



# ACL REHABILITATION PROTOCOL

Updated June 2018

---

Associate Professor Leo Pinczewski MBBS, FRACS

Associate Professor Justin Roe MBBS, FRACS

Dr Matthew Lyons MBBS, FRACS

Dr Benjamin Gooden MBBS, FRACS

Dr Lucy Salmon BAppSc(Phty), PhD

Emma Heath MPhty, BAppSc



NORTH SYDNEY ORTHOPAEDIC  
& SPORTS MEDICINE CENTRE

North Sydney Orthopaedic Research Group

Suite 2, The Mater Clinic, 3 Gillies St Wollstonecraft NSW 2065

email: [lsalmon@nsosmc.com.au](mailto:lsalmon@nsosmc.com.au)

Tel: +61 2 9409 0500



## Overview

Recovery after ACL reconstruction requires a thorough rehabilitation programme to ensure both optimal function of the knee and prevention of further injury. The long term goal should be both a return to sport, but also correction of preinjury deficits, potentially making the patient a better athlete than before their ACL injury.

The rehabilitation program must consider multiple factors. Following implantation the human body will use the ACL graft as a scaffold to remodel into a ligament in a biological process that takes in excess of 12 months[1]. During this time the ACL graft has significantly less strength than a normal ligament, so is vulnerable to injury with low force. Accompanying the “ligamentization” process are significant other deficiencies such as muscular weakness, impaired proprioception, altered muscle reaction times, impaired muscular function, and impaired neuromuscular control. The progress through rehabilitation must respect both the neuromuscular deficiencies and the biological process of healing tissue.

**We recognize that GOAL based rehabilitation  
is far superior to TIME based rehabilitation....  
but biological healing must also be respected**

## Stages of Rehabilitation

The phases of recovery after ACL reconstruction can be considered to broadly follow 6 stages. The goals of each stage should be achieved before progression to the next stage.

1. Prehabilitation before surgery
2. Acute Recovery
3. Muscular Control and Coordination
4. Proprioception and Agility
5. Sports Specific Skills
6. Return to Play

## Prehabilitation

There is considerable evidence to demonstrate that rehabilitation before surgery is beneficial to recovery. ACL reconstruction should be performed once the knee has recovered from the acute injury, has a full range of motion, and is pain free in order to optimise the outcome and avoid complications such as knee stiffness. For many this may only take a few weeks, but for some it can be several months. A recent study demonstrated that a 5 week program of preoperative rehabilitation supervised by a physiotherapist improved knee related function and strength following surgery [2] and rate of return to sports at 2 years[3]. Quadriceps strength deficits of more than 20% before surgery are associated with persistent strength differences 2 years after surgery[4]. **A thorough prehabilitation, restoring the knee to optimal function before surgery is beneficial on every level, and will lead to a faster recovery after surgery.**

### Goals of prehabilitation

1. Regain pain free full range movement
2. Optimise muscular strength and function
3. Familiarise with basic post operative exercises
4. Prevention of episodes of knee instability which may cause further damage

### Treatment guidelines

- Initial goal is to resolve knee impairments related to swelling and ROM deficits
- Regular icing to reduce effusion and pain
- Commence basic VMO strengthening with use of biofeedback and range exercises
- Once sufficient range of movement is achieved stationary exercise bike is encouraged++
- Once swelling and ROM is achieved then progress to restoration of muscle strength with intensive muscle strength training (increasing resistance, complexity and reps), and controlled plyometric exercises (eg balance board, progressing to squats on board)
- Running and jumping sports should be avoided due to risk of knee instability.



## Acute Recovery - Phase 1

In the acute period after ACL reconstruction the knee needs some time to recover from the acute trauma of surgery. Basic gentle exercises, regular application of ice and elevation of the knee are beneficial. The grafted ACL sees minimal force with normal daily activities and immediate weight bearing will help facilitate return of functional strength. Most will leave hospital using crutches, which should be used to achieve a normal gait pattern during the first week after surgery. Crutches may also be used to avoid fatigue and alert others to disability. Crutches can be discontinued once walking comfortably.

