

### RATIONALE OF REHABILITATION

Based upon the following assumptions:

The ACL graft is merely a scaffold which the human body will use to remodel into a ligament in a biological process that takes in excess of 12 months. Accompanying the "ligamentization" process are significant other deficiencies such as weakness, impaired proprioception, impaired muscular function, impaired neuromuscular control.

#### Prehabilitation

- Only operate on pain-free mobile joints – minimizes complications
- May take weeks or months
- Prehabilitation advantages the patient but preparing a pain free joint with full ROM and optimal strength
- Patients are better able to manage postoperative exercises if they have learnt them before surgery

#### Stage 1 - Acute Post op - 0 -14 days

- ACL sees minimal force in ADL and closed chain exercises
- Surgery has placed the ACL graft in the functionally anatomic position
- Immediate weight bearing 1 RCT
  - ↓ pf pain, ↑ VMO strength and does not ↑ laxity (Tyler Clin Orth, 1998)
- CPM offers no advantage 6 RCT
- Rehab must respect fixation choice
  - Chosen fixation allows for immediate mobilisation
- Graft tissue is probably never stronger than the day it is implanted

#### Stage 2 - Muscular control - 2-6 weeks

- In an anatomically correct position the ACL graft will allow a full ROM without excessive loading
- EMG biofeedback is beneficial 1 RCT
  - ↑ quads strength at 3 months, earlier full extension (Draper 1990)
- Bracing offers no advantage 11 RCT
  - No difference injuries, pain, laxity, ROM at 6 wks

#### Stage 3 - Proprioception - 6 -12 weeks

- Laxity should not be assessed until full ROM
- The prime determinant of laxity is graft position
- Fixation improves with time
  - HT graft ST to bone healing in 8 -12 weeks
- Open Chain Exercises 5 RCT
  - Early open chain = ↑ laxity + ↑ pf pain (Bynum, 1995)
  - Closed chain 6 weeks then open chain = ↑ quads, ↑ return to sport, = laxity (Mikkelsen, 2000)
  - Start 40-90° progress to 10-90° over 6 weeks
  - Beware highly increased pf forces, desist if patellofemoral symptoms develop
- Deficits in hip and postural control have been found to be strong predictors of further ACL graft rupture (Paterno AJSM 2010)

#### Stage 4 – Neuromuscular and Sport Specific - 3 - 5 months

- Graft maturation continuing
- Proprioceptive recovery vital and takes time and practice and practice and practice
- For jumpers practice good landing technique
  - ↑ knee flexion, ↓ valgus rotation and toe land
- Neuromuscular training improves subjective function and hamstring strength compared to strength training alone (Risberg AJSM 2009)

#### Stage 5 –Prepare for return to sport - 6 -12 months

- Normal graft strength and stiffness 8 months, gross histology graft remodelled by 12 months but maturation of the ultra-structure continues > than 3 years
- Compliance with a sport specific neuromuscular training (eg PEP) reduces primary ACL injuries and repeat ACL injuries (Gilchrist AJSM 2008)
  - Warm up with strengthening, plyometrics, agility drills
  - PEP program RCT 1435 female soccer (Gilchrist AJSM 2008)
  - ↓ non contact ACL injury by 70% & if prior ACL injury - ↓ non contact ACL injury by 5x
- Joint injury results in impaired muscle function for at least 18 months
  - Slower muscle reaction times
  - Altered muscle recruitment order patterns and spinal reflexes (Wojtys 2000) in 25 ACL rec vs 40 normal

#### Stage 6 – Return to Sports

- Knee normal = Which knee? Approx 18 months coincides with muscular function
- Rate of another ACL injury > 12 months is 1% per knee per year (equal graft and opposite ACL) (Salmon Arthroscopy, 2005, Bourke AJSM 2012)
- Neuromuscular programs as warm before ball sports are beneficial in reducing odds of further ACL injuries (eg PEP, FIFA Mark 11)

