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**Anterior Cruciate Ligament Reconstruction**

**- GGC Guidelines for Rehabilitation -**

**Updated March 2019**

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# Introduction

Anterior Cruciate Ligament reconstruction surgery is carried out in various sites across NHSGGC as a day surgery procedure with patients discharged following assessment by the orthopaedic inpatient physiotherapists.

These guidelines are for outpatient rehabilitation to commence within 3-6 days following surgery and may continue for up to 6-12 months following surgery depending on patient progress and individual goals.

Treatment should be based on **individual needs** and **appropriate clinical decision making** regarding the progression of the patient’s post-operative course. The actual post-surgical physiotherapy management must be based on the physical examination, individual progress and the presence of complications. **Please review the patient’s operation note to clarify any specific instructions.** Some patients will not meet the early targets due to pain/swelling/other underlying conditions in the knee or other extenuating circumstances.

Orthopaedic outpatient clinic review is carried out by local surgical protocol and individual clinical need.

January 2019

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**LOCAL CLASSES and CONTACTS**

**West Glasgow ACH – Yorkhill (Catriona Dunwoodie)**

Monday 1500 - 1630

Thursday 0800 - 1000

**Gartnavel General Hospital (Becky Dunphy)**

Tuesday 0830 - 1030

Friday 0830 - 1030

**Glasgow Royal Infirmary (Rosemarie Quinn and Jayne Ford Anderson)**

Monday 1300 - 1400

Thursday 1300 - 1400

**Stobhill Hospital (Fergal Lally)**

Monday 1600 - 1730

**Royal Alexandra Hospital (Katie Black)**

Thursday 1700 - 1800

**Inverclyde Royal Hospital (Hassine Hamraras)**

Monday 1045 - 1145

Wednesday 1045 - 1145

Please contact one of the above in case of changes to time, location or staff.

Phase 1

**Day 1 onwards, see patient information booklet given on discharge**

**NB. Progression of the exercises will be dictated by the patient’s level of pain and swelling.**

* Continue with ice/compression/elevation until effusion resolves.
* Continue ROM exercises until full knee extension is achievable with ease.
* Continue using walking aid(s) until full extension and quadriceps control on the operated leg is achieved and there is no evidence of a limp.
* The wound dressing can be removed at ~ 7-10 days post surgery.
* If you have any concerns regarding the wound/suspected infection request that the patient contacts the orthopaedic department/A&E.

|  |  |
| --- | --- |
| **Goals of Phase** | Monitor wound Commence ROM and strengthening exercisesAchieve terminal extensionGait re-educationProprioceptive exercisesSet patient specific Goals |
| **Includes** | Knee ROMProne StretchLong sitting Calf Stretch**Quadriceps** * Static quads in long sitting
* Knee bracing in standing
* Straight Leg Raise

**Hip Strength** Abduction in supine, progress to side lyingHip Extensors - Prone lying, passive knee flexion to 900, extend hip (use assistance of other leg when initiating bending and straightening of the knee) |
| **Progress to****Progress to** | **Increase quads strength**e.g. terminal extension with therabandmini squats 0-500**Calf strength** – bilateral heel raises**Calf Flexibility -** Standing calf stretch **Proprioception**:Weight transference:1) Forward/lateral in standing2) Unilateral stand as able with full knee extension3) Single leg stance**CV:** static bike |
| **Aims & Outcome Measures for progression to phase 2** | Terminal extension achievedNormal Gait pattern unaidedNo worsening effusionBaseline [LEFS](#_Lower_Extremity_Functional) (Lower Extremity Functional Score) at 2 weeks |

Phase 2

**4-12 weeks approx**

**Treatment should be based on individual needs and appropriate clinical decision making regarding the progression of the patient’s post-operative course.**

|  |  |
| --- | --- |
| **Goals of Phase** | Progress strength and conditioningCommence return to running programmeCommence basic agility |
| **Includes** | **Develop Full ROM/Flexibility*** Calf
* Quads
* Hamstring
* Hip Flexors
* Ab/adductors

