

ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION REHABILITATION PROTOCOL

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PRE-OPERATIVE

A brace will be fitted and you will be taught to adjust the settings. For daytime use the range will be 0-120°. At night the brace is to be adjusted to 0° so that the knee is straight.

It is very important that you take responsibility for your rehab, doing home exercises every day. Ask for help if you are not progressing as you would like to, or if you have any problems.

DAY OF SURGERY

Your physiotherapist on the ward will instruct you about which exercises to start on while in hospital. You will also be shown how to use your crutches, you should take as much weight through your leg as is comfortable.

WEEK ONE

Discard crutches after 1-3 days. Full weight bearing from the outset. Start exercises, stage one of the protocol. Brace full range of movement for mobility. Locked in extension at night.

WEEK TWO

Return to office work when comfortable. Start hydrotherapy where possible and short duration static cycling low resistance.

ONE MONTH

Return to active work. Return to driving short distances if comfortable and safe. Continue exercises progress to stage two. Discard brace. Swimming gentle crawl, gym – no resisted leg extensions.

TWO MONTHS

Return to manual work. Commence stage three, progress to stage four of the protocol. Cycling outdoors, gym normally.

THREE MONTHS

Now onto stage four, running, recreational tennis, badminton, golf and cycling.

SIX MONTHS

Return to training for sport rugby, football (no tackling for the first 4-6 weeks). Return to tennis and squash. Skiing in a brace as advised by your physiotherapist.

The planner is a rough guide as to what to expect through your rehabilitation, you will be progressed, as your physiotherapist feels suitable. Don't be disappointed if you are slow to meet these goals, we are all different, if concerned ask.

GENERAL ADVICE FOR ANTERIOR CRUCIATE LIGAMENT REHABILITATION

TO DECREASE SWELLING

Wear tubigrip on the knee during the day (do not use at night). Ice the knee for 20 minutes after exercise and whenever the knee swells. Interferential therapy may also be used to decrease swelling. Your physiotherapist will apply this if necessary.

WALKING

Wean yourself off your crutches after 1-5 days.

HYDROTHERAPY

You may start to exercise in water after 2-4 weeks. Your therapist will advise you on exercises, these will include range of movement exercises, strengthening exercises, balance and body awareness, and gait re-education.

RANGE OF MOVEMENT EXERCISES

Scar tissue can build up around the ligament graft and cause a permanent block to full knee extension unless early knee extension is achieved. Once full extension is achieved DO NOT progress beyond this but maintain full extension.

EXTENSION EXERCISES

- A. Wall stretch. Lie on your back with your leg out straight against the wall. Gently slide your leg down the wall until it is bent. Return your leg to the start position using your hands.
- B. Sitting stretch. Sit on a chair with your foot straight out in front of you. Slide your foot towards you using your hamstring muscles.

KNEE CAP MOBILISATION (if necessary)

Sit with legs out in front with your quadriceps relaxed. Use your thumbs on the outside of your knee cap to push it across firmly to the inside. Hold for 5-10 seconds then slowly release. Repeat this 5 times.

VASTUS MEDIALIS OBLIQUE (VMO)

The VMO muscle is the small muscle on the inside of the knee and controls the position of the knee cap, preventing pain in the front of the knee due to mal-tracking. It is important to reduce swelling, as this inhibits the action of the muscle. The following exercises are aimed at this muscle.

MINI LEG PRESS

Sit with foot out in front of you pressed up against the wall. Bend the knee and push back to the straight position.

VMO IN SITTING

Roll thigh outwards with a pillow or rolled up towel under your knee. The aim is to contract the VMO while the rest of the quadriceps stays relaxed. Dig your heel into the bed contracting the hamstrings, then contract the inner thigh. Hold the contraction for 5 seconds then repeat. Build up to a 10 second contraction.

VMO EXERCISES IN LUNGE STANDING

Stand with affected leg forward and slightly bent. Keep your toes pointed directly forward, and rotate your leg to turn your knee cap outward. Arch your foot, tighten the hamstrings by attempting to pull the heel back along the floor (without actually letting it move). At the same time contract the VMO on the inner thigh, while relaxing the outer thigh muscles. Hold each contraction for 5-10 seconds, rest then repeat this exercise.