### Goals of Phase 1

1. Achieve primary wound healing
2. Minimise swelling
3. Restore range of motion
4. Establish muscular control
5. Progress off crutches



### Treatment Guidelines

- Minimise swelling & pain with ice, elevation, co-contractions and pressure pump.
- Return of co-ordinated muscle function encouraged with biofeedback devices.
- No use of tubigrip around the knee joint region as may increase risk of blood clots.
- Full weight bearing as pain allows.
- Active range of motion exercises as swelling permits
- Patella mobilisations to maintain patella mobility.
- Gait retraining with full extension at heel strike.
- Active quadriceps strengthening is begun as a static co-contraction with hamstrings emphasising VMO control at various angles of knee flexion and progressed into weight bearing positions.
- Gentle hamstring stretching to minimise adhesions.
- Active hamstring strengthening begins with static weight bearing co-contractions and progresses to active free hamstring contractions by day 14.
- Resisted hamstring strengthening should be avoided for at least 6-8 weeks.

## Strength and Coordination - Phase 2

During phase 2 exercises can progress from simple muscular control to body weight exercises and then to a gym based program. Any resisted 'open chain' quadriceps exercises should be avoided as they can apply a strain to the ACL graft (eg leg extension machine and a freestyle swimming kick).

**Intermittent episodes of increased swelling may occur, and if so exercises and loads may need to be adjusted accordingly.**

As the ACL graft progressively remodels into a ligament, its strength and load to failure decrease such that it reaches a low of around 30% of a normal ACL around 3 months, before it then progressively increases in strength over the subsequent 9 months. Caution should be emphasised during this vulnerable phase of healing. Activities that involve speed or height should be avoided. Walking is encouraged. Swimming with a kick may be commenced after 8 weeks. Before that time swimming with a pool buoy between the legs is possible. Road bike commenced after 6 weeks if stationary bike has been mastered, but toe cleats should be avoided.

### Goals of Phase 2

1. Develop good muscle control
2. Recover basic balance & proprioceptive skills.
3. Reduce any recurrent knee swelling.
4. Continue to improve total leg strength.
5. Improve endurance capacity of muscles.



### Treatment Guidelines

- Commence use of an exercise bike as soon as tolerated
- Aim for a full range of motion using active and passive techniques.
- Progress muscle control by increasing the repetitions, length of contraction and more dynamic positions, e.g. Use of a Reformer, squats, lunges, stepping, resistance bands.
- Progressing of strength work, e.g. half squats with resistance, leg press & curls, wall squats, step work on progressively higher steps, stepper & rowing machine, single leg squats.
- In the presence of swelling continue with ice and/or decrease loads
- Hamstring strengthening progresses with the increased complexity and repetitions of co-contractions eg bridging. From week 6 eccentric hamstring strengthening is progressed and hamstring curl equipment can be introduced.
- Introduce balance exercises, progress from single leg to wobble board
- Consider beyond the knee joint for any deficits, e.g. gluteal control, tight hamstrings, ITB, gastrocs and soleus, etc.
- Core strength is an important component of balance.
- Emphasize gluteal maximus strengthening which is strong hip extender and external rotator while in a flexed hip posture. Deficits in gluteal strength are a significant predictors of recurrent ACL injuries[5]



## Proprioception and Agility - Phase 3

Once sufficient strength is achieved during Phase 2, while this needs to be continued, the emphasis can then be directed to improving balance, agility and proprioceptive deficits. This is an imperative stage of recovery and adherence has the potential to dramatically reduce the risks of further injury. Many will have pre-existing poor techniques on jumping and landing that should be corrected. Repeat ACL injuries have been shown to be strongly associated with poor hip rotation control, increased knee valgus, knee flexor and postural control deficits[5]. For jumpers practice good landing technique = knee flexion, no valgus rotation and toe land. Neuromuscular training has been shown to be superior to strength training alone in terms of subjective function and hamstring strength after ACL reconstruction[6, 7].



### Goals of Phase 3

1. Resumption of running and jumping skills with good technique
2. Recovery of balance and agility
3. Progression of muscular strength and power
4. Develop confidence
5. Prepare for sports specific skills

### Treatment Guidelines

- Running may be progressively commenced once there is good muscular strength and no knee effusion (this is usually around 3 months).
- Proprioceptive work should include hopping and jumping activities and emphasise a good landing technique.
- Progressive single limb landing activities can be assessment and training tool eg anterior single leg hops, lateral single leg hops.
- Hops and jumps can progress by increasing height and complexity – add ball catch
- Agility work may commenced after basic running and progressed through activities such as shuttle runs, bounding runs, sideways running, skipping, etc.
- Emphasis on good form through change of direction drills (eg plant and cut), and hopping, jumping drills. Refer to “key principles” on [knee.netball.com.au](http://knee.netball.com.au) website
- Feedback on good techniques using slow motion video from mobile device can be very beneficial for education
- Pool work can include using flippers.
- Commence basic components of PEP programme and progress as able (see Stage 4 for detail)
- While the exercises through this stage become more dynamic, strength training should also continue with further development of strength and power.