**Strength**Progress from bilateral → unilateral e.g. calf raise, squat, step up, posterior chain/bridge variations, lunge**Proprioception****CV**Cycling, cross trainer, pool (exercises, gentle front crawl, back crawl – no breaststroke until 3 months), walk/jog programme (see appendix) |
| **Progress to** | **Return to Running Criteria – See Appendix****Agility (no pivoting) – see appendix****Early Plyometrics – e.g. skipping / landing drills**[For examples – see Appendices](#_Appendices) |
| **Aims & Outcome Measures for progression to phase 3**  | * Full ROM flexion & Extension
* Working through [Return to running programme](#_RETURN_TO_RUNNING) pain free and controlled effusion
* [Single Hop test](#_Hop_Tests) 80% [Limb Symmetry Index (LSI)](#_Calculating_LSI/RSI)
* [Strength](#_Measuring_Strength_–) 80% LSI (Single leg sit to stand / leg press)
* [Single Leg Bridge](#_Measuring_Strength_–_) 80% LSI

  |
| **Measures of Improvement** | Complete:* [Y-Balance](#_Y-Balance_Test)
* [LEFS](#_Lower_Extremity_Functional) 6 weeks and 12 weeks
 |

Phase 3

**3-6 months approx - Dynamic Training**

**Treatment should be based on individual needs and appropriate clinical decision making regarding the progression of the patient’s post-operative course.**

|  |  |
| --- | --- |
| **Goals of Phase** | Progress strength & conditioningProgress AgilityContinue Running ProgrammeJumping drills |
| **Includes** | **Ongoing strength training****Double leg/multi-directional jumps****Hopping****Progress CV/Endurance training****Progress agility – can gradually introduce pivoting**[For examples – see Appendices](#_Appendices) |
| **Progress to** | **Prepare for sports specific training** |
| **Aims & Outcome Measures for progression to Phase 4** | * Pain & effusion free continuous running relative to patient goals
* [Hop test battery](#_Hop_Tests) 90% LSI
* [Strength](#_Measuring_Strength_–) 90% LSI (Single leg Sit To Stand / leg press)
* [Single Leg Bridge](#_Measuring_Strength_–_) 90% LSI
 |
| **Measures of Improvement** | Complete:* [Y-Balance](#_Y-Balance_Test)
* [LEFS](#_Lower_Extremity_Functional) 20 weeks
 |

Phase 4

**>6 months approx - Sports specific Training**

**Treatment should be based on individual needs and appropriate clinical decision making regarding the progression of the patient’s post-operative course.**

|  |  |
| --- | --- |
| **Goals** | Introduce sports specific movements in a controlled environment |
| **Includes** | **Progress to advanced agility / sports specific drills****Ongoing strength and CV**For examples – see Appendices |
| **Aims** | [Hop test](#_Hop_Tests) 90-100% LSI[Strength](#_Measuring_Strength_–) 90-100% LSI (Single leg STS / leg press) [Single leg bridge](#_Measuring_Strength_–_) 90-100% LSI[ACL-RSI](#_A_C_L) if indicated**SET GOALS ACHIEVED** |

# Appendices

## Lower Extremity Functional Scale

[**Physiopedia Link**](https://www.physio-pedia.com/Lower_Extremity_Functional_Scale_%28LEFS%29)

***Patient Label***

Date: June 19, 2019

We are interested in knowing whether you are having any difficulty at all with the activities listed below *because of your lower limb problem* for which you are currently seeking attention. Please provide an answer for *each* activity.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Today, *do you* or *would you* have any difficulty at all with:**  | **Extreme difficulty or unable to perform activity** | **Quite a bit of****difficulty** | **Moderate difficulty** | **A little bit of****difficulty** | **No****difficulty** |
| 1. Any of your usual work, housework or school activities.  | 0 | 1 | 2 | 3 | 4 |
| 2. Your usual hobbies, recreational or sporting activities.  | 0 | 1 | 2 | 3 | 4 |
| 3. Getting into or out of the bath.  | 0 | 1 | 2 | 3 | 4 |
| 4. Walking between rooms.  | 0 | 1 | 2 | 3 | 4 |
| 5. Putting on your shoes or socks.  | 0 | 1 | 2 | 3 | 4 |
| 6. Squatting.  | 0 | 1 | 2 | 3 | 4 |
| 7. Lifting an object, like a bag of groceries from the floor.  | 0 | 1 | 2 | 3 | 4 |
| 8. Performing light activities around your home.  | 0 | 1 | 2 | 3 | 4 |
| 9. Performing heavy activities around your home.  | 0 | 1 | 2 | 3 | 4 |
| 10. Getting into or out of a car.  | 0 | 1 | 2 | 3 | 4 |
| 11. Walking 2 blocks.  | 0 | 1 | 2 | 3 | 4 |
| 12. Walking a mile.  | 0 | 1 | 2 | 3 | 4 |
| 13. Going up or down 10 stairs (about1 flight of stairs).  | 0 | 1 | 2 | 3 | 4 |
| 14. Standing for 1 hour.  | 0 | 1 | 2 | 3 | 4 |
| 15. Sitting for 1 hour.  | 0 | 1 | 2 | 3 | 4 |
| 16. Running on even ground.  | 0 | 1 | 2 | 3 | 4 |
| 17. Running on uneven ground.  | 0 | 1 | 2 | 3 | 4 |
| 18. Making sharp turns while running fast.  | 0 | 1 | 2 | 3 | 4 |
| 19. Hopping.  | 0 | 1 | 2 | 3 | 4 |
| 20. Rolling over in bed.  | 0 | 1 | 2 | 3 | 4 |
| **Column Totals:**  |  |  |  |  |  |