Updated November 2012

STAGE	AIMS	GOALS	TREATMENT GUIDELINES
<b>Prehabilitation</b>	<ul style="list-style-type: none"> <li>Prepare the patient for surgery</li> </ul>	<ul style="list-style-type: none"> <li>Full ROM</li> <li>Painfree mobile joint</li> <li>Teach simple post op exercises</li> </ul>	<ul style="list-style-type: none"> <li>Operate on pain free mobile joints – minimizes complications and speeds recovery</li> <li>May take many months</li> <li>Do not be pressured by patient into early surgery.</li> <li>Preprogramming post operative rehabilitation is beneficial at every level</li> <li>Patients are better able to manage postoperative exercises if they have learnt them before surgery</li> </ul>
<b>Stage I Acute Recovery Day 1 to Day 10-14</b>	<ul style="list-style-type: none"> <li>Post-operative pain relief and management of soft tissue trauma.</li> <li>Progress off crutches and normal gait.</li> </ul>	<ul style="list-style-type: none"> <li>Wound healing.</li> <li>Manage the graft donor site morbidity, i.e. pain and swelling.</li> <li>Decrease joint swelling.</li> <li>Restore full extension (including hyperextension)</li> <li>Establish muscle control.</li> </ul>	<ul style="list-style-type: none"> <li>Decrease swelling &amp; pain with ice, elevation, co-contractions and pressure pump.</li> <li>Full weight bearing as pain allows.</li> <li>Aim for a full range of motion using active and passive techniques.</li> <li>Patella mobilisations to maintain patella mobility.</li> <li>Gait retraining with full extension at heel strike.</li> <li>Return of co-ordinated muscle function encouraged with biofeedback. 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.</li> <li>Commence use of an exercise bike after day 3 postop.</li> <li>Gentle hamstring stretching to minimise adhesions.</li> <li>Active hamstring strengthening begins with static weight bearing co-contractions and progresses to active free hamstring contractions by day 14.</li> <li>Resisted hamstring strengthening should be avoided for at least 6-8 weeks.</li> </ul>
<b>Stage II Hamstring And Quadriceps Control 2-6 Weeks</b>	<ul style="list-style-type: none"> <li>To return the patient to normal function.</li> <li>Prepare the patient for Stage III.</li> </ul>	<ul style="list-style-type: none"> <li>Develop good muscle control and early proprioceptive skills.</li> <li>If not done sooner, restore a normal gait.</li> <li>Reduce any persistent or recurrent effusion.</li> </ul>	<ul style="list-style-type: none"> <li>Progress co-contractions for muscle control by increasing the repetitions, length of contraction and more dynamic positions, e.g. two leg quarter squats, lunges, stepping, elastic cords.</li> <li>Gym equipment can be introduced gradually such as stepper, leg press, mini trampoline, cross trainer.</li> <li>If swelling is persistent, continue with pressure pump and ice</li> <li>Hamstring strengthening progresses with the increased complexity and repetitions of co-contractions. Open chain hamstring exercises are commenced although often they are painful.</li> <li>Care must be taken as hamstring straining may occur</li> <li>Low resistance, high repetition weights aim to increase hamstring endurance.</li> <li>Continue with intensive stretching exercises.</li> <li><u>Week 6:</u></li> <li>Eccentric hamstring strengthening is progressed as pain allows. Hamstring curl equipment can be introduced.</li> <li>Consider beyond the knee joint for any deficits, e.g. gluteal control, tight hamstrings, ITB, gastrocs and soleus, etc.</li> </ul>
<b>Stage III Proprioception 6-12 weeks</b>	<ul style="list-style-type: none"> <li>Improve neuromuscular control and proprioception</li> </ul>	<ul style="list-style-type: none"> <li>Continue to improve total leg strength.</li> <li>Improve endurance capacity of muscles.</li> <li>Improve confidence.</li> </ul>	<ul style="list-style-type: none"> <li>Progress co-contractions to more dynamic movements, e.g. step lunges, half squats.</li> <li>Proprioceptive work more dynamic, e.g. lateral stepping, slide board etc.</li> <li>Can begin jogging in straight lines on the flat.</li> <li>Progress resistance on gym equipment such as leg press and hamstring curls. Hamstring strengthening programme aims for a progression in both power and speed of contraction.</li> <li>Start cycling on normal bicycle.</li> <li>Consider pelvic and ankle control plus cardiovascular fitness.</li> <li>Solo sports such as cycling, jogging and swimming are usually permitted with little or no restrictions during this stage.</li> <li>Open chain exercises commence (if no patellofemoral symptoms) 40-90° progressing to 10-90° by 12 weeks</li> </ul>