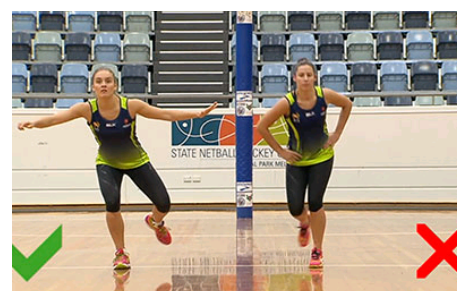


## Sports Specific Skills - Phase 4

Resumption of sports specific drills can be commenced once the goals of Phase 3 have been successfully achieved. It is however imperative to continue building strength with exercise selection targeting speed of force generation/power to better replicate sporting demands. The athlete should be able to confidently run, perform single and double leg jumping and hopping drills, as well as change of direction activities. Consideration of the biology of the healing ACL graft remains important, and as such **sports specific skills and drills involving significant speed or height should rarely be considered before 6 months**. Several sports specific injury prevention programs have been developed which incorporate excellent drills to perfect. Repeated practice of good jumping, landing and change of direction drills will reinforce muscle memory and good movement patterns. This can significantly reduce the risk of further injury. Netball Australia's [Knee Program](#) has excellent videos demonstrating the key principles.

### Goals of Phase 4

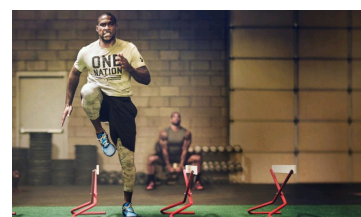
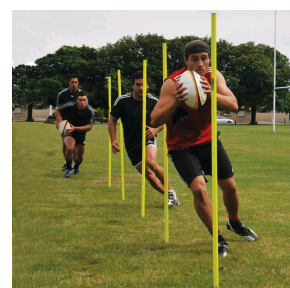
1. Perfect jumping, landing and change of direction techniques
2. Regain confidence with sports specific drills and skills
3. Prepare for return to a team training environment



### Treatment Guidelines

Several sports specific injury prevention programs have been developed which incorporate excellent drills to perfect. It is recommended that these programs be performed >once per week and continue for at least 6 weeks to maximise effectiveness. Each program should include plyometric and agility drills, single and double leg hops/jumps and change of direction drills. Some sports specific drills should be individualised according to the sports e.g.

- Netball - progress through skill components using Netball Australia's "Knee Program" <https://knee.netball.com.au/>
- Soccer - progress through skill components using the [FIFA 11+](#) or [PEP program](#)
- AFL – progress through [FootyFirst components](#)
- Touch - Agilities such as sidestepping through cones or poles, consider FIFA 11+ program
- Rugby codes - progress through burpees, commando rolls, drop and roll drills, tacklebags and then contact drills and tackles. Agilities such as sidestepping through cones or poles, side hurdles, plant and cut and quick feet drills. Refer NSW rugby ["Preparation to Perform" program](#)
- Tennis - lateral step lunges, forward and backwards running drills
- Skiing - slide board, hill climbers, lateral box stepping and jumping, zigzag hopping
- Volleyball or Basketball - vertical jumps progressing to jumps with overhead ball catching, consider using netball drills (see below).



Once the athlete has mastered the sports specific skill components a return to team training may be considered (rarely before 10 months).

