
A Mini-Review on the Rehabilitation of Anterior Cruciate Ligament Injury

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INTRODUCTION

The anterior cruciate ligament (ACL) is attached medially to the anterior intercondylar area of the tibia partly blending with the anterior of the lateral meniscus; it ascends posterolaterally, twisting on itself and fanning out to attach to the posteromedial aspect of the lateral femoral condyle.¹ ACL is the main static stabilizer against anterior translation of the tibia on the femur. Because of oblique anatomy of ACL, it is efficient for limiting excessive anterior tibial translation as well as axial tibial and valgus with knee rotations.² Besides its mechanical function related to knee stabilization, there is also neuromuscular function of the ACL due to mechanoreceptors.³ If there is a ACL deficiency, deafferentation zones can be seen. These zones alter spinal and supraspinal motor control.⁴ The changes in motor control strategy can reveal changes in proprioception, postural control, muscle strength, movement and recruitment patterns.³ Therefore, an ACL injury is not only a musculoskeletal injury, both also neurophysiological dysfunction.

ACL injuries are reported to be the most common knee ligament injury. It has been estimated that injury rate of 1 per 3,000 in general population.⁵ A rehabilitation programme, which promoting the muscular strength and re-establishing the knee joint functional stability, is an essential and integral part of treatment after ACL injury.⁶ If exercises are not compatible with normal arthrokinematics of knee, abnormal stresses, such as overloading, occur on the tibiofemoral joint articulating surfaces and other joint structures.⁶

Intrinsic and extrinsic factors related to ACL determine both rehabilitation protocol and return to sports and recruitment activities.⁷ Intrinsic factors are genetics/biological characteristics, type of lesion, anatomical features, compliance with the rehabilitation protocol, motivation, and psychological attitude. As for extrinsic factors, they are type of graft, surgical technique, rehabilitation phases, and biological

support.⁷ Because of existence of a numerous of factors, rehabilitation protocol should be patient-tailored.

Some factors and functional capacity of the patient in the preoperative period affect the success of the ACL rehabilitation. Preoperative extension deficit, preoperative deficit in quadriceps strength of >20%, lack of preoperative rehabilitation are important factors to predict the outcome of treatment.^{8,9} Functional recovery of the patient may be worse if mentioned predictive factors are present. Therefore, treatment programme modifications may be needed to achieve the best functional level. Cornerstone of rehabilitation is time of programme and whether the program is supervised rehabilitation or home-based rehabilitation. A minimally supervised rehabilitation programme may result in successful rehabilitation in specific groups of patients that are highly motivated and live far from a physical therapist.¹⁰ Duration of the treatment in either program can be selected to be 19 or 32 weeks. When comparing a 19-week with a 32-week rehabilitation programme, there are no differences in terms of laxity, range of motion, self-reported knee function, single-leg hop test for distance or isokinetic concentric quadriceps and hamstring muscle strength.³ The rehabilitation program for ACL should include the following headings: open kinetic chain (OKC) and closed kinetic chain (CKC) exercises, strength training and neuromuscular training, electrostimulation and electromyographic feedback, and cryotherapy.

Andersson et al. have determined that CKC quadriceps exercises are effective on less pain, less risk of increased laxity and better self-reported knee function compared to OKC quadriceps exercises.¹¹ Although it has been known that CKC is more beneficial, OKC can also be used. Fukuda et al. described that OKC quadriceps exercises can be started from week 4 after ACL reconstruction with hamstring autograft, but in a limited ROM between 45° and 90°.¹² An early start to OKC exercises result in more laxity after a follow-up period of 7 months.¹³ Therefore, it is important for the

clinician to train ACL with CKC exercises in early phases of rehabilitation. Although isometric quadriceps exercises are safe from the first postoperative week, starting eccentric quadriceps training (in CKC) from 3 weeks after ACL reconstruction is safe and contributes to a bigger improvement in quadriceps strength than concentric training.³ Neuromuscular training and electrostimulation/electromyographic feedback in combination with conventional rehabilitation should be added to strength training in early phases to optimise self-reported outcome measurements. Regardless of early or late phase of rehabilitation, important problems that clinicians should eliminate in individuals with ACL lesion is the pain and edema. Cryotherapy is effective in decreasing pain and edema immediately after application up to 1 week ACL postsurgery in addition to electrical stimulation applications based on "Gate Control" theory.¹⁶

Return to sports and recruitment activities after ACL lesion is a critical situation which should be correctly timed against possible risk of re-injury. It has been reported that rate of ACL re-injury is 23% in young individuals.¹⁷ First criteria of return to sports, it has been considered that 6 months as a cut-off value for allowing sport resumption, without major differences emerging between grafts.⁷ As regards muscle strength, the cut-off value of >90% isokinetic strength compared to the contralateral side is important criterion most used, followed by lower values of the same parameter (>85%, >80%) or different parameters, such as a quadriceps index >90% and weighted leg extension >90%.⁷ Self-report knee scoring (Modified Noyes system ≥ 90 , International Knee Documentation Committee subjective knee form >70) is frequently used for returning to sports.^{18,19} In addition to these clinical criterias, if patient is a athlete, the sport branch of the athlete should also be taken into account for the return to the sports.²⁰

CONCLUSION

The decision to allow a patient to return to sport and recruitment activities is a challenge for the clinician. Because there are criterias both clinic-based and performance-based. It is not possible to form a standardised criteria for each patient indiscriminately. It would be preferable to apply patient-tailored rehabilitation protocols and return-to-sport and recruitment activities criteria, based on individual characteristics.

