Research Article

International Journal of Orthopedic Surgery & Research

Anterior Cruciate Ligament Reconstruction Rehabilitation Protocol

EL HASSNAOUI Youssef[1]*, TAZI Mohamed[2], EL ANSARI Abdelaziz[1], EL AKADI Omar[3], AIT BENALI Hicham[1] and SHIMI Mohammed[1]

[1]Department of Orthopedic Traumatology, Mohammed VI University Hospital Tangier, Abdelmalek Essaadi University, Faculty of Medicine and Pharmacy - Tangier, Morocco.

[2]Department of Rheumatology, Mohammed VI University Hospital Tangier, Abdelmalek Essaadi University, Faculty of Medicine and Pharmacy - Tangier, Morocco.

[3]Department of Physical Medicine and Rehabilitation, Mohammed VI University Hospital Tangier, Abdelmalek Essaadi University, Faculty of Medicine and Pharmacy – Tangier, Morocco.

***Correspondence:**

EL HASSNAOUI Youssef, Department of Orthopedic Traumatology, Mohammed VI University Hospital Tangier, Abdelmalek Essaadi University, Faculty of Medicine and Pharmacy - Tangier, Morocco.

Received: 10 Aug 2025; **Accepted:** 18 Sep 2025; **Published:** 26 Sep 2025

Citation: EL HASSNAOUI Youssef, TAZI Mohamed, EL ANSARI Abdelaziz, et al. Anterior Cruciate Ligament Reconstruction Rehabilitation Protocol. Int J Orthop Surg Res. 2025; 1(1): 1-3.

ABSTRACT

Introduction: *Anterior cruciate ligament (ACL) reconstruction is a common surgical procedure, particularly in athletes. Surgical success is highly dependent on a structured, progressive, and individualized rehabilitation protocol.*

Objective: *To present a detailed postoperative rehabilitation protocol following ACL reconstruction, outlining the goals and recommended exercises for each phase, from the immediate postoperative period to return-to-sport readiness.*

Methods: *The protocol is divided into four phases: early (0–8 weeks), intermediate (8–12 weeks), advanced (12–24 weeks), and return to activity (after 24 weeks). Each phase includes specific goals and exercises focusing on pain control, joint mobility, muscle strengthening (including isokinetics), proprioception, and functional assessment.*

Results: *A tailored rehabilitation program with regular evaluations, especially isokinetic testing, allows optimal recovery of joint function, stability, and muscular strength. Gradual integration of sport-specific exercises enhances the likelihood of a safe return to physical activity.*

Conclusion: *Successful ACL rehabilitation relies on a well-structured, patient-specific program. A multidisciplinary approach, close monitoring, and progressive reintroduction of functional tasks are essential to prevent complications and ensure long-term outcomes.*

Keywords

Anterior cruciate ligament (ACL), Postoperative rehabilitation, Functional recovery, Isokinetic strengthening.

Introduction

Anterior cruciate ligament (ACL) reconstruction is a common procedure in orthopedic surgery, particularly among young and active individuals. Postoperative outcomes largely depend on the quality of rehabilitation, as inadequate programs can lead to persistent instability, muscle weakness, stiffness, and delayed return to sport. Modern rehabilitation aims to control pain, restore range of motion, prevent complications, strengthen muscles, and optimize neuromuscular control. Evidence emphasizes individualized, progressive, and patient-specific approaches [1,2].

This review presents a structured rehabilitation protocol after ACL reconstruction, integrating proprioceptive exercises, neuromuscular electrical stimulation, and regular isokinetic assessments to ensure safe, effective recovery and a timely return to sport.

Rehabilitation Protocol

Phase 1: Early Phase (0–8 weeks postoperative)

Objectives:

- Control inflammation and pain
- Achieve full knee extension
- Prevent complications such as stiffness and thrombosis
- Maintain muscle activation

Exercises:

- Gentle passive and active mobilization (flexion/extension without load)
- Adjustable brace locked at 0°–30° initially
- Isometric quadriceps and hamstring contractions
- Neuromuscular electrical stimulation to prevent atrophy
- Partial weight-bearing with crutches as tolerated

Phase 2: Intermediate Phase (8–12 weeks postoperative)

Objectives:

- Recover complete range of motion
- Strengthen knee musculature
- Initiate proprioceptive training

Exercises: (Figure 1,2)

- Isokinetic strengthening (60–90°/s, concentric only, ROM 0°–90°)
- Bilateral strength evaluation (≥60% of contralateral side)
- Balance and proprioception exercises (unstable platforms, single-leg stance)
- Closed-chain strengthening: partial squats, step-ups



Figure 1: Isometric rehabilitation device.

