

ACL Reconstruction Post-Operative Rehabilitation Protocol

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 “ligamentisation” 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.

Goal-based rehab has evolved and evidence has shown it to be clearly 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 following surgery.

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.

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 (e.g. balance board, progressing to squats on board)
- Running and jumping sports should be avoided due to risk of knee instability.

Acute Recovery

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 Acute Recovery

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.
- 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

Exercises can now 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 (e.g. leg extension machine and a freestyle swimming kick).

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. Road bike commenced after 6 weeks if stationary bike has been mastered, but toe cleats should be avoided.

Goals of Strength and Coordination

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 e.g. 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 gluteus 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.

Proprioception and Agility

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.

Goals of Proprioception and Agility

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 e.g. anterior single leg hops, lateral single leg hops.
- Hops and jumps can progress by increasing height and complexity – add ball catch
- Agility work may be 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 (e.g. plant and cut), and hopping, jumping drills.
- 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 (Injury Prevention) programme and progress as able (see next stage for detail)
- While the exercises through this stage become more dynamic, strength training should also continue with further development of strength and power.

Sport Specific Skills

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.

Goals of Sports Specific Skills

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.

An appropriate injury prevention program for all is the PEP injury prevention program developed by Santa Monica University. An overview of this available to download. A video example of PEP program exercises is available on YouTube - <https://youtu.be/7Lag8uNU6AQ>

Some additional sports specific drills should be individualised according to the sports e.g.

- Football - progress through skill components using the FIFA 11+ or PEP programs
- Netball, Basketball, Volleyball - vertical jumps progressing to jumps with overhead ball catching. Consider using progress through skill components such as Netball Australia's "Knee Program" <https://knee.netball.com.au>
- Rugby- progress through skill components using Activate – World Rugby's Injury Prevention Program. <https://iris.world.rugby/coaching/activate-injury-prevention-exercise-programme>
- 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,

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

Returning to Competitive Team Ball Sports

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) (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.

Goals of Returning to Competitive Team Ball Sports

1. Achieve >90% on Patient Reported Outcome Score (e.g. 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. 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 (i.e. low friction)

ACL RSI Scale

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 Score

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

- Very strenuous activities like jumping or pivoting as in basketball or soccer 5
- Strenuous activities like heavy physical work, skiing or tennis 4
- Moderate activities like moderate physical work, running or jogging 3
- Light activities like walking, housework or yard work 2
- 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?

- Very strenuous activities like jumping or pivoting as in basketball or soccer 5
- Strenuous activities like heavy physical work, skiing or tennis 4
- Moderate activities like moderate physical work, running or jogging 3
- Light activities like walking, housework or yard work 2
- 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?

- Very strenuous activities like jumping or pivoting as in basketball or soccer 5
- Strenuous activities like heavy physical work, skiing or tennis 4
- Moderate activities like moderate physical work, running or jogging 3
- Light activities like walking, housework or yard work 2
- 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?

- Very strenuous activities like jumping or pivoting as in basketball or soccer 5
- Strenuous activities like heavy physical work, skiing or tennis 4
- Moderate activities like moderate physical work, running or jogging 3
- Light activities like walking, housework or yard work 2
- 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"/> | |