STRENGTHENING EXERCISES

Lying hamstrings – Lie on stomach. Bend operated leg slowly towards buttock and lower gently. Control on the way down.

Hip extension – Lie on stomach. Keep knee straight, tighten stomach muscles and lift leg off the bed. Hold for 3 seconds and slowly lower.

As above, bend knee and lift the leg off the bed, hold for 3 seconds and lower.

Adduction – Lie on the operated side with good leg bent over in front of the operated leg. Lift the operated leg off the ground, and try to tighten the VMO.

Abduction – Lie on the side with the operated leg uppermost. Keep leg straight and in line with the body (do not bend hip forwards). Lift leg 30cm. Hold for 3 seconds and lower gently.

Bridging – Lying on your back lift your pelvis up off the floor, (your shoulders and arms remain in contact with the floor). Progress by using one leg to lift your pelvis off the floor.

Quadriceps – Sit with the knee bent at 90°. Straighten knee to 50°, hold then slowly lower.

Calf raises – Keep your knees straight and rise on to your toes. Slowly lower.

Sitting hamstrings – Sitting with your leg out in front of you. Gently slide your foot towards you, use theraband around your ankle to make this exercise more difficult.

NOTE: Closed kinetic chain exercises are the safest and most functional way of exercising following ACL reconstruction. These exercises in which the foot is fixed with the knee joint in motion (eg squats, exercise bike, rowing machine). Open kinetic chain exercises involve the knee being fixed and the foot moving, often against resistance (eg knee extensions in the gym, kicking a football, etc). The open chain exercises cause shear stresses at the knee, and this places strain on the ACL graft.

Evidence based post ACL reconstruction rehabilitation guidelines (bone-patella-bone and hamstring)

STAGE ONE

You may discard your crutches at 1-5 days, as soon as comfortable.

The aims of treatment are:

- To decrease swelling
- Increase range of motion as tolerated
- Improve knee muscle control

Early stage: week 0-2

Aims		Treatment options
Increase ROM – full hyper extension -- increase flexion		<ul style="list-style-type: none"> • Static quadriceps in extension, prone heel hangs • Rest in full extension with heel raise • Active flexion, heel slides
Minimise pain and swelling		<ul style="list-style-type: none"> • Intermittent cryocuff • Elevation above heart +/- compression not at rest • Analgesia prn
Increase muscle control	Quadriceps Hamstrings Calves	<ul style="list-style-type: none"> • Static quads, mini squats, step ups • Prone knee bends, co-contraction • Calf raises
proprioception		<ul style="list-style-type: none"> • Weight transfer, balance board

Criteria progression for next stage:

- At least 90° knee flexion
- Full hyperextension
- Minimal pain and swelling
- Concentric and eccentric muscle control in available range

References: Corry et.al (1999), Shelbourne et.al. (1992,1997, 1998,1999), Risberg et.al. (2004), Ejerhead et.al. (2003,2004), Pinczewski et.al. (2002), Howell et.al. (1998), Yunes et.al. (2001), O'Neill (1996)

STAGE TWO

Full weight bearing without a brace or crutches is achieved.

AIM

- Increase functional exercises in weight bearing.
- Continue to increase range of motion as tolerated.

STRENGTHENING AND FUNCTIONAL EXERCISES

Continue all stage one exercises.



Sit to stand

Use different chair heights to make this exercise more difficult. The lower the chair the more difficult the exercise.

Wall squats

Stand with back against the wall, legs straight. Slowly slide down the wall until knees are bent to 90°.

Step Ups

Place operated leg on to a 3cm step. Keep weight on the outside of the foot, and knee pointing out over the 2nd and 3rd toes. Bring the weight on to the operated leg and slowly straighten the knee by contracting VMO. Slowly lower the opposite leg until the foot is on the ground.

Step Downs

Stand on the step with your weight on the affected leg. Your toes should point forward, knee rotated outwards. Slowly step down, concentrate on contracting VMO and controlling the movement. Return slowly to the starting position and repeat.

Theraband

Start with the theraband around the knee rotate the leg outwards and away from the other leg. Once able to perform this exercise progress to:-

In standing, perform the exercises below with the theraband around the unoperated leg. Use VMO and hamstrings to control the position of the operated leg whilst moving the other leg. Keep stomach and buttock muscles tight to stabilise the pelvis when performing these exercises..

