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Accelerated Return to Sport with a Standardized Rehabilitation Protocol Following ACL Reconstruction: A Case Series

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ABSTRACT

This case series evaluates the effectiveness of a standardized rehabilitation protocol in facilitating recovery and return to sport (RTS) following anterior cruciate ligament (ACL) reconstruction. Four male athletes aged 20 to 30 years with isolated ACL tears underwent reconstruction using a semitendinosus tendon autograft, followed by a phased rehabilitation protocol. The program progressed from early pain management and ROM restoration to proprioceptive, plyometric, and sport-specific training. Functional outcomes were assessed through range of motion (ROM), muscle strength, Lysholm and Knee injury and Osteoarthritis Outcome Score (KOOS) scores, hop test performance, and limb symmetry index. All patients achieved >90% limb symmetry and functional test scores, with RTS achieved within an average of eight months. No complications or psychological barriers were reported. This case series underscores the importance of integrating physical and psychological rehabilitation components, demonstrating the protocol's adaptability and effectiveness in optimizing post-ACL reconstruction recovery and minimizing re-injury risk.

Keywords: Rehabilitation, ACL, Recovery, Sport, Outcomes

INTRODUCTION

The anterior cruciate ligament (ACL) is a critical stabilizer of the knee, essential for joint stability and movement in daily activities and sports. ACL injuries are among the most common and debilitating sports-related injuries, particularly in high-impact activities such as basketball, football, and skiing. If untreated, these injuries can lead to significant functional impairments and early-onset osteoarthritis.[1]

Surgical reconstruction is the standard treatment for complete ACL tears, particularly in young, active individuals aiming to return to sports.[2] However, postoperative outcomes depend heavily on structured rehabilitation to restore ROM, strength, proprioception, and neuromuscular control. A phased rehabilitation approach is essential to minimizing graft failure and optimizing functional recovery.[3]

Despite advances in rehabilitation, returning to sports remains challenging due to both physical and psychological barriers, including fear of re-injury.[4] Psychological readiness plays a significant role in an athlete's decision to return to sport, with studies indicating that higher psychological confidence is associated with a greater likelihood of successful return.[5]

This case series assesses a standardized rehabilitation protocol's effectiveness in facilitating RTS post-ACL reconstruction. In East Java, where ACL injuries are common in high-risk sports, structured rehabilitation is essential. This study explores rehabilitation outcomes and clinical implications, integrating physical and psychological factors to optimize recovery and reduce re-injury risk.[6]

CASE REPORT

Patients and Diagnosis

This case series included four male athletes aged 20 to 30 years who underwent ACL reconstruction using a semitendinosus tendon autograft. Injuries occurred during sports activities involving pivoting, improper landings, or direct trauma. Diagnosis was confirmed through clinical assessments, including the Lachman, anterior drawer, and pivot shift tests, along with MRI evaluation. In a representative case, preoperative Magnetic Resonance Imaging (MRI) demonstrated a complete ACL tear with associated posterolateral corner injury, bone contusions of the lateral femoral condyle and posterior tibial condyle consistent with a pivot-shift injury pattern, grade II MCL sprain, complex tear of the posterior horn of the medial meniscus, longitudinal red-zone tear of the posterior horn of the lateral meniscus, and mild joint effusion, while the PCL, LCL, quadriceps tendon, and patellar tendon remained intact (Figure 1). Postural balance deficits are common after ACL reconstruction due to compromised mechanoreceptor function, affecting dynamic stability and increasing re-injury risk. Baseline assessments included ROM, muscle strength using Manual Muscle Testing (MMT), and functional knee scoring with the Lysholm Knee Scoring Scale and Knee Injury and Osteoarthritis Outcome Score (KOOS). Patients provided written consent, and ethical approval ensured confidentiality and compliance.