Phase 3: Advanced Phase (12–24 weeks postoperative)

Objectives:

- Achieve muscle strength close to contralateral limb
- Enhance stability and proprioception
- Prepare for return to sport

Exercises:

- Intensive isokinetic training (120–180°/s), including eccentric hamstring work
- Open- and closed-chain strengthening
- Bilateral strength evaluation (≥80–90% of contralateral limb)
- Plyometric training: double- and single-leg jumps, change of direction drills

Phase 4: Return to Sport (>24 weeks)

Objectives:

- Achieve full muscle strength symmetry
- Prepare for specific sport or daily activity demands

Exercises:

- Maximal isokinetic strengthening (180–300°/s) with eccentric hamstring loading
- Functional sport-specific training: sprints, agility, reactive drills
- Return-to-sport functional testing (single-leg hop test, pivot shift, agility drills)
- Patient-reported confidence assessment (e.g., IKDC, ACL-RSI)



Figure 2: Patient setup.

Discussion

Postoperative rehabilitation following ACL reconstruction is as crucial as the surgery itself. The success of reconstruction depends not only on restoring ligamentous stability but also on regaining neuromuscular control, preventing complications, and progressively preparing the patient for functional recovery. A structured, progressive, and individualized rehabilitation program ensures restoration of joint stability, muscular strength, and proprioception while minimizing risks such as stiffness, muscle atrophy, or thrombosis [2].

Knecht and Puskas highlighted a phased approach starting with inflammation control, followed by muscle strengthening and proprioception, progressing to functional sport-specific activities [1]. Early pain and inflammation management, along with full recovery of knee extension, lays the foundation for subsequent muscle strengthening and neuromuscular control.

Hoch and McKeon emphasized the role of proprioception and neuromuscular control in injury prevention and improved outcomes, supporting the early inclusion of balance and coordination exercises in rehabilitation [3]. These elements are essential to restore dynamic knee stability and prepare athletes for sport-specific demands. Muscle strength deficits, particularly in the quadriceps and hamstrings, are common after ACL reconstruction and may persist without appropriate rehabilitation. Beynnon et al. detailed *in vivo* ligament strain studies, highlighting the need for progressive strengthening to protect the graft and improve knee mechanics [2]. Isokinetic testing integrated into the protocol allows objective measurement of strength recovery and guides progression.

Wang et al. emphasized the importance of functional and sport-specific exercises during later rehabilitation phases to ensure a safe return to activity [4]. Plyometric and agility drills included in advanced phases enhance neuromuscular control, power, and confidence.

Myer et al. demonstrated the benefits of plyometric training on muscle-tendon mechanics, injury prevention, and performance enhancement, supporting its inclusion in the rehabilitation program [5].

Shelbourne and Nitz advocated accelerated rehabilitation focusing on early mobilization and strengthening, consistent with the initial phases of the protocol promoting early controlled motion and muscle activation to reduce stiffness and atrophy [6].

Additional studies confirm the need for individualized progression and regular functional evaluations to optimize outcomes [7,8].

In summary, adherence to a detailed, evidence-based rehabilitation protocol is essential to optimize outcomes after ACL reconstruction. Multidisciplinary coordination involving physiotherapists and surgeons should focus on patient-specific adaptations to ensure functional recovery and a safe return to sport.

Conclusion

Rehabilitation after ACL reconstruction is essential for the long-term success of the surgery. A well-structured, progressive, and individualized program is crucial to restore knee function, improve stability, and enable safe return to daily and sport activities. Careful adherence to the rehabilitation phases and regular patient progress assessments are key to minimizing complications and maximizing functional recovery.

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