



Role of Physiotherapy in Anterior Cruciate Ligament Injury: A literature review

¹Gladys Swamy ²Claries Swamy

¹Director and consultant ²Additional Director and consultant

¹Minerva Physiotherapy Clinic

Kurla, Mumbai, India.

Abstract

Physiotherapy has a very significant role after a knee injury that involves the ACL ligament. It is very important to begin rehabilitation as soon as the inflammation has subsided. This qualitative study explored physiotherapist's experiences of ACL injury management, from time of injury to return to occupational or recreational activities. While both conservative and surgical management of ACL injuries was discussed, the main findings of this study focused on referral and rehabilitation following surgery.

Key words: Ligament injury, Rehabilitation, Post operative management, Physiotherapy.

Introduction

The anterior cruciate ligament (ACL) rupture has become a very common injury and it is usually sports-related. The incidence of this injury has an increasing tendency, as people tend to engage more with sporting activities. There are three timing stages where physiotherapy has a very important role in this injury. The first stage is before the injury and the strategies we are adopting to avoid a potential ACL injury^{1,2}. The second stage is after the injury and how we end up deciding on operative or conservative management for the patient. The third stage is the rehabilitation protocol after the ACL reconstruction surgery. In all of these stages, the physiotherapist has the primary role in the patient's treatment^{3,4,5}.

Anatomy and Biomechanics

The knee is a hinge joint connecting the femur and tibia bones. It is held together by several important ligaments. The most important ligament to the knee's stability is the Anterior Cruciate Ligament (ACL). The ACL attaches from the front part of the tibia to the back part of the femur^{6,7}. The purpose of this ligament is to keep the tibia from sliding forward and rotating on the femur. For this reason, the ACL is most susceptible to injury when twisting or rotational forces are placed on the knee. Although this can happen with contact, approximately 70% of ACL tears occur during non-contact events when athletes are cutting, decelerating, or landing from a jump. After the ACL is torn, the knee is less stable and it becomes difficult to maintain a high level of activity without the knee buckling or giving way. It is particularly difficult to perform the repetitive cutting and pivoting that is required in many sports^{8,9,10}.

Pre-operative Rehabilitation

Prior rehabilitation is essential for improved outcomes following Anterior Cruciate Ligament (ACL) Reconstruction surgery. Your knee incurs deficits in terms of strength, proprioception (the ability to maintain balance), muscle timing, and gait (walking patterns) after suffering an ACL injury. Physiotherapy before undergoing ACL reconstructive surgery is effective in improving strength and balance which may reduce the episodes of 'giving way' and decrease the chances of re-injury in an ACL deficient knee. The goals of pre-operative rehabilitation include restoring full range of motion, achieve adequate neuromuscular control, strengthening muscles that are important in post-operative rehabilitation, and achieving an understanding of exercises to be performed after surgery. These factors greatly influence the chances of surgery^{11,12,23,14}.

Post-operative Rehabilitation

The surgeon and physiotherapists will guide you through a comprehensive rehabilitation program to optimize recovery following surgery and facilitate return to sport/activities.

Treatment Options: Regardless of how the ACL is torn, your physician will work with you to determine a personalized course of treatment. People participating in sports or work-related activities that require a lot of pivoting, cutting, or jumping may decide to have surgery. Depending on your lifestyle, however; conservative treatment may be the best option. In the case of an isolated ACL tear with no other ligamentous or cartilage involvement, the associated pain and dysfunction can be successfully treated with physical therapy^{15,16,17}.