STAGE	AIMS	GOALS	TREATMENT GUIDELINES
<b>Stage IV Neuromuscular 12 Weeks To 5 Months</b>	<ul style="list-style-type: none"> <li>• Sport Specific preparation</li> </ul>	<ul style="list-style-type: none"> <li>• Incorporate more sport specific activities.</li> <li>• Introduce agility and reaction time into proprioceptive work.</li> <li>• Increase total leg strength.</li> <li>• Develop patient confidence.</li> </ul>	<ul style="list-style-type: none"> <li>• Progressing of strength work, e.g. half squats with resistance, leg press &amp; curls, wall squats, step work on progressively higher steps, stepper &amp; rowing machine.</li> <li>• Proprioceptive work should include hopping and jumping activities and emphasise a good landing technique. Incorporate lateral movements.</li> <li>• Agility work may include shuttle runs, ball skills, sideways running, skipping, etc.</li> <li>• Low impact and step aerobics classes help with proprioception and confidence.</li> <li>• Pool work can include using flippers.</li> <li>• Sport specific activities will vary for the individual, e.g. Tennis - lateral step lunges, forward and backwards running drills: Skiing - slide board, lateral box stepping and jumping, zigzag hopping; Volleyball or Basketball - vertical jumps.</li> <li>• Commence PEP programme and progress as able (see Stage V for detail)</li> <li>• For jumpers practice good landing technique</li> <li>• ❌ knee flexion, ❌ valgus rotation and toe land</li> <li>• Emphasize gluteal maximus strengthening which is strong hip extender and external rotator while in a flexed hip posture</li> </ul>
<b>Stage V Sport Specific 6-12 Months</b>	Restoration of strength and neuromuscular function	<ul style="list-style-type: none"> <li>• Improve confidence and skill level</li> <li>• Return to training</li> </ul>	<ul style="list-style-type: none"> <li>• Continue progression of plyometrics and sport specific drills.</li> <li>• Return to training and participating in skill exercises.</li> <li>• Continue to improve power and endurance.</li> <li>• Train in neuromuscular program for warm up to reduce further ACL injury</li> <li>• Good examples are FIFA and PEP (shown below)               <ol style="list-style-type: none"> <li>1. Warm-up (50 yards each):                   <ul style="list-style-type: none"> <li>• Jog line to line of soccer field (cone to cone)</li> <li>• Shuttle run (side to side)</li> <li>• Backward running</li> </ul> </li> <li>2. Stretching (30 s × 2 reps each):                   <ul style="list-style-type: none"> <li>• Calf stretch</li> <li>• Quadriceps stretch</li> <li>• Figure 4 hamstring stretch</li> <li>• Inner thigh stretch</li> <li>• Hip flexor stretch</li> </ul> </li> <li>3. Strengthening:                   <ul style="list-style-type: none"> <li>• Walking lunges (20 yards × 2 sets)</li> <li>• Russian hamstring (3 sets × 10 reps)</li> <li>• Single toe-raises (30 reps on each side)</li> </ul> </li> <li>4. Plyometrics (20 reps each):                   <ul style="list-style-type: none"> <li>• Lateral hops over 2 to 6 inch cone</li> <li>• Forward/backward hops over 2 to 6 inch cone</li> <li>• Single leg hops over 2 to 6 inch cone</li> <li>• Vertical jumps with headers</li> <li>• Scissors jump</li> </ul> </li> <li>5. Agilities:                   <ul style="list-style-type: none"> <li>• Shuttle run with forward/backward running (40 yards)</li> <li>• Diagonal runs (40 yards)</li> <li>• Bounding run (45–50 yards)</li> </ul> </li> </ol> </li> </ul> <p style="text-align: center;">Ref: Gilchrist et al AJSM 2008 See you tube for excellent sample video of programme.</p>
<b>Stage VI Return to Sports 12+months</b>	Safe return to sports	<ul style="list-style-type: none"> <li>• Minimise risk of further injury</li> </ul>	<ul style="list-style-type: none"> <li>• By this stage should be adept at PEP program (or similar neuromuscular program).</li> <li>• Neuromuscular warm up before training and playing</li> <li>• Advice may be needed as to the need for modifications to be able to return to sport, e.g. Football - start back training in running shoes or short sprigs. Will usually return to lower grades initially; Skiing - stay on groomed slopes and avoid moguls and off piste initially. Racers may initially lower their DIN setting on the bindings.</li> </ul>

### OUTLINE OF THE SURGICAL PROCEDURE

The knee joint is examined via the arthroscope. Meniscal surgery is performed as required and the ruptured ACL stumps are removed. Via a 2cm incision on the anterior tibia the semitendinosus and gracilis hamstring tendons are harvested at about 20 cm up the medial thigh. The two tendons are doubled over to create a 4 strand graft and sutured together at both ends. The tunnels for the graft are drilled through the tibia and femur and the graft pulled into place in an anatomic position. The graft is secured with interference screws in both the femur and tibia. Full ROM is achieved prior to final tibial fixation. The wounds are closed then closed. Braces are not used routinely postoperatively and patients may weight bear as tolerated immediately after surgery. For the vast majority of patients this is a day surgery procedure.

Updated November 2012