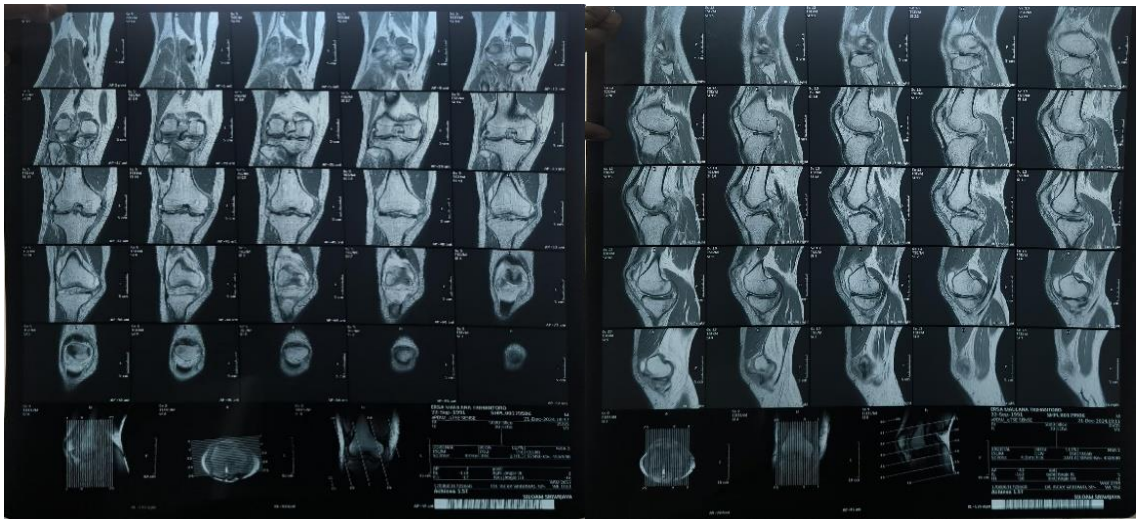

Figure 1. Preoperative MRI of the knee showing complete ACL tear with associated internal derangements

Rehabilitation Protocol

The rehabilitation protocol followed a phased approach. The immediate postoperative phase (Weeks 1–2) focused on pain and edema management, patellar mobilization, and isometric quadriceps activation, with partial weight-bearing as tolerated.

The early rehabilitation phase (Weeks 3–6) emphasized full ROM restoration, gait normalization, and proprioceptive training through closed kinetic chain exercises. Balance training was integrated to address postural instability commonly observed in ACL-reconstructed athletes.[7]

The intermediate phase (Weeks 7–12) progressed to strengthening quadriceps and hamstrings, improving endurance, and enhancing proprioception with single-leg drills and core stability exercises. Given that proprioceptive deficits persist post-ACL reconstruction, training included tasks with eyes closed to improve neuromuscular control.[7]

The advanced phase (Months 3–6) focused on neuromuscular control and dynamic stability through plyometrics, agility drills, and sport-specific training. Progressive exposure to unpredictable perturbations refined postural adaptation, addressing delayed anticipatory motor control in ACL-reconstructed athletes.[7]

The return-to-sport phase (Months 6–9) prioritized high-intensity drills, sprinting, and jump-landing mechanics, with progression based on limb symmetry (>90%), ROM, and strength restoration. Targeted proprioceptive training continued to mitigate re-injury risk, particularly during rapid directional changes in sports.[2,7]

Follow-Up and Outcomes

Patients underwent follow-up at two weeks, six weeks, three months, six months, and nine months postoperatively. Assessments included knee circumference, ROM, MMT for quadriceps and hamstrings, and functional tests (Lysholm, KOOS, single-leg hop, and 30-second sit-to-stand). Psychological readiness was evaluated based on confidence and fear of re-injury.

All patients showed significant functional recovery, achieving >90% limb symmetry and Lysholm/KOOS scores >85. The mean return-to-sport time was eight months, with all resuming pre-injury activity levels. No complications or psychological barriers were reported, demonstrating the protocol's effectiveness in ensuring structured recovery.

Cross-Case Summary

Despite differences in baseline clinical presentation, all patients achieved the predefined return-to-sport criteria within the expected timeframe. This consistent pattern across cases supports the adaptability of the standardized rehabilitation protocol. The findings also reinforce the clinical value of a structured rehabilitation program that integrates physical recovery and psychological readiness to optimize functional outcomes and reduce re-injury risk.