Physiotherapy for ACL deficient patients: Physiotherapy has a very significant role after a knee injury that involves the ACL ligament. It is very important to begin as soon as the inflammation has subsided passive range of motion exercises of the knee and weight-bearing as tolerated limitation of complete extension, delay in strength recovery, anterior knee pain]. Prevention of muscle atrophy is important as well. A balanced quadriceps-hamstrings co-activation ratio exercises, such as single-limb leg-lift, lateral and transverse hop-to-balance exercises can be proven beneficial for the ACL deficient patients. Lunge exercises can help with quadriceps strengthening^{18,19,20}. Good hamstrings control is linked with a high incidence of successful avoidance of surgery after an ACL rupture. The use of a knee brace has been proposed to reduce patients' instability feeling, but some reports could interfere with the day-to-day activities from the open-chain exercises, as they are. Patients who have high demands such as professional players engaging with sports which include pivoting movements and patients with other major knee injuries (pathology in the other ligaments, menisci tears, or cartilage injuries) will be treated operatively with an ACL reconstruction^{21,22}. For the rest of them, conservative management is the initial option, which includes an intense physiotherapy protocol to return to the pre-injury activities without instability symptoms. This program lasts at least 6 weeks and consists of muscle strengthening exercises, cardiovascular endurance training, and sport-specific and agility exercises such as quick start and stops, cutting, and pivoting. At the end of the program, the patients who achieve to return to their pre-injury activity level without symptoms are identified as 'copers', the rest of them are candidates for operative treatment and identified as 'non-copers' thereby ultimately resulting in knee instability and dysfunction. However, ACL rupture does not automatically infer functional impairment and instability as confirmed by the ACL deficiency (ACLD). Although 'copers' have normal activity levels and they manage to overcome their deficiency without functional problems, their walking economy remains impaired compared to the healthy baseline. This fact could lead us to treat them operatively as well when the energy cost is important for the patient^{22,23,24}.

Phase 1: Immediate Post-op (0-2 weeks post surgery)

Rehabilitation Goals:	<ul style="list-style-type: none"> • Protect graft • Reduce swelling, minimize pain • Restore patellar mobility • Restore full extension, gradually improve flexion • Minimize arthrogenic muscle inhibition, re-establish quad control, regain full active extension • Patient education <ul style="list-style-type: none"> o Keep your knee straight and elevated when sitting or laying down. Do not rest with a towel placed under the knee o Do not actively kick your knee out straight; support your surgical side when performing transfers (i.e. sitting to laying down) o Do not pivot on your surgical side.
Weight Bearing	<p>Walking</p> <ul style="list-style-type: none"> • Initially brace locked, crutches • May start walking without crutches as long as there is no increased pain <ul style="list-style-type: none"> o Allograft and hamstring autograft continue partial weight bearing with crutches for 6 weeks unless otherwise instructed by MD • May unlock brace once able to perform straight leg raise without lag • May discontinue use of brace after 6 wks per MD and once adequate quad control is achieved • When climbing stairs, make sure you are leading with the non-surgical side when going up the stairs, make sure you are leading with the
Intervention	<p>Swelling Management</p> <ul style="list-style-type: none"> • Ice, compression, elevation (check with MD re: cold therapy) • Retrograde massage • Ankle pumps Range of motion/Mobility • Patellar mobilizations: superior/inferior and medial/lateral o **Patellar mobilizations are heavily emphasized in the early post-operative phase following patella tendon autograft** • Seated assisted knee flexion extension and heel slides with towel • Low intensity, long duration extension stretches: prone hang, heel prop • Standing gastronemius stretch and soleus stretch • Supine active hamstring stretch and supine passive hamstring stretch <p>Strengthening</p> <ul style="list-style-type: none"> • Calf raises • Quad sets • NMES high intensity (2500 Hz, 75 bursts) supine knee extended 10 sec/50 sec, 10 contractions, 2x/wk during sessions—use of clinical stimulator during session, consider home units distributed immediate post op • Straight leg raise o **Do not perform straight leg raise if you have a knee extension lag • Hip abduction • Multi-angle isometrics 90 and 60 deg knee extension
Criteria to progress	<ul style="list-style-type: none"> • Knee extension ROM 0 deg • Quad contraction with superior patella glide and full active

	extension • Able to perform straight leg raise without lag
--	---

Phase 2- Intermediate Post-Op (3-5 weeks after surgery):

Rehabilitation goals.	<ul style="list-style-type: none"> • Continue to protect graft • Maintain full extension, restore full flexion (contra lateral side) • Normalize gait
Additional intervention Continue with Phase 1 interventions.	Range of motion/Mobility <ul style="list-style-type: none"> • Stationary bicycle • Gentle stretching all muscle groups: prone quad stretch, standing quad stretch, kneeling hip flexor stretch Strengthening <ul style="list-style-type: none"> • Prone hamstring curls • Step ups and step ups with march • Partial squat exercise • Ball squats, wall slides, mini squats from 0-60 deg • Lumbopelvic strengthening: bridge & unilateral bridge, side lying hip external rotation clamshell, bridges on physio ball, bridge on physio ball with roll-in, bridge on physio ball alternating, hip hike Balance/proprioception <ul style="list-style-type: none"> • Single leg standing balance (knee slightly flexed) static progressed to dynamic and level progressed to unsteady surface • Lateral step-overs • Joint position re-training
Criteria to progress	<ul style="list-style-type: none"> • No swelling (Modified Stroke Test) • Flexion ROM within 10 deg contra lateral side • Extension ROM equal to contra lateral side