Balance Work

(start proprioceptive programme)

- Balance on operated leg, ensure all the muscles around the hip and thigh are contracting.
- As above but maintain balance while moving arms.
- Balance with eyes closed.

Wobble board

When confident standing on one leg with eyes closed, progress to the wobble board. Start with two legs on the board, evenly spaced. Rock the board backwards and forwards and side to side. Attempt to balance with the rim off the ground.

Abdominals

The stomach muscles are important as stabilisers in every lower limb activity. It is important to start controlled abdominal exercises. Lying on your back, hip and knees bent up to 90°. Gently raise your head and neck off the floor, your mid to lower back should remain in contact with the floor.

Stationary bicycle

Use with a high seat and little resistance at high speed for short durations.

Swimming

No breaststroke or butterfly kicks.

STAGE TWO

Middle stage: week 2 –12

Aims	Treatment options
No pain or swelling	<ul style="list-style-type: none">• Use as guide to progression of rehabilitation
Full range of movement including hyperextension	<ul style="list-style-type: none">• As above• Accessory mobilisations – TFJ,PFJ• Static bike

Increase muscle control	<p>Quadriceps</p> <p>Hamstrings</p> <p>Calves</p>	<ul style="list-style-type: none"> • Closed chain in less than 60° flexion, squats, step up/down/side, lunges, leg press, bilateral to unilateral as able • Open chain in more than 40° flexion from 6 weeks • Curls, prone knee bends, bridging, progress weight as able • Calf raises, unilateral, add weight
Maintain muscle length		<ul style="list-style-type: none"> • Muscle stretches
Function		<ul style="list-style-type: none"> • Normalise gait • Prepare for jogging by increasing speed and impact of programme • Treadmill running from week 12, if painfree, FROM, full muscle control, no swelling • Swimming, straight leg kick only • Cycling
Graft protection		<ul style="list-style-type: none"> • Discard elbow crutches by 2-3 days • Minimise weightbearing rotational forces

Criteria for progression to next stage:

- Painfree and no swelling
- Full range of movement
- Full muscle control
- Normal full weight bearing gait

References: Risberg et.al.(2004), Shelbourne et.al.(1999), Beynnon et.al. (1997), Morrissey et.al. (2000), Steinkamp et.al.(1993), Heller et.al.(2003), Ross et.al.(2001), Synder-Mackler et.al.(1995), O'Neill (1996)

STAGE THREE

AIM

Prepare for jogging programme by increasing strength and stability.

FUNCTIONAL ACTIVITIES

Stepmaster

Your physiotherapist will show this to you.

Body awareness

Progress to a more difficult wobble board, eg single leg balance on trampoline.

Mini-tramp

Only start this if knee control is good:
 Heel and toe standing balance (two feet)
 Single leg balance
 Single leg dip using VMO and hamstrings

Gymnastic ball

- Put both heels on the large ball. Lift buttocks off the supporting surface and keep them off during this exercise. Rock the ball towards you, then away. Walk the ball towards you then away.
- Stand with the unaffected leg on the ball, ensure the operated leg muscles are contracted. Move the ball towards you and away.

Jump and hop down

Start hop and jump downs, ensure good hamstring contraction and good knee control on landing.

Slide (Reebok)

Feet evenly placed. Use leg muscles to control the swing side to side.



Swimming

Use float between the legs for upper body strengthening and aerobic fitness during the early stages of rehab.

Commence jogging in waist deep water.

Continue to swim front crawl or backstroke.

Cycling

Continue low resistance.