# Sample Sports Specific Prevention Program: FIFA 11+

## FIFA 11+

### PART 1 RUNNING EXERCISES · 8 MINUTES



#### 1 RUNNING STRAIGHT AHEAD

The course is made up of 6 to 10 pairs of parallel cones, approx. 5-6 metres apart. Two players start at the same time from the first pair of cones. **Jog together** all the way to the last pair of cones. On the way back, you can increase your speed progressively as you warm up. **2 sets**



#### 4 RUNNING CIRCLING PARTNER

Run forwards as a pair to the first set of cones. Shuffle sideways by 90 degrees to meet in the middle. **Shuffle an entire circle around one other** and then return back to the cones. Repeat for each pair of cones. Remember to stay on your toes and keep your centre of gravity low by bending your hips and knees. **2 sets.**



#### 2 RUNNING HIP OUT

Walk or jog easily, stopping at each pair of cones to lift your knee and **rotate your hip outwards**. Alternate between left and right legs at successive cones. **2 sets.**



#### 5 RUNNING SHOULDER CONTACT

Run forwards in pairs to the first pair of cones. Shuffle sideways by 90 degrees to meet in the middle then **jump sideways towards each other to make shoulder-to-shoulder contact**. Note: Make sure you land on both feet with your hips and knees bent. Do not let your knees buckle inwards. Make it a full jump and synchronize your timing with your teammate as you jump and land. **2 sets**



#### 3 RUNNING HIP IN

Walk or jog easily, stopping at each pair of cones to lift your knee and **rotate your hip inwards**. Alternate between left and right legs at successive cones. **2 sets.**



#### 6 RUNNING QUICK FORWARDS & BACKWARDS

As a pair, run quickly to the second set of cones then run **backwards quickly to the first pair of cones keeping your hips and knees slightly bent**. Keep repeating the drill, running two cones forwards and one cone backwards. Remember to take small, quick steps. **2 sets.**

### PART 2 STRENGTH · PLYOMETRICS · BALANCE · 10 MINUTES



#### LEVEL 1 7 THE BENCH STATIC

**Starting position:** Lie on your front, supporting yourself on your forearms and feet. Your elbows should be directly under your shoulders.  
**Exercise:** Lift your body up, supported on your forearms, pull your stomach in, and hold the position for 20-30 sec. Your body should be in a straight line. Try not to sway or arch your back. **3 sets.**



#### 8 SIDEWAYS BENCH STATIC

**Starting position:** Lie on your side with the knee of your bottommost leg bent to 90 degrees. Support your upper body by resting on your forearm and knee. The elbow of your supporting arm should be directly under your shoulder.  
**Exercise:** Lift your uppermost leg and hips until your shoulder, hip and knee are in a straight line. Hold the position for 20-30 sec. Take a short break, change sides and repeat. **3 sets on each side.**



#### 9 HAMSTRINGS BEGINNER

**Starting position:** Kneel on a soft surface. Ask your partner to hold your ankles down firmly.  
**Exercise:** Your body should be completely straight from the shoulder to the knee throughout the exercise. Lean forward as far as you can, controlling the movement with your hamstrings and your gluteal muscles. When you can no longer hold the position, gently take your weight on your hands, falling into a push-up position. Complete a minimum of 3-5 repetitions and/or 60 sec. **1 set.**



#### 10 SINGLE-LEG STANCE HOLD THE BALL

**Starting position:** Stand on one leg.  
**Exercise:** Balance on one leg whilst holding the ball with both hands. Keep your body weight on the ball of your foot. Remember: try not to let your knees buckle inwards. Hold for 30 sec. Change leg and repeat. The exercise can be made more difficult by passing the ball around your waist and/or under your other knee. **2 sets.**



#### 11 SQUATS WITH TOE RAISE

**Starting position:** Stand with your feet hip-width apart. Place your hands on your hips.  
**Exercise:** Imagine that you are about to sit down on a chair. Perform squats by bending your hips and knees to 90 degrees. Do not let your knees buckle inwards. Descend slowly then straighten up more quickly. When your legs are completely straight, stand up on your toes then slowly lower down again. Repeat the exercise for 30 sec. **2 sets.**



#### 12 JUMPING VERTICAL JUMPS

**Starting position:** Stand with your feet hip-width apart. Place your hands on your hips if you like.  
**Exercise:** Imagine that you are about to sit down on a chair. Bend your legs slowly until your knees are flexed to approx 90 degrees, and hold for 2 sec. Do not let your knees buckle inwards. From the squat position, jump up as high as you can. Land softly on the balls of your feet with your hips and knees slightly bent. Repeat the exercise for 30 sec. **2 sets.**



