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Anterior Cruciate Ligament Hamstring Rehabilitation Protocol

Based on the Fowler Kennedy Sports Medicine Clinic ACL Rehab Guidelines

Pre-operative Rehabilitation

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

Post-operative Rehabilitation

The surgeon and physiotherapists will guide you through a comprehensive rehabilitation programme to optimize recovery following surgery and facilitate return to sport/activities. General aspects of the post-operative rehabilitation and goals are listed below:

Range of Motion (ROM)

Restoring pre-injury range of motion improve surgical outcomes and minimise the chances of scarring within the knee. Attaining full knee extension may minimise the risk of anterior knee pain and restore walking patterns (gait) early. Studies recommend 30 second stretches to improve ROM in healthy individuals. Longer stretching times with more repetitions are generally required for persons with larger muscle mass (larger mass correlates with increased muscle stiffness).

Gait (Walking pattern)

Muscle imbalances/dysfunction is common in the early stages following ACL reconstructive surgery. This leads to altered gait mechanics with reductions in stride length, altered swing and stance phases together with weak/uncoordinated firing of hip, knee and ankle musculature. Early weight bearing attempts to restore gait mechanics in a timely fashion and reduce the incidence of anterior knee pain.

Treadmill rehabilitation (mid-stage) is a good way of normalising joint motion of the lower limb. Backwards walking in particular, strengthens the quadriceps while minimising anterior knee pain. This also provides for sport-specific training requiring backward locomotion.

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Muscle strengthening and endurance training

Muscle contains Type 1 (endurance) and Type 2 (fast-twitch) fibres in varying amounts. Following ACL injury, these fibres show signs of atrophy (wasting away) and changes in cellular composition. Therefore, ACL rehabilitation requires focus on both these different types of fibres namely; low-load/high repetitions (endurance) and high-load/low repetitions (strength)

Open (OKC) vs Closed (CKC) Kinetic Chain Exercises

This depends on whether the end of the limb is grounded/supported (closed) or unsupported (open). Squatting is an example of a closed-chain activity while knee extensions while sitting would constitute an open-chain exercise for the quadriceps muscle. OKC was initially thought to detrimentally increase anterior tibial translation (shin bone moving forward) following ACL reconstruction and these types of exercises were barred up to a year post-operatively. Current research however shows that controlled OKC does not lead to excessive laxity post-operatively and newer programmes incorporate both types of exercises (ensuring appropriate timing and range when initially commencing OKCs).

Focus on exercise quality: It is imperative NOT to begin new exercises prior to neuromuscular readiness. If certain muscle groups remain weak, this leads to compensation which in turn produce faulty movement patterns. If these faults are not corrected, this may perpetuate the original weakness. Any weakness along the kinetic chain predisposes to injury and failure following ACL reconstruction.

Hamstring graft precautions: Patients who received hamstring graft reconstruction must avoid overstressing the donor area while it heals. Typically, isolated hamstring strengthening begins after the 6 week mark to allow adequate donor site recovery.

Neuromuscular/Proprioceptive retraining

Neuromuscular control is often altered following ACL injury and surgery. Specific exercises activate receptors within the knee joint which in turn trigger compensatory muscle activation patterns to aid knee stability. These exercises should commence early following surgery to promote neuromuscular integration which help with gait training and muscle strengthening.

Proprioceptive progression takes in the form of static balance (supported one leg stance), to wobble-boards and in the end, dynamic exercises on mini-trampolines. Functional outcomes highly correlate with balance and proprioception following ACL reconstruction.

Terminology
Concentric: the muscle is shortening while it is contracting ('positive contraction"); **Eccentric**: the muscle is lengthening while it is contracting ('negative contraction"); **Extension**: straightening; **Flexion**: bending; **FWB**: Full Weight Bearing; **Hamstrings**: muscles in the back of the thigh; **Isometrics**: tightening/contracting of a muscle without movement of the leg **Isokinetic**: Contraction of a muscle at a constant rate/speed; **Plyometrics**: exercises that enable a group of muscles to reach a maximum strength in as short a time as possible. It tries to bridge the gap between speed and strength training.; **Prone**: lying on your stomach; **Proprioception**: The sense or perception of the position of the limb/muscle/joint in space. Important in maintaining balance and for the stability of the knee joint.; **Quads**: Quadriceps. The muscles on the front of the thigh; **ROM**: Range of Motion; amount of bending and straightening of the knee; **Supine**: lying on your back