Phase 3- Late Post-Op (6-8 weeks after surgery):

Rehabilitation goals	<ul style="list-style-type: none"> • Continue to protect graft site • Maintain full ROM • Safely progress strengthening • Promote proper movement patterns • Avoid post exercise pain/swelling • Avoid activities that produce pain at graft donor site
Additional Intervention (Continue with Phase I-II Interventions)	Range of motion/Mobility <ul style="list-style-type: none"> • Rotational tibial mobilizations if limited ROM Cardio <ul style="list-style-type: none"> • Elliptical, stair climber, flutter kick swimming, pool jogging Strengthening <ul style="list-style-type: none"> • Gym equipment: leg press machine, seated hamstring curl machine and hamstring curl machine, hip abductor and adductor machine, hip extension machine, roman chair, seated calf machine <ul style="list-style-type: none"> o Hamstring autograft can begin resisted hamstring strengthening at 12 weeks • Progress intensity (strength) and duration (endurance) of exercises * <p>*The following exercises to focus on proper control with</p>

	<p>emphasis on good proximal stability • Squat to chair</p> <ul style="list-style-type: none"> • Lateral lunges • Romanian deadlift • Single leg progression: partial weight bearing single leg press, slide board lunges: retro and lateral, step ups and step ups with march, lateral step-ups, step downs, single leg squats, single leg wall slides • Knee Exercises for additional exercises and descriptions <p>Balance/proprioception</p> <ul style="list-style-type: none"> • Progress single limb balance including perturbation training.
Criteria to progress	<ul style="list-style-type: none"> • No swelling/pain after exercise • Normal gait • ROM equal to contra lateral side • Joint position sense symmetrical (<5 degree margin of error) • Quadriceps index $\geq 80\%$; HHD mean preferred (isokinetic testing if available)

Phase 4 - Transitional (9-12 weeks after surgery)

Rehabilitation goals	<ul style="list-style-type: none"> • Maintain full ROM • Safely progress strengthening • Promote proper movement patterns • Avoid post exercise pain/swelling • Avoid activities that produce pain at graft donor site
Additional Intervention (Continue with Phase I-III interventions)	<ul style="list-style-type: none"> • Begin sub-max sport specific training in the sagittal plane • Bilateral PWB plyometrics progressed to FWB plyometrics
Criteria to progress	<ul style="list-style-type: none"> • No episodes of instability • Maintain quad strength • 10 repetitions single leg squat proper form through at least 60 deg knee flexion • Drop vertical jump with good control • KOOS-sports questionnaire >70% • Functional Assessment <ul style="list-style-type: none"> o Quadriceps index >80%; HHD mean preferred (isokinetic testing if available) o Hamstring, glut med, glut max index $\geq 80\%$; HHD mean preferred (isokinetic testing for HS if available) o Single leg hop test $\geq 75\%$ compared to contra lateral side (earliest 12 wks) • Return-to-sport testing

Phase 5 - Early return to sport (3-5 months after surgery)

Rehabilitation goals	<ul style="list-style-type: none"> • Safely progress strengthening • Safely initiate sport specific training program • Promote proper movement patterns • Avoid post exercise pain/swelling • Avoid activities that produce pain at graft donor site
Additional Intervention (Continue with Phase II-IV interventions)	<ul style="list-style-type: none"> • Interval running program <ul style="list-style-type: none"> ◦ Return to Running Program • Progress to plyometric and agility program (with functional brace if prescribed) <ul style="list-style-type: none"> ◦ Agility and Plyometric Program
Criteria to Progress	<ul style="list-style-type: none"> • Clearance from MD and ALL milestone criteria below have been met • Completion jog/run program without pain/swelling • Functional Assessment <ul style="list-style-type: none"> ◦ Quad/HS/glut index $\geq 90\%$; HHD mean preferred (isokinetic testing if available) ◦ Hamstring/Quad ratio $\geq 70\%$; HHD mean preferred (isokinetic testing if available) ◦ Hop Testing $\geq 90\%$ compared to contra lateral side • KOOS-sports questionnaire $>90\%$ • International Knee Committee Subjective Knee Evaluation >93 • Psych Readiness to Return to Sport (PRRS)