#### LEVEL 2 7 THE BENCH ALTERNATE LEGS

**Starting position:** Lie on your front, supporting yourself on your forearms and feet. Your elbows should be directly under your shoulders.  
**Exercise:** Lift your body up, supported on your forearms, and pull your stomach in. Lift each leg in turn, holding for a count of 2 sec. Continue for 60-90 sec. Your body should be in a straight line. Try not to sway or arch your back. **3 sets.**



#### 8 SIDEWAYS BENCH RAISE & LOWER HIP

**Starting position:** Lie on your side with both legs straight. Lean on your forearm and the side of your foot so that your body is in a straight line from shoulder to foot. The elbow of your supporting arm should be directly beneath your shoulder.  
**Exercise:** Lower your hip to the ground and raise it back up again. Repeat for 20-30 sec. Take a short break, change sides and repeat. **3 sets on each side.**



#### 9 HAMSTRINGS INTERMEDIATE

**Starting position:** Kneel on a soft surface. Ask your partner to hold your ankles down firmly.  
**Exercise:** Your body should be completely straight from the shoulder to the knee throughout the exercise. Lean forward as far as you can, controlling the movement with your hamstrings and your gluteal muscles. When you can no longer hold the position, gently take your weight on your hands, falling into a push-up position. Complete a minimum of 7-10 repetitions and/or 60 sec. **1 set.**



#### 10 SINGLE-LEG STANCE THROWING BALL WITH PARTNER

**Starting position:** Stand 2-3 m apart from your partner, with each of you standing on one leg.  
**Exercise:** Keeping your balance, and with your stomach held in, throw the ball to one another. Keep your weight on the ball of your foot. Remember: keep your knees just slightly flexed and try not to let them buckle inwards. Keep going for 30 sec. Change legs and repeat. **2 sets.**



#### 11 SQUATS WALKING LUNGES

**Starting position:** Stand with your feet hip-width apart. Place your hands on your hips if you like.  
**Exercise:** Lunge forward slowly at an even pace. As you lunge, bend your leading leg until your hip and knee are flexed to 90 degrees. Do not let your knee buckle inwards. Try to keep your upper body and hips steady. Lunge your way across the pitch (approx. 10 times on each leg) and then jog back. **2 sets.**



#### 12 JUMPING LATERAL JUMPS

**Starting position:** Stand on one leg with your upper body bent slightly forwards from the waist, with knees and hips slightly bent.  
**Exercise:** Jump approx. 1 m sideways from the supporting leg on to the free leg. Land gently on the ball of your foot. Bend your hips and knees slightly as you land and do not let your knee buckle inwards. Maintain your balance with each jump. Repeat the exercise for 30 sec. **2 sets.**



#### LEVEL 3 7 THE BENCH ONE LEG LIFT AND HOLD

**Starting position:** Lie on your front, supporting yourself on your forearms and feet. Your elbows should be directly under your shoulders.  
**Exercise:** Lift one leg about 10-15 centimetres off the ground, and hold the position for 20-30 sec. Your body should be straight. Do not let your opposite hip dip down and do not sway or arch your lower back. Take a short break, change legs and repeat. **3 sets.**



#### 8 SIDEWAYS BENCH WITH LEG LIFT

**Starting position:** Lie on your side with both legs straight. Lean on your forearm and the side of your foot so that your body is in a straight line from shoulder to foot. The elbow of your supporting arm should be directly beneath your shoulder.  
**Exercise:** Lift your uppermost leg up and slowly lower it down again. Repeat for 20-30 sec. Take a short break, change sides and repeat. **3 sets on each side.**



#### 9 HAMSTRINGS ADVANCED

**Starting position:** Kneel on a soft surface. Ask your partner to hold your ankles down firmly.  
**Exercise:** Your body should be completely straight from the shoulder to the knee throughout the exercise. Lean forward as far as you can, controlling the movement with your hamstrings and your gluteal muscles. When you can no longer hold the position, gently take your weight on your hands, falling into a push-up position. Complete a minimum of 12-15 repetitions and/or 60 sec. **1 set.**



#### 10 SINGLE-LEG STANCE TEST YOUR PARTNER

**Starting position:** Stand on one leg opposite your partner and at arm's length apart.  
**Exercise:** Whilst you both try to keep your balance, each of you in turn tries to push the other off balance in different directions. Try to keep your weight on the ball of your foot and prevent your knee from buckling inwards. Continue for 30 sec. Change legs. **2 sets.**