DISCUSSION

This case series demonstrates the effectiveness of a standardized rehabilitation protocol in facilitating recovery and return to sport (RTS) following ACL reconstruction. The structured, phased approach optimized functional outcomes, addressed physical and psychological challenges, and ensured a safe RTS. These findings are consistent with contemporary criterion-based rehabilitation concepts, which emphasize progressive loading, restoration of knee motion, neuromuscular retraining, and multidimensional RTS assessment after ACL reconstruction.[8,9]

Effectiveness of the Rehabilitation Protocol

The rehabilitation protocol effectively facilitated recovery, with all four patients achieving RTS within an average of eight months. Functional improvements were evidenced by increased range of motion (ROM), muscle strength, and dynamic stability. All patients exceeded a 90% limb symmetry index and achieved high scores on functional knee scales (>85 points). The systematic progression from early ROM restoration to plyometric training was key to these outcomes.[10] The mean RTS time observed in this series is in line with recent literature showing that RTS clearance commonly occurs between 6 and 9 months after surgery, although the decision should remain criterion-based rather than time-based alone.[8,9]

Post-ACL reconstruction, neuromuscular deficits are common and can hinder RTS. The incorporation of proprioceptive and plyometric exercises in this protocol likely contributed to enhanced joint stability, reducing re-injury risk.[11] Targeted proprioceptive training mitigates the "dead zone" phenomenon, where mechanoreceptor deficits impair dynamic control. This interpretation is supported by Attalin et al., who demonstrated impaired proprioceptive reweighting and postural control in elite athletes following ACL reconstruction, particularly under challenging balance conditions, reinforcing the importance of ongoing proprioceptive and balance-oriented rehabilitation.[12,13]

Physical Recovery and Functional Outcomes

The protocol emphasized early ROM recovery and isometric quadriceps activation, minimizing stiffness and muscle atrophy. Proprioceptive training progressively restored knee stability, crucial for neuromuscular control.[14] This is concordant with the Aspetar clinical practice guideline, which recommends early restoration of extension, effusion control, and progressive quadriceps strengthening as central components of successful ACL reconstruction rehabilitation.[8]

Strength training in the intermediate phase systematically improved quadriceps and hamstring strength, with symmetry indices progressing from 80–85% to over 90%. Correcting muscle imbalances is essential for safe RTS, preventing compensatory movement patterns that elevate re-injury risk. Advanced rehabilitation incorporated neuromuscular control training and sport-specific exercises, reinforcing optimal movement mechanics.[15] These findings are clinically relevant because recent evidence has shown that residual quadriceps asymmetry at the time of RTS is associated with persistent landing asymmetries and suboptimal knee function at later follow-up.[16]

Targeted proprioceptive and balance training further enhanced postural stability, addressing residual deficits often seen in ACL-reconstructed athletes. Research suggests these interventions significantly reduce abnormal loading patterns, improving long-term knee function and injury prevention.[17] This is also supported by recent proprioceptive rehabilitation evidence showing improvements in dynamic balance, joint stability, and patient-reported knee function after ACL reconstruction.[18]

Psychological Readiness and RTS

Beyond physical recovery, psychological readiness is a critical factor in RTS. Fear of re-injury often persists even in physically recovered athletes, delaying RTS. The gradual exposure to sport-specific activities in this protocol likely helped build confidence, supporting a smoother transition back to pre-injury performance levels.[19] This observation is consistent with a recent systematic review and meta-analysis of 3,744 patients, which found that individuals who returned to sport after primary ACL reconstruction had significantly higher psychological readiness, greater self-efficacy, and lower kinesiophobia than those who did not return.[5]

All patients reported high confidence and no fear of re-injury, reinforcing the role of progressive rehabilitation in psychological adaptation. Future applications of this protocol could benefit from integrating standardized psychological assessments to further quantify RTS

readiness.[20] Similarly, Webster et al. reported that greater psychological readiness was associated with successful RTS after ACL reconstruction, highlighting that emotional recovery should be considered alongside physical performance when determining readiness for sport participation.[21]

Challenges and Adaptations

Variability in baseline characteristics, such as preoperative ROM and muscle strength, influenced early recovery. One patient required additional interventions, including electrical muscle stimulation, to address quadriceps weakness. This underscores the need for individualized modifications within a standardized protocol.[22] Such tailoring is justified, as recent reviews have shown substantial heterogeneity in RTS tests, thresholds, and progression criteria across ACL rehabilitation studies, even when broad criterion-based principles are shared.[9]