Late stage 12 weeks to 6 months

Aims	Treatment options
Swelling control	<ul style="list-style-type: none">• Risk of swelling with load progression
Maintain full range of movement	<ul style="list-style-type: none">• Check no loss after each exercise session
Increase muscle control	<ul style="list-style-type: none">• Progress with weights and controlled rotational stresses, endurance
Improve proprioception	<ul style="list-style-type: none">• More dynamic, hopping, landing
Function Running Impact Drills	<ul style="list-style-type: none">• Progress speed, distance, incline 6/52, slowly• Treadmill to road as able• Hopping, trampette then floor• Lateral hops/ Z hops/ jump downs• Figure 8 running, backwards/side running• Sports specific drills• Gentle pivoting/changing direction• Acceleration/deceleration• Zigzag running• Uneven surface jogging, downhill running at 6/12
Increase cardiovascular fitness	<ul style="list-style-type: none">• Treadmill walking, running, cycling, rowing, swimming(no breaststroke) cross trainer• Build endurance to competitive levels
Maintain muscle length	<ul style="list-style-type: none">• Continue stretches

Criteria for progression to return to sport stage (6 months +)

- Full painfree range not affected by exercise
- No residual swelling
- Cardiovascular fitness similar to pre-injury
- Normal running gait
- Symmetry of sports/occupational specific skills

Graded return to sport at this stage.

STAGE FOUR

JOGGING PROGRAMME

Running may be commenced at approximately 10-12 weeks. To do this you must have full extension, good quads control, good balance and body awareness. Your physio will tell you when you are ready to start this programme.

1. Start with brisk walking (7-8 minutes/km), building up to 1km.
2. Alternate jogging and brisk walking at 100 metre intervals. Build up to 2-3km.
3. Slowly increase the walk/run until you are running 500m at a time.
4. Increase jogging to 1-2km on alternate days.
5. Progress from ½ pace to ¾ pace to full pace in a straight line. Increase distances from 100m, 200m to 800m.
6. Progress to running 5-8km. You must build up running endurance before agility drills can be commenced.
7. Running may be alternated with swimming, rowing and cycling to build up endurance. Low impact step aerobics may also be commenced. (Refer to agility programme).

Continue associated muscle strengthening

- Squats
- Leg Press
- Lunges

STAGE FIVE

AGILITY AND BODY AWARENESS DRILLS

- Jogging in large circles, increasing pace.
- Jogging in narrower and shorter circles, increasing pace.
- Jogging in large to small figure of 8's, increasing pace.
- High knee running, backward running and zigzag running.
- Shuttle runs
- Side steps (off balls of feet).
- Crossed side step running (cariocas)
- Zigzag hop.
- High leaps
- Running stairs
- Agility

NOTE

Running mileage can be reduced once performing agility drills, depending on the requirements of the sport.

SPORT SPECIFIC SKILLS

- The emphasis is on technique, endurance and accuracy. You need to practice and perfect any special skills you need for your sport. This may include ball skills, kicking, throwing or catching.
- Once strength of the operated leg is within 10% of the other leg, and full range of movement is normal, full activity may be resumed.
- You should discuss with your consultant or physiotherapist when you can return to competitive sport.

NOTE

For skiing it is recommended that you wear a brace, your physiotherapist will advise.

Evidence based A.C.L. reference list

Chmielewski T.L., Rudolph K.S., Snyder- Mackler L. (2002). Development of dynamic knee stability after acute ACL injury. *Journal of Electromyography and Kinesiology* 12. 267-274

Corry, I. MD, FRCS (Orth), Webb, J.M. FRCS (Orth), Clingeleffer, A.J. Pinczewski, L. FRCS (1999) 'Arthroscopic Reconstruction of the Anterior Cruciate Ligament; A Comparison of patellar Tendon Autograft and Four-Strand hamstring Tendon Autograft', *The American Journal of Sports Medicine*, Vol. 27, No.3. American Orthopaedic Society for Sports Medicine.

Ejerhed, L. MD, Kartus, J. MD, PhD, Sernert, N. Kohler, K. Karlsson, J. MD, PhD (2003) 'Patellar Tendon or Semitendinosus Tendon Autografts for Anterior Cruciate Ligament Reconstruction? A Prospective Randomized Study with a Two-Year Follow-up'. *The American Journal of Sports Medicine*.