Source: Binkley JM, Stratford PW, Lott SA, Riddle DL. The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application. North American Orthopaedic Rehabilitation Research Network. *Phys Ther*. 1999 Apr;79(4):371-83.

The Lower Extremity Functional Scale (LEFS) is a questionnaire containing 20 questions about a person’s ability to perform everyday tasks. The LEFS can be used by clinicians as a measure of patients' initial function, ongoing progress and outcome, as well as to set functional goals.

The LEFS can be used to evaluate the functional impairment of a patient with a disorder of one or both lower extremities. It can be used to monitor the patient over time and to evaluate the effectiveness of an intervention.

**Scoring instructions**

The columns on the scale are summed to get a total score. The maximum score is 80.

**Interpretation of scores**

* The lower the score the greater the disability.

## ACLRSI - Anterior Cruciate Ligament – Return to Sport after Injury

**Instructions:**

Rate the following questions on a scale of 0-10, with 0 being extremely and 10 not at all.

|  |  |  |
| --- | --- | --- |
| **1. Are you nervous about playing your sport?**  |  |  |
|  Not at all 0 1 2 3 4 5 6 7 8 9                       | 10   | Extremely  |
| **2. Do you find it frustrating to have to consider your knee with respect to your sport?**  |  |  |
|  Not at all 0 1 2 3 4 5 6 7                   | 8   | 9   | 10   | Extremely  |
| **3. Do you feel relaxed about playing your sport?**  |  |  |  |  |
|  Not at all 0 1 2 3 4 5 6 7                   | 8   | 9   | 10   | Extremely  |
| **4. Are you fearful of re-injuring your knee by playing your sport?**  |  |  |  |  |
|  Not at all 0 1 2 3 4 5 6 7                   | 8   | 9   | 10   | Extremely  |
| **5. Are you afraid of accidentally injuring your knee by playing sport?**  |  |  |  |  |
|  Not at all 0 1 2 3 4 5 6 7                   | 8   | 9   | 10   | Extremely  |
| **6. Are you confident that your knee will not give way by playing sport?**  |  |  |  |  |
|  Not at all 0 1 2 3 4 5 6 7 8 9                      | 10   | Extremely  |
| **7. Are you confident that you could play your sport without concern for your knee?**  |  |  |

Not at all 0 1 2 3 4 5 6 7 8 9 10 Extremely























1

|  |  |
| --- | --- |
| **8. Are you confident about your knee holding up under pressure?**  |  |
|  Not at all 0 1 2 3 4 5 6 7 8 9 10                         | Extremely  |
| **9. Are you confident that you can perform at your previous level of sport participation?**  |  |
|  Not at all 0 1 2 3 4 5 6 7 8 9 10                         | Extremely  |
| **10. Are you confident about your ability to perform well at your sport?**  |  |
|  Not at all 0 1 2 3 4 5 6 7 8 9 10                         | Extremely  |
| **11. Do you think you are likely to re-injure your knee by participating in your sport?**  |  |

Not at all 0 1 2 3 4 5 6 7 8 9 10 Extremely























**12. Do thoughts of having to go through surgery and rehabilitation again prevent you from playing your sport?**

Not at all 0 1 2 3 4 5 6 7 8 9 10 Extremely























**Score ACL-RSI (Total x 100) / 120 = \_\_\_\_ %**

## Hop Tests

Video Link: <https://www.youtube.com/watch?v=OejqiPbxs4g>

**SINGLE HOP (A):**

The test is a single ‘big’ hop covering the maximum possible distance and landing on the same leg. It is performed 3 times on each side with the average distance for each leg obtained. The percentage distance between the 2 sides is then calculated. Aim for 85% of distance covered by non-operated leg.