Adherence to rehabilitation was another challenge, particularly in the advanced phase when patients resumed sports activities. Consistent training was essential to maintaining progress and preventing premature RTS. This is in line with recent narrative evidence emphasizing that late-stage rehabilitation and sport-specific reconditioning remain essential, particularly for athletes returning to pivoting and cutting sports with high neuromuscular demands.[23,24]

Clinical Implications

This case series underscores the value of standardized rehabilitation protocols in clinical practice. A structured but adaptable framework ensures consistency while allowing individualized adjustments. The protocol demonstrated broad applicability, particularly for recreational and semi-professional athletes.[25] This aligns with current evidence favoring criterion-based, multimodal rehabilitation rather than reliance on elapsed postoperative time alone.[8,9]

The integration of both physical and psychological components highlights the importance of a holistic rehabilitation approach. Addressing psychological barriers, such as fear of re-injury, facilitated a smoother RTS process. Future protocols should incorporate validated psychological readiness assessments to further refine RTS criteria.[26] At the same time, recent evidence suggests that conventional RTS test batteries should not be interpreted in isolation. Zhou et al. found that passing RTS testing was associated with a lower risk of graft rupture, but not consistently with all subsequent knee injuries, while Simonsson et al. showed that commonly used limb symmetry index cut-offs alone have limited ability to define truly safe RTS.[27]

Objective functional measures, including hop tests and strength symmetry indices, served as reliable benchmarks for assessing recovery and determining RTS readiness. Integrating such evidence-based metrics into clinical practice enhances precision in rehabilitation decision-making, improving patient outcomes.[28] Accordingly, hop tests and limb symmetry measures are best interpreted as components of a broader RTS framework that also includes movement quality, psychological readiness, and sport-specific performance demands.[9] Patients were satisfied with recovery and RTS, citing structured rehabilitation as key to confidence. No instability or psychological barriers were reported.

Limitations and Future Directions

This study has limitations. The small sample size restricts generalizability, and the absence of a control group precludes direct comparisons with alternative rehabilitation protocols. Psychological readiness was assessed subjectively, highlighting the need for structured psychological evaluations in future research. This limitation is important because recent literature increasingly supports the inclusion of validated psychological tools, such as the ACL-RSI, alongside strength and hop performance testing in RTS decision-making.[5,21]

Further studies should explore the application of this protocol in larger, more diverse cohorts. Comparative research evaluating its effectiveness against alternative rehabilitation models could provide additional insights into best practices. Long-term follow-up is needed to assess the durability of functional recovery and re-injury rates. Longer-term follow-up is particularly relevant because successful early functional recovery does not necessarily eliminate the risk of subsequent knee injury after RTS.[27]

CONCLUSION

This case series highlights the effectiveness of a standardized rehabilitation protocol in optimizing post-ACL reconstruction recovery. All patients achieved >90% limb symmetry and returned to sports within eight months. The protocol's structured, holistic approach enhanced functional outcomes and minimized re-injury risk, reinforcing its clinical value in diverse patient populations.

REFERENCES

Manoharan A, Fithian A, Xie V, Hartman K, Schairer W, Khan N. return to Sports after anterior Cruciate ligament reconstruction. The Permanente Journal. 2024;28(2):102.

Gokeler A, Della Villa F, Welling W, Baumeister J. Return to sports following ACL reconstruction: where do we stand in 2020? Orthopaedic Journal of Sports Medicine. 2020 Sep 1;8. doi:10.1177/2325967120s00551

Mayer M, Deliso M, Hong I, Saltzman B, Longobardi R, DeLuca P, et al. Rehabilitation and Return to Play Protocols After Anterior Cruciate Ligament Reconstruction in Soccer Players: A Systematic Review. The American journal of sports medicine. 2024 Apr 15;3635465241233161. doi:10.1177/03635465241233161

Russell H, Arendt E, Wiese-Bjornstal D. Psychological responses during latter rehabilitation and return to sport following ACL reconstruction surgery. Journal of athletic training. 2024 Mar 6. doi:10.4085/1062-6050-0058.23