#### 11 SQUATS ONE-LEG SQUATS

**Starting position:** Stand on one leg, loosely holding onto your partner.  
**Exercise:** Slowly bend your knee as far as you can manage. Concentrate on preventing the knee from buckling inwards. Bend your knee slowly then straighten it slightly more quickly, keeping your hips and upper body in line. Repeat the exercise 10 times on each leg. **2 sets.**



#### 12 JUMPING BOX JUMPS

**Starting position:** Stand with your feet hip-width apart. Imagine that there is a cross marked on the ground and you are standing in the middle of it.  
**Exercise:** Alternate between jumping forwards and backwards, from side to side, and diagonally across the cross, jump as quickly and explosively as possible. Your knees and hips should be slightly bent. Land softly on the balls of your feet. Do not let your knee buckle inwards. Repeat the exercise for 30 sec. **2 sets.**

### PART 3 RUNNING EXERCISES · 2 MINUTES



#### 13 RUNNING ACROSS THE PITCH

Run across the pitch, from one side to the other, at 75-80% maximum pace. **2 sets.**



#### 14 RUNNING BOUNDING

Run with high bounding steps with a high knee lift, landing gently on the ball of your foot. Use an exaggerated arm swing for each step (opposite arm and leg). Try not to let your leading leg cross the midline of your body or let your knees buckle inwards. Repeat the exercise until you reach the other side of the pitch, then jog back to recover. **2 sets.**



#### 15 RUNNING PLANT & CUT

Jog 4-5 steps, then plant on the outside leg and cut to change direction. Accelerate and sprint 5-7 steps at high speed (80-90% maximum pace) before you decelerate and do a new plant & cut. Do not let your knee buckle inwards. Repeat the exercise until you reach the other side, then jog back. **2 sets.**



## Return to Competitive Team Ball Sports - Phase 5

Over recent years there is increasing evidence that return to competitive team ball sports within 12 months of ACL reconstruction is associated with significant risk of repeat ACL injury.

- From a biological perspective, normal ACL graft strength and stiffness occurs after 8 months, and the remodelling continues beyond 12 months.
- The rate of ACL reinjury has been shown to decrease by 51% for each month a return to sport is delayed until 9 months after surgery (Grindem et al BJSM 2016),
- The rate of another ACL injury after 12 months is 1% per knee per year (equal graft and opposite ACL) (Salmon Arthroscopy, 2005, Bourke AJSM 2012).
- Athletes who successfully pass a specific return to sport criteria have a 4x lower risk of injury (Grindem BJSM 2016 & Kyritsis BJSM 2016).

Our recommended criteria for assessing return to sport is detailed on the following page.



At NSOSMC dynamic testing using specialised accelerometry and inertial sensors to quantify performance on Balance, Agility, Strength and Speed (BASS) tests can provide feedback to an athlete eager to return to sport.

### Goals of Phase 5

1. Achieve >90% on Patient Reported Outcome Score (eg IKDC Subjective Score)
2. >90% quads strength & >90% hop symmetry
3. Completed on field sports specific rehabilitation & return to team training
4. Athlete has confidence and is comfortable to return to sports
5. Athlete understands the importance of continued injury prevention program while active in team ball sports



### Treatment Guidelines

For the vast majority of athletes we advocate delaying a return to any competitive team ball sports until after 12 months from surgery. This is especially important in those with risk factors such as young age, those with a positive family history and those with a history of multiple ACL injuries. The goals of Phase 5 must be achieved before a return to team ball sports is advocated. Once the athlete is deemed ready to return advice may be needed as to the need for modifications to be able to return to sport, e.g. Football - start back training in short sprigs, or similar shoes with less grip. Will usually return to lower grades initially; Skiing - stay on groomed slopes and avoid moguls and off piste initially. Lower their DIN setting on the bindings. Athletes should be encouraged to play within their individual level of confidence. Repetition of training and skill work, and adherence to prevention programs before play will improve both performance and confidence.