REFERENCES

- [1] Markatos K, Kasetta MK, Lallos SN, Korres DS, Efstathopoulos N. The anatomy of the ACL and its importance in ACL reconstruction. *Eur J Orthop Surg Traumatol.* 2013;23(7):747-52.
- [2] Woo SL, Wu C, Dede O, Vercillo F, Noorani S. Biomechanics and anterior cruciate ligament reconstruction. *J Orthop Surg Res.* 2006;1:2
- [3] van Melick N, van Cingel RE, Brooijmans F, Neeter C, van Tienen T, Hullegie W, Nijhuis-van der Sanden MW. Evidence-based clinical practice update: practice guidelines for anterior cruciate ligament rehabilitation based on a systematic review and multidisciplinary consensus. *Br J Sports Med.* 2016;50(24):1506-1515.
- [4] Decker LM, Moraiti C, Stergiou N, et al. New insights into anterior cruciate ligament deficiency and reconstruction through the assessment of knee kinematic variability in terms of nonlinear dynamics. *Knee Surg Sports Traumatol Arthrosc.* 2011;19:1620-33.
- [5] Sadegh N, Fateme E, Ali S, Reza S, Mohammad A, Farzam F. Rehabilitation after ACL injury: a fluoroscopic study on the effects of type of exercise on the knee sagittal plane arthrokinematics. *BioMed Research International.* vol. 2013, Article ID 248525, 7 pages,
- [6] Irrgang JJ, Fitzgerald GK. Rehabilitation of the multiple ligament-injured knee. *Clinics in Sports Medicine.* 2000;19(3):543-71.
- [7] Zaffagnini S, Grassi A, Serra M, Marcacci M. Return to sport after ACL reconstruction: how, when and why? A narrative review of current evidence. *Joints.* 2015;3(1):25-30.
- [8] de Valk EJ, Moen MH, Winters M, et al. Preoperative patient and injury factors of successful rehabilitation after anterior cruciate ligament reconstruction with single-bundle techniques. *Arthroscopy.* 2013;29:1879-95.
- [9] Eitzen I, Holm I, Risberg MA. Preoperative quadriceps strength is a significant predictor of knee function two years after anterior cruciate ligament reconstruction. *Br J Sports Med.* 2009;43:371-6.
- [10] Wright RW, Preston E, Fleming BC, et al. A systematic review of anterior cruciate ligament reconstruction rehabilitation. Part I: continuous passive motion, early weight bearing, postoperative bracing, and home-based rehabilitation. *J Knee Surg.* 2008;21:217-24.

- [11] Andersson D, Samuelsson K, Karlsson J. Treatment of anterior cruciate ligament injuries with special reference to surgical technique and rehabilitation: an assessment of randomized controlled trials. *Arthroscopy*. 2009;25:653–85.
- [12] Fukuda TY, Fingerhut D, Coimbra Moreira V, et al. Open kinetic chain exercises in a restricted range of motion after anterior cruciate ligament reconstruction. A randomized controlled trial. *Am J Sports Med*. 2013;41:788–94.
- [13] Heijne A, Werner S. Early versus late start of open kinetic chain quadriceps exercises after ACL reconstruction with patellar tendon or hamstring grafts: a prospective randomized outcome study. *Knee Surg Sports Traumatol Arthrosc*. 2007;15:402–14.
- [14] Kruse LM, Gray B, Wright RW. Rehabilitation after anterior cruciate ligament reconstruction. A systematic review. *J Bone Joint Surg Am*. 2012;94:1737–48.
- [15] Imoto AM, Peccin S, Melo Almeida GJ, et al. Effectiveness of electrical stimulation on rehabilitation after ligament and meniscal injuries: a systematic review. *Sao Paulo Med J*. 2011;129:414–23.
- [16] Raynor MC, Pietrobon R, Guller U, et al. Cryotherapy after ACL reconstruction: a meta-analysis. *J Knee Surg*. 2005;18:123–9.
- [17] Wiggins AJ, Grandhi RK, Schneider DK, Stanfield D, Webster KE, Myer GD (2016) Risk of secondary injury in younger athletes after anterior cruciate ligament reconstruction: a systematic review and meta-analysis. *Am J Sports Med*. 44(7):1861–1876
- [18] Wilk KE, Arrigo C, Andrews JR, et al. Rehabilitation after anterior cruciate ligament reconstruction in the female athlete. *J Athl Train*. 1999;34:177–93.
- [19] Myer GD, Paterno MV, Ford KR, et al. Rehabilitation after anterior cruciate ligament reconstruction: criteria-based progression through the return-to-sport phase. *J Orthop Sports Phys Ther*. 2006;36:385–402.
- [20] Rambaud AJM, Ardern CL, Thoreux P, Regnaud JP, Edouard P. Criteria for return for running after anterior cruciate ligament reconstruction: a scoping review. *Br J Sports Med*. 2018 May 2. pii: bjsports-2017-098602.