Xiao M, Van Niekerk M, Trivedi N, Hwang C, Sherman S, Safran M, et al. Patients Who Return to Sport After Primary Anterior Cruciate Ligament Reconstruction Have Significantly Higher Psychological Readiness: A Systematic Review and Meta-analysis of 3744 Patients. The American Journal of Sports Medicine. 2022 Jun 20;51:2774–83. doi:10.1177/03635465221102420

Nascimento D, Rolnick N, Neto I, Severin R, Beal F. A Useful Blood Flow Restriction Training Risk Stratification for Exercise and Rehabilitation. Frontiers in Physiology. 2022 Mar 11;13. doi:10.3389/fphys.2022.808622

Lestari RD, Tinduh D, Pawana IPA, Utomo DN. Postural Balance Differences in Athletes Post Anterior Ligament Cruciate Reconstruction. 2018.

Kotsifaki R, Korakakis V, King E, Barbosa O, Maree D, Pantouveris M, et al. Aspetar clinical practice guideline on rehabilitation after anterior cruciate ligament reconstruction. British Journal of Sports Medicine. 2023 Feb 2;57:500–14. doi:10.1136/bjsports-2022-106158

Wright A, Reid D, Potts G. Return to sport (RTS) tests and criteria following an anterior cruciate ligament (ACL) reconstruction (ACLR): a scoping review. The Knee. 2025 Dec 1;57:179–99. doi:10.1016/j.knee.2025.08.010

Li Q. REHABILITATION OF NEUROMUSCULAR FUNCTION BY PHYSICAL EXERCISE. Revista Brasileira De Medicina Do Esporte. 2021 May 17;27:291–4. doi:10.1590/1517-8692202127032021_0082

Pangestuputra AW, Changestu DA. Neuromuscular Training in ACL Injury Prevention: A Narrative Review. Orthopaedic Journal of Sports Medicine. 2024 Oct 1. doi:10.1177/2325967124s00394

Kal E, Ellmers T, Diekfuss J, Winters M, Van Der Kamp J. Explicit motor learning interventions are still relevant for ACL injury rehabilitation: do not put all your eggs in the implicit basket! British Journal of Sports Medicine. 2021. doi:10.1136/bjsports-2020-103643

Attalin B, Sagnard T, Laboute E, Forestier N, Rémy-Néris O, Picot B. Proprioceptive Reweighting and Postural Control are Impaired Among Elite Athletes Following Anterior Cruciate Ligament Reconstruction. Int J Sports Phys Ther. 2024;19(11):1314–23. doi:10.26603/001c.124802

Di Giminiani R, Marinelli S, La Greca S, Di Blasio A, Angelozzi M, Cacchio A. Neuromuscular Characteristics of Unilateral and Bilateral Maximal Voluntary Isometric Contractions following ACL Reconstruction. Biology. 2023 Aug 26;12. doi:10.3390/biology12091173

Raoul T, Klouche S, Guerrier B, Elhariri B, Herman S, Gerometta A, et al. Are athletes able to resume sport at six-month mean follow-up after anterior cruciate ligament reconstruction? Prospective functional and psychological assessment from the French Anterior Cruciate Ligament Study (FAST) cohort. The Knee. 2019;26 1:155–64. doi:10.1016/j.knee.2018.11.006

Ithurburn MP, Thomas S, Paterno MV, Schmitt LC. Young athletes after ACL reconstruction with asymmetric quadriceps strength at the time of return-to-sport clearance demonstrate drop-landing asymmetries two years later. The Knee. 2021 Mar 1;29:520–9. doi:10.1016/j.knee.2021.02.036

Smeets A, Verschueren S, Staes F, Claes S, Vandenneucker H, Vanrenterghem J. 223 Challenging ACL reconstructed athletes and their sensorimotor system at return-to-sport: a vital step towards exposing the roots of their neuromuscular deficits. British Journal of Sports Medicine. 2020 Mar 1;54. doi:10.1136/bjsports-2020-IOCAbstracts.223