## Checklist for Return to Play

Stable knee to physical examination

IKDC subjective score more than 90/100

ACL-RSI score >60

>90% quads strength relative to opposite limb

>90% hop symmetry relative to opposite limb

(hop for distance, triple hop for distance, crossover hop tests)

Good performance on drop vertical jump (no valgus, adequate knee flexion, symmetrical landing)

Completion of sports specific training program

Successful return to team training

Patient understanding and adherence to an ongoing injury prevention program

Consideration of appropriate footwear (ie low friction)



## ACL-RSI Scale

Score \_\_\_\_/100

Instructions: Please answer the following questions referring to your main sport prior to injury. For each question, tick a box between the two descriptions to indicate how you feel right now relative to the two extremes.

1. Are you confident that you can perform at your previous level of sport participation?

Not at all confident	0	10	20	30	40	50	60	70	80	90	100	Fully confident
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

2. Do you think you are likely to reinjure your knee by participating in your sport?

Extremely likely	0	10	20	30	40	50	60	70	80	90	100	Not likely at all
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

3. Are you nervous about playing your sport?

Extremely nervous	0	10	20	30	40	50	60	70	80	90	100	Not nervous at all
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

4. Are you confident that you could play your sport without concern for your knee?

Not at all confident	0	10	20	30	40	50	60	70	80	90	100	Fully confident
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

5. Do you find it frustrating to have to consider your knee with respect to your sport?

Extremely frustrating	0	10	20	30	40	50	60	70	80	90	100	Not at all frustrating
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

6. Are you fearful of reinjuring your knee by playing your sport?

Extremely fearful	0	10	20	30	40	50	60	70	80	90	100	No fear at all
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Scale reproduced with permission from Webster et al [8]

Sum individual items and divide by 6.

Maximum score = 100, higher score indicates a more positive psychological response.

## IKDC Subjective Evaluation

Score \_\_\_\_/100

1. What is the highest level of activity that you can perform without significant knee pain?

- |  |   |
|--|---|
| <input type="checkbox"/> Very strenuous activities like jumping or pivoting as in basketball or soccer | 5 |
| <input type="checkbox"/> Strenuous activities like heavy physical work, skiing or tennis               | 4 |
| <input type="checkbox"/> Moderate activities like moderate physical work, running or jogging           | 3 |
| <input type="checkbox"/> Light activities like walking, housework or yard work                         | 2 |
| <input type="checkbox"/> Unable to perform any of the above activities due to knee pain                | 1 |

2. During the past 4 weeks, or since your injury, how often have you had pain?

Constant	1	2	3	4	5	6	7	8	9	10	11	Never
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

3. If you have pain, how severe is it?

Worst pain	1	2	3	4	5	6	7	8	9	10	11	No pain
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

4. During the past 4 weeks, or since your injury, how stiff or swollen was your knee?

Not at all (5)    Mildly (4)    Moderately (3)    Very (2)    Extremely (1)

5. What is the highest level of activity you can perform without significant swelling in your knee?

- |  |   |
|--|---|
| <input type="checkbox"/> Very strenuous activities like jumping or pivoting as in basketball or soccer | 5 |
| <input type="checkbox"/> Strenuous activities like heavy physical work, skiing or tennis               | 4 |
| <input type="checkbox"/> Moderate activities like moderate physical work, running or jogging           | 3 |
| <input type="checkbox"/> Light activities like walking, housework or yard work                         | 2 |
| <input type="checkbox"/> Unable to perform any of the above activities due to knee pain                | 1 |

6. During the past 4 weeks, or since your injury, did your knee lock or catch?    ☐ Yes (1)    ☐ No (2)

7. What is the highest level of activity you can perform without significant giving way in your knee?

- |  |   |
|--|---|
| <input type="checkbox"/> Very strenuous activities like jumping or pivoting as in basketball or soccer | 5 |
| <input type="checkbox"/> Strenuous activities like heavy physical work, skiing or tennis               | 4 |
| <input type="checkbox"/> Moderate activities like moderate physical work, running or jogging           | 3 |
| <input type="checkbox"/> Light activities like walking, housework or yard work                         | 2 |
| <input type="checkbox"/> Unable to perform any of the above activities due to knee pain                | 1 |

8. What is the highest level of activity you can participate in on a regular basis?

- |  |   |
|--|---|
| <input type="checkbox"/> Very strenuous activities like jumping or pivoting as in basketball or soccer | 5 |
| <input type="checkbox"/> Strenuous activities like heavy physical work, skiing or tennis               | 4 |
| <input type="checkbox"/> Moderate activities like moderate physical work, running or jogging           | 3 |
| <input type="checkbox"/> Light activities like walking, housework or yard work                         | 2 |
| <input type="checkbox"/> Unable to perform any of the above activities due to knee pain                | 1 |