**TRIPLE HOP (B):**

The triple hop for distance is performed with the patient standing on 1 leg and performing 3 consecutive hops as far as possible.

**CROSSOVER HOP (C):**

The crossover hop for distance is performed with the patient standing on one leg and performing 3 consecutive hops as far as possible while crossing a centre ling with each consecutive hop.



##

## Y-Balance Test

<https://www.scienceforsport.com/y-balance-test/>

Video Link: <https://www.youtube.com/watch?v=kUBpKXAgo2s>



Scoring Chart:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Right | Left | Diff | Initial/sign |
| Anterior |  |  |  |  |
| Postero-medial |  |  |  |  |
| Postero-lateral |  |  |  |  |
| TOTAL |  |  |  |  |

Total Difference should be less than 4cm if planning on return to Sport/Advanced Functional task

**Measuring Strength**

**Leg Press/Sit to Stand**

Test either Leg Press (if machine is available) or single leg sit to stand

Leg Press

Measuring 1RM in post operative patients/rehabilitation may not be appropriate; either 5RM/10RM may be more suitable.

LSI can be calculated using these parameters.

If leg Press is unavailable then a max rep single leg sit to stand can be used, this is demonstrated in the below video:

Mick Hughes <https://www.youtube.com/watch?v=-VQ9DtPRrBU>

**Measuring Strength – Single Leg Bridge**

Patient in Supine bridge position, knees at 90˚. Ask patient to lift one foot from the floor and proceed to bridge 20 repetitions

 or until fatigue or unable to complete a full repetition.

Repeat on opposite leg.

Use the numbers for each leg to calculate LSI.

## Pure Physio <https://youtu.be/A_irxl-8_rQ>

## Calculating LSI/RSI

**Calculation of Limb Symmetry Index (LSI)**

LSI (%) = Injured Limb Score ÷ uninjured limb score x 100

**Calculation of Relative Strength Index (RSI)**

RSI (%) = weight pushed (Kg) ÷ bodyweight (Kg) x100

**Video Links - Exercise Ideas**

**These videos are included to give you some ideas, ensure you have assessed the patient’s readiness to progress/perform the exercise by referring to the guideline.**

**Phase 1**

ACL Reconstruction Rehab- Matthew Boes Video 1&2

<https://youtu.be/7TAslg8p2Vo?list=PLMnHlHoq4yFSjXGYFg6Aw0LqTvgIaYs5f>

Terminal knee extension - <https://www.youtube.com/watch?v=cU1rJjacMFE>

**Phase 2**

ACL Reconstruction Rehab- Matthew Boes

Video 3 <https://www.youtube.com/watch?v=M9thyTdrYxw>

Video 4 <https://www.youtube.com/watch?v=1zv-tPGjXqY>

Hamstring Strength

“Tantrum” Hamstring – Mick Hughes <https://www.youtube.com/watch?v=etp6-G0SJc4>

Arabesque for Hamstring

<https://www.youtube.com/watch?v=ee6szWZTyuM>

Glider hamstring exercise (from Aspetar Hamstring protocol) <https://www.youtube.com/watch?v=UU8pRuYL4b4&index=28&list=PLkeoBd4A272PvOD-KSdr_uELkF6kvvL8G>

(RDL) Single leg Romanian dead lift <https://www.youtube.com/watch?v=WAMBVWe65Qo>

Bridging progression ideas:

Bridge Progression - Christopher Johnson <https://www.youtube.com/watch?v=WpQFJBfWIlo>

Single leg bridge (from Aspetar Hamstring protocol) <https://www.youtube.com/watch?v=ada1X4jipe0&index=29&list=PLkeoBd4A272PvOD-KSdr_uELkF6kvvL8G>

Single Leg hamstring bridge - chair <https://www.youtube.com/watch?v=vfFUqJ3sn88>

Bridge on stability Ball with progressions <https://www.youtube.com/watch?v=czf-1snzG2c>

Single Leg gymball Hamstring Bridge <https://www.youtube.com/watch?v=jS2Lf59urv4>