Phase 6 - unrestricted return to sport (6+ months after surgery)

Rehabilitation goals	<ul style="list-style-type: none"> • Continue strengthening and proprioceptive exercises • Symmetrical performance with sport specific drills • Safely progress to full sport
Additional Intervention (Continue with Phase II-V interventions)	<ul style="list-style-type: none"> • Multi-plane sport specific plyometrics program • Multi-plane sport specific agility program <ul style="list-style-type: none"> • Include hard cutting and pivoting depending on the individuals' goals (~7 mo) • Non-contact practice → Full practice → Full play
Criteria to progress	<ul style="list-style-type: none"> • Last stage, no additional criteria ^{25,26,27,28}.

Discussion

A biopsychosocial approach to health care is considered an important part of providing the best possible management for sports injuries. The participants believed in this holistic view of the management of ACL injuries to provide individualized management considering biomechanical, psychological, and social factors. Some participants were also cognizant of patients' fears of returning to heavy manual occupations (such as farming) or the ability to perform at previous sporting levels. They appeared comfortable dealing with psychological concerns through clinical experience, using a variety of methods such as education, reassurance, and relevant goal-based exercise prescription^{29,30,31,32}

While participants were aware of published guidelines for ACL management, they discussed a milestone (as opposed to time frame) approach for rehabilitation. They believed this was particularly important to increase patient motivation and allowed individualized rehabilitation. A milestone approach enables treatment flexibility based on the patients' individual needs, contributing towards motivation^{33,34}.

Physiotherapists' ideas for future research: It was clear from the participants' responses that they did access, critique, and apply evidence. There is debate in the literature regarding the optimal combination of open and closed kinetic chain exercises. Return to sport is complex and entails consideration of psychological, social, and physical factors^{35,36}. Thus, making sense of research findings in these areas, often with contradicting findings, and translating these into clinical practice appeared to be challenging for the clinicians. The facilitation of evidence-based practice in this area might require the use of expert clinical commentary which synthesizes, critiques the relevant literature, summarises, and then applies the evidence via a case study^{337,38,39}.

Implications for clinical practice and future research: Physiotherapists may want to maintain, improve or consider adopting a biopsychosocial and evidence-informed approach to managing ACL injuries to achieve the best outcomes. A milestone approach to rehabilitation progression appears to be more readily adopted rather than timeframe-based goals. Enhancing inter-professional communication to adopt a more team-based approach, and problem-solving to simplify the current referral process, could potentially further improve ACL injury management. In particular, psychological needs should be acknowledged and addressed to achieve best possible outcomes for return to sport. Physiotherapists may need further education and research to support them in understanding and applying these approaches. Research in psychological management for sports injuries and the inclusion of rurally based participants should be considered.

Conclusion

In conclusion, we can state that physiotherapy is the most important part of the patient's management and treatment. Physiotherapy has a significant impact on the prevention of ACL injury and a leading part of pre-and post- ACL reconstruction management. The main aims are to restore the full ROM of the knee and to restore muscle strength and proprioception. These aims have to be achieved by performing easy and safe exercises and by avoiding shear forces of the knee, to prevent re-injury.