9. How does your knee affect your ability to:

	Not difficult (5)	Minimally (4)	Moderately (3)	Extremely (2)	Unable (1)
Go up stairs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Go down stairs	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Kneel on the front of your knee	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Squat	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sit with your knee bent	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rise from a chair	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Run straight ahead	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Jump and land on your leg	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Stop and start quickly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

10. How would you rate the current function of your knee on a scale of 0 to 11 with 11 being normal, excellent function and 0 being the inability to perform any of your usual daily activities which may include sports?

Cannot perform daily activities	1	2	3	4	5	6	7	8	9	10	11	No limitation in activities
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

## References and Recommended Reading

1. Claes S, Verdonk P, Forsyth R, Bellemans J. The “Ligamentization” Process in Anterior Cruciate Ligament Reconstruction: What Happens to the Human Graft? A Systematic Review of the Literature. *Am J Sports Med*, 2011
2. Alshewaiher S, Yeowell G, Fatoye F. The effectiveness of pre-operative exercise physiotherapy rehabilitation on the outcomes of treatment following anterior cruciate ligament injury: a systematic review. *Clinical Rehabilitation* 31(1): 34, 2017
3. Failla MJ, Logerstedt DS, Grindem H, Axe MJ, Risberg MA, Engebretsen L, Huston LJ, Spindler KP, Snyder-Mackler L, Investigation performed at the University of Delaware NDUSA. Does Extended Preoperative Rehabilitation Influence Outcomes 2 Years After ACL Reconstruction?: A Comparative Effectiveness Study Between the MOON and Delaware-Oslo ACL Cohorts. *The American Journal of Sports Medicine* 44(10): 2608, 2016
4. Eitzen I, Holm I, Risberg MA. Preoperative quadriceps strength is a significant predictor of knee function two years after anterior cruciate ligament reconstruction. *British Journal of Sports Medicine* 43(5): 371, 2009
5. Paterno MV, Schmitt LC, Ford KR, Rauh MJ, Myer GD, Huang B, Hewett TE. Biomechanical Measures During Landing and Postural Stability Predict Second Anterior Cruciate Ligament Injury After Anterior Cruciate Ligament Reconstruction and Return to Sport. *The American Journal of Sports Medicine* 38 (10 ): 1968, 2010
6. Risberg MA, Holm I. The Long-term Effect of 2 Postoperative Rehabilitation Programs After Anterior Cruciate Ligament Reconstruction. *The American Journal of Sports Medicine* 37 (10 ): 1958, 2009
7. van Melick N, van Cingel REH, Brooijmans F, Neeter C, van Tienen T, Hullegie W, Nijhuis-van der Sanden MWG. Evidence-based clinical practice update: practice guidelines for anterior cruciate ligament rehabilitation based on a systematic review and multidisciplinary consensus. *British Journal of Sports Medicine* 50(24): 1506, 2016
8. Bourke H, Salmon LJ, Waller A, Patterson V, Pinczewski LA. The survival of the anterior cruciate ligament graft and the contralateral ACL at a minimum of 15 years. *Am J Sports Med*. 2012;40(9):1985-1992.
9. Webster KE, Feller JA. Development and Validation of a Short Version of the Anterior Cruciate Ligament Return to Sport After Injury (ACL-RSI) Scale. *Orthopaedic Journal of Sports Medicine* 6(4): 2325967118763763, 2018
10. Grindem H, Snyder-Mackler L, Moksnes H, Engebretsen L, Risberg MA. Simple decision rules can reduce reinjury risk by 84% after ACL reconstruction: the Delaware-Oslo ACL cohort study. *British Journal of Sports Medicine*. 2016;50(13):804-808.
11. Kyritsis P, Bahr R, Landreau P, Miladi R, Witvrouw E. Likelihood of ACL graft rupture: not meeting six clinical discharge criteria before return to sport is associated with a four times greater risk of rupture. *British Journal of Sports Medicine*. 2016;50(15):946-951.

Icons made by Freepik from [www.flaticon.com](http://www.flaticon.com)