## RETURN TO RUNNING – Mick Hughes <https://www.youtube.com/watch?v=MnBVw3in8B4>

## Examples of early drills <https://www.youtube.com/watch?v=HvH5WZk0f90>

Landing - Mick Hughes <https://www.youtube.com/watch?v=XI_VQQaPblo>

## Early Plyometrics - Fusion Sport <https://www.youtube.com/watch?v=yI2PPMsvPNg&t=128s>

Ladder drills with progression – Redefining Strength (phase 2/3) <https://www.youtube.com/watch?v=67XP-AekUoA>

**Phase 3**

Mick Hughes Plyometric sequence 1 <https://www.youtube.com/watch?v=ek1uudCX97U>

Plyometric sequence 2 <https://www.youtube.com/watch?v=u-bx1X6tjus>

Cone drills - Redefining Strength <https://www.youtube.com/watch?v=a2sCgSIOFIg>

## Mini Hurdle Drills – Nick Parasiliti <https://www.youtube.com/watch?v=aQwKvO4yCG4>

King Sports <https://www.youtube.com/watch?v=aQwKvO4yCG4>

Reaction drills cones <https://www.youtube.com/watch?v=OejqiPbxs4g>

Nordic hamstrings - (from Aspetar Hamstring Protocol) <https://www.youtube.com/watch?v=ygdv2gZiT6Y&index=32&list=PLkeoBd4A272PvOD-KSdr_uELkF6kvvL8G>

ACL Reconstruction Rehab- Matthew Boes Video 6

<https://www.youtube.com/watch?v=ZWu9MSC6WMw&index=7&list=PL8SDFq4IlgdWCRrMIpYfNy7D0HLEQoVZ6&t=0s>

**Phase 4 – sports specific**

Football Decision making drill Football (from 40sec) <https://www.youtube.com/watch?v=kbZ4YAp0ucs>

Racquet / footwork drills <https://www.youtube.com/watch?v=-UubC-SIQz4>

Rugby speed / agility /stepping drills <https://www.youtube.com/watch?v=2jJrZd3ZcYs>

Jump exercises for basketball <https://www.youtube.com/watch?v=bjzgqbQp_k0>

## RETURN TO RUNNING (guideline)

## RETURN TO RUNNING CRITERIA – Mick Hughes <https://www.youtube.com/watch?v=MnBVw3in8B4>

**SIGNS OF TOO RAPID PROGRESSION:**

* **Increased pain**
* **Increased swelling**
* **Decreased range of movement**

|  |  |  |
| --- | --- | --- |
| **Walk** | **Run** | **Reps** |
| 4min 30secs | 30secs | 6 |
| 4min | 1min | 6 |
| 3min 30secs | 1min 30secs | 6 |
| 3min | 2min | 6 |
| 2min 30secs | 2min 30secs | 6 |
| 2min | 3min | 6 |
| 1min 30secs | 3min 30secs | 6 |
| 1min | 4min | 6 |
| 30secs | 4min 30secs | 6 |
| 0 | 30 minutes | 1 |

**↓**

**PROGRESS SPEED/DISTANCE AS ABLE**

**↓**

 **‘SINGLE HOP TEST FOR DISTANCE TEST’**

**↓**

**‘START-STOP DRILLS’ – NO PIVOTING/TWISTING**

**LADDER DRILLS, DOUBLE LEG JUMPS, TUCK JUMPS, HOPPING ON THE SPOT, STRAIGHT LINE HOPPING**

##

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Post Op | Week 2 | Week 6 | Week 12 | Week 20  | Discharge |
|  | \_\_/\_\_/\_\_\_\_Sign:  | \_\_/\_\_/\_\_\_\_Sign: | \_\_/\_\_/\_\_\_\_Sign: | \_\_/\_\_/\_\_\_\_Sign: | \_\_/\_\_/\_\_\_\_Sign: | \_\_/\_\_/\_\_\_\_Sign: |
|  | Injured | Uninjured | Injured | Uninjured | Injured | Uninjured | Injured | Uninjured | Injured | Uninjured | Injured | Uninjured |
| VAS | /10 |  | /10 |  | /10 |  | /10 |  | /10 |  | /10 |  |
| LEFS |  |  |  |  |  |  |  |  |  |  |  |  |
| Leg Press |  |  | LSI: |  | LSI: |  | LSI: |  | LSI: |  |
| Hop |  |  |  |  |  |  | LSI: |  | LSI: |  | LSI: |  |
| Triple Hop |  |  |  | LSI: |  | LSI: |  | LSI: |  |
| Crossover Hop |  |  |  | LSI: |  | LSI: |  | LSI: |  |
| Single leg bridge |  |  |  | LSI: |  | LSI: |  | LSI: |  |
| Y-Balance |  |  |  | Diff |  | Diff |  | Diff |  |
| ACL-RSI |  |  |  |  |  |  |  |  |  |  |