Chen S, Gu J, Shaharudin S. Effects of proprioceptive training intervention on knee function in patients with anterior cruciate ligament reconstruction: a systematic review and meta-analysis. Ann Med. 2025 Dec;57(1):2542441. doi:10.1080/07853890.2025.2542441

Zink G, Zwolski C, Thomas S, Paterno M, Schmitt L. The Influence of Strength and Sport Exposure on Psychological Readiness After ACL Reconstruction. Sports Health. 2024 Jan 30;16:239–46. doi:10.1177/19417381231223522

Christino M, Coene R, Cook D, Kocher M, Kramer D, Yen YM, et al. Poster 353: LOWER PSYCHOLOGICAL READINESS FOR RETURN TO SPORT AFTER ACL RECONSTRUCTION IS ASSOCIATED WITH REDUCED PERFORMANCE AND GREATER LIMB ASYMMETRY ON FUNCTIONAL TESTING. Orthopaedic Journal of Sports Medicine. 2023 Jul 1;11. doi:10.1177/2325967123s00318

Webster K, Feller J. Psychological Readiness to Return to Sport After Anterior Cruciate Ligament Reconstruction in the Adolescent Athlete. Journal of athletic training. 2022 Sep 1;57 9-10:955–60. doi:10.4085/1062-6050-0543.21

Aizawa J, Hirohata K, Ohji S, Ohmi T, Koga H, Yagishita K. Factors Associated With Psychological Readiness to Return to Sports With Cutting, Pivoting, and Jump-Landings After Primary ACL Reconstruction. Orthopaedic Journal of Sports Medicine. 2020 Nov 1;8. doi:10.1177/2325967120964484

Suzuki M, Ishida T, Matsumoto H, Kaneko S, Inoue C, Aoki Y, et al. Association of Psychological Readiness to Return to Sports With Subjective Level of Return at 12 Months After ACL Reconstruction. Orthopaedic Journal of Sports Medicine. 2023 Sep 1;11. doi:10.1177/23259671231195030

Welling W. Return to sports after an ACL reconstruction in 2024 - A glass half full? A narrative review. Phys Ther Sport. 2024 May;67:141–8. doi:10.1016/j.ptsp.2024.05.001

Duncan B, Reid M, Kleihege J, Higbie S, Gardner E, Lowe W, et al. Comparison of Psychological Readiness to Return to Sport After Primary Versus Revision Anterior Cruciate Ligament Reconstruction. Orthopaedic Journal of Sports Medicine. 2023 May 1;11. doi:10.1177/23259671231159408

Liew B, Feller J, Webster K. Understanding the psychological mechanisms of return to sports readiness after anterior cruciate ligament reconstruction. PLoS ONE. 2022 Mar 24;17. doi:10.1371/journal.pone.0266029

Zhou W, Liu X, Hong Q, Wang J, Luo X. Association between passing return-to-sport testing and re-injury risk in patients after anterior cruciate ligament reconstruction surgery: a systematic review and meta-analysis. PeerJ. 2024 Apr 29;12:e17279. doi:10.7717/peerj.17279

Sanborn R, Badger G, Proffen B, Sant N, Barnett S, Fleming B, et al. Psychological Readiness to Return to Sport at 6 Months Is Higher After Bridge-Enhanced ACL Restoration Than Autograft ACL Reconstruction: Results of a Prospective Randomized Clinical Trial. Orthopaedic Journal of Sports Medicine. 2022 Feb 1;10. doi:10.1177/23259671211070542

Table 1 Patient Data Summary

No	Gender	Age	Sport	ACL Tear Severity	Operative Procedure	Post Operative Symptoms	Follow-Up	Complications	Final ROM	Strength Symmetry	Functional Test Performance
1	Male	27	Basketball	Complete	Semitendinosus Autograft	Pain, swelling	9 months	None	0°-135°	>90%	>90%
2	Male	30	Basketball	Complete	Semitendinosus Autograft	Swelling, stiffness	8 months	Mild effusion	0°-130°	>90%	>90%
3	Male	20	Martial Arts	Partial	Semitendinosus Autograft	Mild pain	7.5 months	None	0°-130°	>90%	>90%
4	Male	21	Soccer	Partial	Semitendinosus Autograft	Pain, limited ROM	8.5 months	None	0°-135°	>90%	>90%