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Weeks 0-2

Goals

- Pain & post-operative swelling management
- To establish 0-90° range of motion (Full extension priority!)
- Patient education regarding gait, balance and wound management

ROM

- Exercise to establish a range 0-90° with the aid of heel slides.
- Calf & hamstring passive stretches
- Exercise bike (slow cycles and low resistance)

Muscles

- **Quadriceps**
  Static and Inner range quadriceps exercises (cushion under thigh, extend knee). Mini wall squats (up to 30°). Static lunges. Sit to stand.
- **Hamstrings**
  Static and co-contraction (with quadriceps)
- **Gluteals**
  Isometric and eccentric hip flexion, extension and abduction (both standing and lying down)
- **Calves**
  Standing single & double heel raises (this can be done with or without support)

Proprioception

- Single leg stance for 30 to 60 seconds

Gait

- Start full-weight bearing with 2 crutches (progress to one crutch until patient has normal gait with 1)
- Weight-shifting exercises (side-to-side & forward-and –backward)

Modalities

- Ice packs for 20-30 minutes at a time (allow 2-3 hours in between)
- Analgesics (Paracetamol, NSAIDs)
- Muscle stimulation

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Week 2 – Week 6

Goals

- Progress to full knee flexion and extension
- Achieve normal gait pattern
- Strengthen opposite limb
- Progress with proprioception

ROM

- Prone assisted knee flexion and extension (protect hamstrings)
- Standing calf and hamstring stretches
- Assisted quadriceps stretching exercises (standing)
- Heel slides and exercise bike (allow full circles forward & backward)

Muscles

- **Quadriceps**
  Assisted squats with increasing range and resistance as tolerated. Commence leg press machine (allow a maximum of 70% body weight), Wall squats (allow maximum of 60°), Forward & Lateral step-ups (ensure body weight passes through heel)
- **Hamstrings**
  Prone assisted hamstrings (use opposite limb), bridging lying supine on the floor with legs on a Swiss ball.
- **Gluteals**
  Hip strengthening all directions (with ankle weight). Both concentric & eccentric exercises.
- **Calves**
  Progress to single heel raises (with or without support)

Proprioception

- Double/single leg stance (with eyes forward, looking away and closed)
- Standing on a half roam roller and maintain balance

Gait

- Progress to unassisted full weight bearing
- Exaggerate hip and knee flexion during swing phase of gait

Cardiovascular

- Exercise bike
- Start elliptical trainer

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Week 6 – Week 9

Goals

- To achieve full, pain free range of motion
- Begin limited/specific isokinetic quadriceps exercises

ROM

- Achieve full knee flexion and extension
- Continue hamstring and calf stretches

Muscles

- **Quadriceps**
  Full & inner range squats with increasing resistance as tolerated, static lunges (all directions) progressing to dynamic lunges, Step – ups (up to 20cm), eccentric lateral step downs (slow, controlled knee flexion), full wall squats (up to 90°). Initiate isokinetic quadriceps rehabilitation programme
- **Hamstrings**
  Bridging (supine on the floor with legs on a Swiss Ball), active low resistance hamstring curls in prone, standing and sitting positions
- **Gluteals**
  Advance on all direction strengthening (ankle weights, resistance cables)
- **Calves**
  Advance on all direction strengthening (ankle weights, resistance cables)

Proprioception

- Single leg stance on mini-trampoline
- Upper body work (throwing)
- Floor disc squatting & throwing
- Wobble board (balance)

Gait

- Hydrotherapy sessions: Knee ROM, walking (all directions), hip ROM

Cardiovascular

- Exercise bike (increasing time & resistance)
- Swimming (flutter kick only)
- Pool jogging
- Treadmill (Walking. Avoid jogging)

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Week 9 – Week 12

Goals

- Progressive quadriceps & hamstring strengthening, proprioception and flexibility

ROM

- Continue stretches as before ensuring achievement of full knee range of motion

Muscles

- **Quadriceps**
  Dynamic lunges ensuring proper truncal alignment, backward step-ups, eccentric step downs (20cm), single leg squats, low resistance jumping (2 legs, then jogging, then single leg hops), progress with isokinetic programme
- **Hamstrings**
  Hamstring curls (in the standing, sitting and prone position) with increasing resistance as tolerated, eccentric hamstring rehabilitation
- **Gluteals**
  Progress as before
- **Calves**
  Eccentric heel drops

