>8<br>.<br>3<br>6 | 6.6<br>7 |
|                | B                     | 6<br>4<br>.<br>2<br>6 | 5.1<br>0 |
|                | T<br>o<br>t<br>a<br>l | 7<br>1<br>.<br>3<br>1 | 9.2<br>3 |

| Source         | p<br>-<br>v<br>a<br>l<br>u<br>e |
|----------------|---------------------------------|
| Time           | <<br>0<br>.<br>0<br>0<br>1<br>* |
| Group          | <<br>0<br>.<br>0<br>0<br>1<br>* |
| Time<br>*Group | <<br>0<br>.<br>0<br>0<br>1<br>* |

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Accelerated rehabilitation enhances functional independence and task performance earlier, reflecting improved neuromuscular control and strength recovery.

## DISCUSSION

This study aimed to compare the short term effects of accelerated rehabilitation protocol with traditional rehabilitation protocol following hamstring tendon graft.

The findings suggest that accelerated rehabilitation protocols may lead to earlier improvement in pain reduction, range of motion (ROM) and functional strength compared to traditional

protocols. Early weight bearing and initiation of movements in accelerated rehabilitation promote faster recovery of joint mobility and muscle activation.<sup>(15)(16)</sup>

Pain levels measured using the Visual Analogue Scale (VAS) showed a quicker decline in the accelerated group which may be attributed to improved circulation and reduced joint stiffness.<sup>(5)</sup>

Similarly, ROM improvements were more rapid due to early mobilization strategies, consistent with findings.<sup>(3)</sup>

Strength outcomes assessed using the double limb squat test indicate that early closed kinetic chain exercises contribute to better neuromuscular control and functional strength.<sup>(17)</sup> However studies also suggest that

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excessive early loading may increase the risk of graft strain or joint laxity if not properly monitored.<sup>(18)</sup>

In contrast, traditional rehabilitation protocols, although slower, provide a more conservative and protective approach, potentially reducing complications such as graft failure or instability.<sup>(9)</sup>

The results of this study are consistent with previous literature highlighting the importance of early physiotherapy intervention while emphasizing individualized rehabilitation planning for optimal outcomes. Limitations of this study include small sample size and short follow up duration which may limit generalizability of the findings.

### CONCLUSION

Based on the objectives and methodology of this study, both rehabilitation protocols aim to restore knee function, reduce pain, improve range of motion, and enhance muscle strength. However, accelerated rehabilitation emphasizes early mobilization, early weight bearing, and faster progression of functional activities, whereas the traditional protocol follows a more conservative and gradual approach.

The findings of this study are expected to provide evidence regarding whether accelerated rehabilitation offers superior short term outcomes in terms of pain reduction, improved range of motion and functional strength without increasing the risk of complications. If proven effective, accelerated rehabilitation may facilitate earlier return to daily activities and improve patient satisfaction.

At the same time, it is important to consider patient specific factors such as surgical outcomes, individual healing capacity, and risk of reinjury when selecting a rehabilitation protocol. A balance, evidence based approach remains essential in clinical decision making.

Thus, this study contributes to the growing body of knowledge in musculoskeletal physiotherapy and may help clinicians optimize post-operative rehabilitation strategies following ACL reconstruction. Further long term studies are recommended to assess the sustained effects and safely accelerated rehabilitation protocols.

### CONFLICT OF INTEREST

The authors declare no potential conflicts of interest with respect to research, authorship and / or publication of this article.

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