References :

1. Siegel L, Vandenakker-Albanese C, Siegel D. Anterior cruciate ligament injuries: anatomy, physiology, biomechanics, and management. *Clin J Sport Med.* 2012, 22(4): 349–355.
2. Myer GD, Sugimoto D, Thomas S, Hewett TE. The Influence of Age on the Effectiveness of Neuromuscular Training to Reduce Anterior Cruciate Ligament Injury in Female Athletes A Meta-Analysis. *Am J Sports Med.* 2013, 41(1): 203-215.
3. Adams D, Logerstedt D, et al. Current Concepts for Anterior Cruciate Ligament Reconstruction: A Criterion-Based Rehabilitation Progression. *JOSPT* 2012 42(7): 601-614.
4. Shelbourne KD, Nitz P. Accelerated rehabilitation after anterior cruciate ligament reconstruction. *Am J sports Med* 1990,18(3):292-299.
5. Di Stasi S, Myer GD, Hewett TE. Neuromuscular Training to Target Deficits Associated with Second Anterior Cruciate Ligament Injury. *JOSPT* 2013 43 (11): 777-792.
6. Christensen JC, Goldfine LR, West HS. The effects of early aggressive rehabilitation on outcomes after anterior cruciate ligament reconstruction using autologous hamstring tendon: a randomized clinical trial. *J Sport Rehabil.* 2013, 22(3): 191– 201.
7. Wright RW, Preston E, Fleming BC, Amendola A, Andrich JT et al. A systematic review of anterior cruciate ligament reconstruction rehabilitation: part II: open versus closed kinetic chain exercises, neuromuscular electrical stimulation, accelerated rehabilitation, and miscellaneous topics. *J Knee Surg.* 2008, 21(3): 225–234.
8. Dubljanin-Raspopović E, Matanović D, Kadija M. Influence of proprioceptive training in the improvement of neuromuscular performance after ACL reconstruction. *Srp Arh Celok Lek.* 2005. 133(9-10): 429-432.
9. Glazer DD. Development and Preliminary Validation of the Injury-Psychological Readiness to Return to Sport (I-PRRS) Scale. *Journal of Athletic Training.* 2009;44(2):185-189.
10. Cooper RL, Taylor NF, Feller JA. A randomised controlled trial of proprioceptive and balance training after surgical reconstruction of the anterior cruciate ligament. *Res Sport Med.* 2005, 13(3): 217–230.
11. Kruse LM, Gray B, Wright RW. Rehabilitation after anterior cruciate ligament reconstruction: a systematic review. *J Bone Jt Surg Am.* 2012, 94(19): 1737–1748.
12. Lobb R, Tumilty S, Claydon LS. A review of systematic reviews on anterior cruciate ligament reconstruction rehabilitation. *Phys Ther Sport.* 2012, 13(4): 270–278.
13. Fitzgerald GK. Open versus closed kinetic chain exercise: issues in rehabilitation after anterior cruciate ligament reconstructive surgery. *Phys Ther.* 1997, 77(12): 1747–1754.
14. Glass R, Waddell J, Hoogenboom B. The Effects of Open versus Closed Kinetic Chain Exercises on Patients with ACL Deficient or Reconstructed Knees: A Systematic Review. *N Am J Sports Phys Ther.* 2010, 5(2): 74–84.
15. Begalle RL, DiStefano LJ, Blackburn T, Padua DA. Quadriceps and hamstrings coactivation during common therapeutic exercises. *J Athl Train.* 2012, 47(4): 396–405.
16. Walla DJ, Albright JP, McAuley E, Martin RK, Eldridge V et al. Hamstring control and the unstable anterior cruciate ligament-deficient knee. *Am J Sports Med.* 1985, 13(1): 34–9.