Proprioception

- Catching & throwing exercises on wobble boards & mini-trampoline.
- Single leg stance on a floor disc (kicking drills, upper body skills)

Cardiovascular

- Pool running (increasing time and repetitions)
- Exercise bike (increasing time & resistance)
- Treadmill (incline walk and increase speed. Avoid jogging)

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Week 12 – Week 16

Goals

- Continue flexibility and strengthening of the lower chain
- Commence sport specific quadriceps/hamstring strengthening, proprioception & cardio fitness

Muscles

- Continue concentric & eccentric quadriceps and hamstring exercises.
- Backward lunge walking.
- Progress from jogging to running.
- Split squat jumps.
- Single leg drop landing (5cm)

Proprioception & Agility

- Ladder drills (forwards/backwards/side-to-side)
- Side step-overs (progressing to side step-overs)
- Skipping and hopping (2 legs progressing to single leg)
- Mini-trampoline (2 feet jumps – jogging – single leg jumps)
- Continue single leg floor disc exercises (aim for sport specific activities. Eg: kicking, hockey shot, cricket batting etc.)

Cardiovascular

- Pool hopping and squat jumping (in shallow water)
- Jogging (straight on flat, even ground. Avoid sudden cuts/change of direction)
- Treadmill jogging progressing to running
- Sport specific cardio training

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Week 16 – Week 26

Goals

- Sport specific lower chain strengthening and progress to plyometric exercises
- Continue proprioceptive & cardiovascular fitness

Muscles

- Progress as before concentrating on specific deficits on muscle groups (if any arise)

Proprioception

- Progress on mini-trampoline
- Forward & side hops (maintain 5 second single leg balance on landing)
- Cutting drills (quick stop & balance)

Agility & Plyometrics

- Ladder drills (all directions)
- Progress on running/lunging/vertical jumps/run-stop-sidestep
- Single leg forward & side hopping.
- Single leg jumps
- Box hops/jump and forward sprints
- Single leg drop landing (progressive up to 25cm)

Cardiovascular

- Increase intensity on bike/treadmill/jogging
- Progress from running to sprinting (ensure proper rhythmic stride)
- Jogging with directional change/uneven surface
- Jogging with turns 90/180/360°
- Jogging and cutting with 45° change of direction
- Acceleration and deceleration running, add on tight turns and hills as tolerated
- Outdoor cycling
- Swimming (avoid the 'whip-kick')

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6-9 Months

Goals

- Adequate cardiovascular fitness, strength, power, agility neuromuscular control, symmetry and stability
- Continue with upper body strengthening
- Back to sport practice for upper skills (as able)
- Return to sport skills on own at practice with minimal risk of re-injury

Exercise Suggestions

- Single leg drop jump 6" step
- Large Figure 8's
- Carioca running full speed
- Last minute decision drills
- 2 and 1 foot hopping with control
- Forward and lateral hop with control and comparable distance L&R
- Triple jump and landing with control and comparable distances L&R
- Single limb hop for distance (within 15% of uninvolved side)
- Single-limb crossover triple hop for distance (within 15% of uninvolved side)
- Single-limb timed hop over 6 m (within 15% of uninvolved side)
- Single limb vertical power hop (within 15% of uninvolved side)
- Single limb drop landing (within 15% of uninvolved side)
- Single limb drop-jump
- 10 second single limb maximum vertical hop (both sides)

Return to sport

Successful individuals following surgery generally return to sport after the 8-10 month mark. This is provided the knee is free from pain and swelling, during or after functional sport specific training drills. The person will also need to show adequate strength and endurance for their specific sport. It is difficult to accurately pre-empt a return to sport early in the post-operative phase as individual responses to rehabilitation do vary. This timeline may be further delayed if concurrent soft tissue or bony injuries were present after the initial trauma. Your surgeon will help advice an appropriate return time for you based on clinical and rehabilitative progress made.

If you are less than 18 years of age, current evidence suggests that this is the greatest risk factor over all others for re-tear of the ACL graft. As such, most patients will remain off sport for 12 months.

Video Links to Prevent ACL Injury

1. Video (PEP programme) : https://www.youtube.com/watch?v=7Lag8uNU6AQ
2. FIFA Injury Prevention Program: http://f-marc.com/11plus/home/