## References

Patient Label

1. Atkinson, H. D., Laver, J. M., & Sharp, E. (2010). (Vi) Physiotherapy and rehabilitation following soft-tissue surgery of the knee. *Orthopaedics and Trauma, 24*(2), 129-138.

2. Dingenen, B., & Gokeler, A. (2017). Optimization of the return-to-sport paradigm after anterior cruciate ligament reconstruction: A critical step back to move forward. *Sports Medicine,* 1-14.

3. Escamilla, R. F., MacLeod, T. D., Wilk, K. E., Paulos, L., & Andrews, J. R. (2012). Cruciate ligament loading during common knee rehabilitation exercises. *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine, 226*(9), 670-680.

4. Glen Sather Sports Medicine Clinic. (2017). ***GSSMC anterior cruciate ligament (ACL) protocol****.*, 2018, from <https://cloudfront.ualberta.ca/-/media/glensatherclinic/forms/acl-gssmc-protocol-20170329.pdf>

5. Heijne, A., & Werner, S. (2007). *Knee Surgery, Sports Traumatology, Arthroscopy, 15*(4), 402-414.

Herrington, L., Myer, G., & Horsley, I. (2013). Task based rehabilitation protocol for elite athletes following anterior cruciate ligament reconstruction: A clinical commentary. *Physical Therapy in Sport, 14*(4), 188-198.

6. Myer, G. D., Paterno, M. V., Ford, K. R., Quatman, C. E., & Hewett, T. E. (2006). Rehabilitation after anterior cruciate ligament reconstruction: Criteria-based progression through the return-to-sport phase. *Journal of Orthopaedic & Sports Physical Therapy, 36*(6), 385-402.

7. Myklebust, G., & Bahr, R. (2005). Return to play guidelines after anterior cruciate ligament surgery. *British Journal of Sports Medicine, 39*(3), 127-131.

8. Ebben, W.P. (2007). Practical guidelines for plyometric intensity. *NSCAs Performance training journal, 6(5)*.

9. Rambaud, A. J. M., Semay, B., Samozino, P., Morin, J. B., Testa, R., Philippot, R., et al. (2017). Criteria for return to sport after anterior cruciate ligament reconstruction with lower reinjury risk (CR'STAL study): Protocol for a prospective observational study in France. *BMJ Open, 7*(6), e015087-2016-015087.

10. Risberg, M. A., & Holm, I. (2009). The long-term effect of 2 postoperative rehabilitation programs after anterior cruciate ligament reconstruction: A randomized controlled clinical trial with 2 years of follow-up. *The American Journal of Sports Medicine, 37*(10), 1958-1966.

11. Shaw, T., Williams, M. T., & Chipchase, L. S. (2005). Do early quadriceps exercises affect the outcome of ACL reconstruction? A randomised controlled trial. *Australian Journal of Physiotherapy, 51*(1), 9-17.

12. Trees, A. H., Howe, T. E., Grant, M., & Gray, H. G. (2007). Exercise for treating anterior cruciate ligament injuries in combination with collateral ligament and meniscal damage of the knee in adults. *Cochrane Database Syst Rev, 3*

13. White, K., Di Stasi, S. L., Smith, A. H., & Snyder-Mackler, L. (2013). Anterior cruciate ligament-specialized post-operative return-to-sports (ACL-SPORTS) training: A randomized control trial. *BMC Musculoskeletal Disorders, 14*(1), 108.

14. Wilk, K. E., & Arrigo, C. A. (2017). Rehabilitation principles of the anterior cruciate ligament reconstructed knee. *Clinics in Sports Medicine, 36*(1), 189-232.

15. Wright, R. W., Haas, A. K., Anderson, J., Calabrese, G., Cavanaugh, J., Hewett, T. E., et al. (2015). Anterior cruciate ligament reconstruction rehabilitation: MOON guidelines. *Sports Health, 7*(3), 239-243.