17. Irrgang JJ, Anderson AF, Boland AL, et al. Development and validation of the International Knee Documentation Committee Subjective Knee Form. *Am J Sports Med.* 2001;29:600-613.
18. Mandelbaum BR, Silvers HJ, Watanabe DS, et al. Effectiveness of a Neuromuscular and Proprioceptive Training Program in Preventing Anterior Cruciate Ligament Injuries in Female Athletes: 2-year follow-up. *Am J Sports Med.* 2005;33:1003-1010.
19. Wright RW, Haas AK, et al. Anterior Cruciate Ligament Reconstruction Rehabilitation: MOON Guidelines. *Sports Health* 2015 7(3): 239-243.
20. Lobb R, Tumilty S, Claydon LS. A review of systematic reviews on anterior cruciate ligament reconstruction rehabilitation. *Phys Ther Sport.* 2012, 13(4): 270–278.
21. Fitzgerald GK. Open versus closed kinetic chain exercise: issues in rehabilitation after anterior cruciate ligament reconstructive surgery. *Phys Ther.* 1997, 77(12): 1747–1754.
22. Glass R, Waddell J, Hoogenboom B. The Effects of Open versus Closed Kinetic Chain Exercises on Patients with ACL Deficient or Reconstructed Knees: A Systematic Review. *N Am J Sports Phys Ther.* 2010, 5(2): 74–84.
23. Wilk KE, Macrina LC, et al. Recent Advances in the Rehabilitation of Anterior Cruciate Ligament Injuries. *JOSPT* 2012 42(3): 153-171.
24. Iliopoulos E, Galanis N, Iosifidis M, Zafeiridis A, Papadopoulos P et al. Anterior cruciate ligament deficiency reduces walking economy in “copers” and “non-copers.” *Knee Surgery, Sport Traumatol Arthrosc.* Springer; 201.
25. Saka T. Principles of postoperative anterior cruciate ligament rehabilitation. *World J Orthop.* 2014, 5(4): 450–459.
26. Shelbourne KD, Gray T. Minimum 10-year results after anterior cruciate ligament reconstruction: how the loss of normal knee motion compounds other factors related to the development of osteoarthritis after surgery. *Am J Sports Med.* 2009, 37(3): 471–480
27. Kruse LM, Gray B, Wright RW. Rehabilitation after anterior cruciate ligament reconstruction: a systematic review. *J Bone Jt Surg Am.* 2012, 94(19): 1737–1748.
28. Moisala AS, Jarvela T, Kannus P, Jarvinen M. Muscle strength evaluations after ACL reconstruction. *Int J Sports Med.* Oct 2007;28(10):868-872
29. Myer GD, Paterno MV, Ford KR, Hewett TE. Neuromuscular training techniques to target deficits before return to sport after anterior cruciate ligament reconstruction. *J Strength Cond Res.* May 2008;22(3):987-1014
30. Myer GD, Paterno MV, Ford KR, Quatman CE, Hewett TE. Rehabilitation after anterior cruciate ligament reconstruction: criteria-based progression through the return-to-sport phase. *J Orthop Sports Phys Ther.* Jun 2006;36(6):385-402.
31. Herrington, L., Myer, G., & Horsley, I. (2013). Task based rehabilitation protocol for elite athletes following anterior cruciate ligament reconstruction: a clinical commentary [Review] *Physical Therapy in Sport*, 14(4), 188e198.
32. Jevon, S. M., & Johnston, L. H. (2003). The perceived knowledge and attitudes of governing body chartered physiotherapists towards the psychological aspects of rehabilitation. *Physical Therapy in Sport*, 4(2), 74e81.

33. Lobb, R., Tumilty, S., & Claydon, L. S. (2012). A review of systematic reviews on anterior cruciate ligament reconstruction rehabilitation. *Physical Therapy in Sports*, 13(4), 270e278.
34. Manske, R. C., & Lehecka, B. J. (2012). Evidence-based medicine/practice in sports physical therapy. *International Journal of Sports Physical Therapy* 7(5): 461-473.
35. Herrington, L., Myer, G., & Horsley, I. (2013). Task based rehabilitation protocol for elite athletes following anterior cruciate ligament reconstruction: a clinical commentary [Review] *Physical Therapy in Sport*, 14(4), 188e198.
36. Ardern, C. L., Taylor, N. F., Feller, J. A., & Webster, K. E. (2014). Fifty-five per cent return to competitive sport following anterior cruciate ligament reconstruction surgery: an updated systematic review and meta-analysis including aspects of physical functioning and contextual factors. *British Journal of Sports Medicine*, 48(21), 1543e1552.
37. Ardern, C. L., Taylor, N. F., Feller, J. A., Whitehead, T. S., & Webster, K. E. (2015). Sports participation 2 years after anterior cruciate ligament reconstruction in athletes who had not returned to sport at 1 year: a prospective follow-up of physical function and psychological factors in 122 athletes. *American Journal of Sports Medicine*, 43(4), 848e856
38. Carson, F., & Polman, R. (2012). Experiences of professional rugby union players returning to competition following anterior cruciate ligament reconstruction. *Physical Therapy in Sport*, 13(1), 35e40
39. Manske, R. C., & Lehecka, B. J. (2012). Evidence-based medicine/practice in sports physical therapy. *International Journal of Sports Physical Therapy*, 7(5), 461e473.

Conflict of interest

None declared