Halling A.H., Howard M.E., Cawley P.W., (1993) Rehabilitation of anterior cruciate ligament injuries. *Clinics in Sports Medicine*. Vol.12 no.2

Hooper D.M., Morrissey M.C., Drechsler W.I., Clark N.C., Coutts F.J., McAuliffe T.B. (2002), Gait analysis 6 and 12 months after ACL reconstruction surgery. *Clinical Orthopaedics and Related Research*, 403:168-178

Howell, Colonel, Taylor, Lieutenant S, Medical Corps, United States Air Force Reserve 'Brace-free Rehabilitation, with Early Return to Activity, for Knees Reconstructed with a Double-Looped Semitendinosus and Gracilis Graft', *Journal of Bone and Joint Surgery – American* 1996 – 1998, June 1996, vol 78-A, Number 6

Hrubesh R., Rangger C., Reichkender M., Sailer R.F., Gloetzer W., Eibl G. (2000), Comparison of score evaluations and instrumented measurement after ACL reconstruction. *American Journal of Sports Medicine*.

O'Neill D.B. (1996) Arthroscopically assisted reconstruction of the anterior cruciate ligament: A prospective randomised analysis of three techniques. *Journal of Joint Surgery Am*: 78: 803-813

Pinczewski, L. FRACS, Deehan, D.J. MD, Salmon, L. J. BappSci (Phy), Russell, V.J. BSc (Biomed), Clingeleffer, A. BappSci (2002) 'A Five-Year Comparison of Patellar Tendon Versus four-Strand Hamstring Tendon Autograft for

Arthroscopic Reconstruction of the Anterior Cruciate Ligament.’ The American Journal of Sports Medicine, vol. 30, No4. American Orthopaedic Society for Sports medicine.

Reid D.C., Current concepts in rehabilitation of the ACL deficient knee. Current Orthopaedics

Risberg M.A., Lewek M., Snyder-Mackler L. (2004).A Systematic review of evidence for anterior cruciate ligament rehabilitation: how much and what type? Physical Therapy in Sport 5, 125-145

Ross M.D., Denegar C.R., Winzenried J.A., (2001). Implementation of open and closed kinetic chain quadriceps strengthening exercises after ACL reconstruction. Journal of Strength and Conditioning Research, 15(4), 466-473

Shaw T., Chipchase L.S., Williams M.T. (2004) A users guide to outcome measurement following ACL reconstruction. Physical Therapy in Sport 5, 57-67.

Stanish W.D., Lai A., (1993) New concepts of rehabilitation following anterior cruciate reconstruction. Clinics in Sports Medicine. Vol. 12. no.1.

Shelbourne K.D., Trumper R.V. (1997). Preventing anterior knee pain after anterior cruciate ligament reconstruction. The American Journal of Sports Medicine, vol.25, no. 1.

Shelbourne K.D., Klotwyk T.E., DeCarlo M.S., (1992) Update on Accelerated rehabilitation after anterior cruciate ligament reconstruction. Journal of Sports Physical Therapy. Vol. 15. no. 6

Shelbourne K.D., Davis T.J., (1999), Evaluation of knee stability before and after participation in a functional sports agility program during rehabilitation after ACL reconstruction. The American Journal of Sports Medicine, vol. 27, no. 2.

Shelbourne K.D., Patel, (1999), Treatment of limited motion after ACL reconstruction. Knee surgery in Sports traumatology and arthroscopy. 7, 85-92.

Shelbourne K.D., Rask B.P., (1998). Controversies with ACL surgery and rehabilitation. American Journal of knee surgery. Vol 11, no.2

Shelburne, K.B., Pandy M.G., (1998), Determinants of cruciate loading during rehabilitation exercise. Clinical Biomechanics, 403-413

Tovin B.J., Tovin T.S., Tovin M., (1992) Surgical and Biomechanical considerations in rehabilitation of patients with intra articular ACL reconstructions. Journal of Sports Physical Therapy. Vol. 15. no.6.

Williams III, R.J. MD, Hyman, J. MD, Petrigliano, F. MD, Rozental, T. MD, Wickiewicz, T.L. MD (2004)‘ Anterior Cruciate Ligament Reconstruction With A Four-Strand Hamstring Tendon Autograft’. The Journal of Bone and Joint surgery.

Yunes, M. M.D., Richmond,J.C. MD. Engels,E. M.D.,M.P.H. Pinczewski, L. F.R.A.C.S(2001) ‘Patellar Versus Hamstring Tendons in Anterior Cruciate Ligament Reconstruction: A Meta-analysis’, Arthroscopy: the Journal of Arthroscopic and Related Surgery, Vol 17, No 3 (March): pp 248-257.

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