The Gundersen Health System Sports Medicine ACL Reconstruction Rehabilitation Program is an evidence-based and soft tissue healing dependent program allowing patients to progress to vocational and sports-related activities as quickly and safely as possible. Individual variations will occur depending on surgical technique and the patient’s response to treatment.

**Early utilization of NMES highly recommended and encouraged with 2x4”, ideally 3x5” stim pads.**

**Early isolated OKC resisted knee extension should be implemented depending on patient tolerance- ie no increase in PF pain/joint effusion.**

If a [meniscus repair](#) is performed in conjunction with the ACL reconstruction, follow meniscus repair WB restrictions (stable or unstable), ROM 0-90 for 2 wk, no squatting >90 for 4 months, as can be seen in meniscus repair protocol.

If a [hamstring/gracilis autograft](#) is utilized, avoid isolated hamstring strengthening for 6 weeks.

If a [patellar tendon graft](#) is utilized, work on patella mobilizations to prevent excessive scarring.

If an [allograft](#) is utilized, patients may need to be cautioned not to advance too quickly as post-operative pain may be less.

Please contact us at 1-800-362-9567 ext. 58600 if you have questions or concerns.

<table>
<thead>
<tr>
<th>Phase I: 0-6 weeks</th>
<th>Immediate post op maximum protection phase</th>
</tr>
</thead>
</table>
| **Goals**         | • Protect surgical graft  
  • Minimize knee joint effusion  
  • Restore full motion ASAP, emphasizing extension  
  • Encourage quadriceps function  
  • Prevent negative effects of immobilization  
  • Normalization of walking with good heel-toe pattern |
| **Brace**         | • Not all patients will utilize a post-operative brace.  
  • wks 0-1: 0-90 deg, locked for ambulation and sleeping  
  • wks 1+: 0-120 deg, unlocked for ambulation when good quadriceps control and ext ROM full  
  • wk 4: D/C brace |
| **ROM**           | • wks 0-2: 0-90 degrees, emphasis on extension initially with gradual progression of flexion  
  • wks 2-3: 0-110 degrees  
  • wks 3-4: 0-120 degrees  
  • wks 6+: Full ROM |
| **WB**            | • wk 0-1: WBAT with brace locked into extension  
  • wk 1-4: WBAT with brace unlocked if good quadriceps control and knee extension ROM. Discontinue crutches when can ambulate with normal heel-to-toe pattern. |
| **Precautions**   | • If hamstring/gracilis autograft, no isolated resistance to knee flexion initially. Start graded isometrics at wk 4 within tolerance. Progress to isotonics at wk 6. Also apply ice to posterior knee to minimize muscle spasm.  
  • Encourage AROM and WB to promote healing, prevent atrophy of soft tissue and bone, prevent a decrease in collagen content, and to align fibroblast and collagen fibrils.  
  • Emphasis on regaining extension ROM ASAP to prevent arthrofibrosis and decrease stress to the PF joint during ambulation.  
  • Avoid descending stair reciprocally until adequate quadriceps control and lower extremity alignment |
- Avoid twisting and pivoting motions for 6-8 weeks to minimize shear forces to the healing graft.

**Modalities**

- Cryotherapy 15 minutes in duration 3x/day
- IFC for pain/effusion if needed
- NMES quadriceps ASAP in varying positions using 2x4” but ideally 3x5” pads
  - Long sitting QS/SLR/SAQ
  - Short sitting LAQ isometrics into strap vs isotonics with resistance
  - Standing TKE with TB or CC resistance

**Treatment Recommendations**

- Active warm-up (Bike AAROM progress to Bike with resistance, Nu Step)
- Stretching to attain full extension with gradual progression of flexion. Goal of full ROM BEFORE wk 6. Emphasis on full return of knee extension ASAP.
  - Low-load long duration stretching for extension with heat if needed (1st TERT= Total End Range Time)
  - Manual stretching for extension with overpressure / recurvatum
  - Patellar mobilizations
  - PROM / AAROM / AROM
  - Manual stretching into flexion (initially limited by knee joint effusion)
  - wb stretch on leg press for knee flexion ROM
- Flexibility exercises for hamstring, gastoc-soleus
- Scar tissue massage
- Consider personalized blood flow restriction therapy if available.
- Therapeutic exercises. Gentle strengthening protecting the surgical graft. Encourage quadriceps activation and strength. Early isolated OKC resisted knee extension can be implemented depending on patient tolerance- ie no increase in PF pain/joint effusion. Exercise in a pain-free manner. Avoid dynamic valgus during strengthening and functional activities (focus on hip abductor and external rotator strengthening). Incorporate total leg strengthening and balance / proprioception exercises. Work on gait drills (step-overs, march walk).
  - Biofeedback QS, SLR (if no lag), CKC knee extension
  - Hip 4 way SLR, sidelying hip ER
  - Gastroc soleus strengthening
  - Hamstring OKC isotonics 0-90 deg in seated position
- **Quadriceps OKC knee extension per patient tolerance**
  - CKC exercises: Heel raises, weight shifts, leg press and wall squats (0-60 deg)
  - wk 2: Leg press, wall squats (0-90 deg), lateral step-overs step-ups, BW squats, retro TM walking for knee extension
  - forward TM walking for gait training
  - wk 3: Partial lunges front and lateral, leg press 2:1, loaded squats as tolerated
  - wk 4: Elliptical Runner, leg press 2:1 and 1:1, deadlifts
  - wk 5: Resisted sidestep with T-band, Bosu partial squats 0-60 deg
- Total leg strengthening
- Balance / Proprioception training:
  - Double leg progress to single leg, static progressing to dynamic activities.
- Perturbation exercises
- CV conditioning / Core Stability
<table>
<thead>
<tr>
<th>Phase II: 6-12 weeks</th>
<th>Moderate protective phase</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goals</strong></td>
<td></td>
</tr>
<tr>
<td>• Minimize knee joint effusion</td>
<td></td>
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<tr>
<td>• Full ROM by 6-8 weeks</td>
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<tr>
<td>• Gradual progression of exercises for strengthening, stretching, and balance</td>
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<tr>
<td>• Implement low level foot placement drills working on control</td>
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<tr>
<td>• Ability to squat with symmetry to 90 degrees and single leg squat with good knee flexion, control of any dynamic valgus, and without pelvic drop</td>
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</tr>
<tr>
<td><strong>ROM / Brace</strong></td>
<td></td>
</tr>
<tr>
<td>• Progress to full ROM by 6-8 weeks.</td>
<td></td>
</tr>
<tr>
<td>• Knee sleeve may be utilized depending on patient activities</td>
<td></td>
</tr>
<tr>
<td><strong>Modalities</strong></td>
<td></td>
</tr>
<tr>
<td>• Cryotherapy 15 minutes in duration 1-2x/day</td>
<td></td>
</tr>
<tr>
<td>• IFC for pain/effusion if needed. NMES quadriceps if needed</td>
<td></td>
</tr>
<tr>
<td><strong>Precautions</strong></td>
<td></td>
</tr>
<tr>
<td>• Avoid overloading the fixation site by utilizing low amplitude low velocity movements.</td>
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<tr>
<td>• Avoid quick twisting and pivoting motions for 10-12 wks to minimize shear forces.</td>
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<tr>
<td>• Implement low level foot placement focus on control at week 9.</td>
<td></td>
</tr>
<tr>
<td><strong>Treatment Recommendations</strong></td>
<td></td>
</tr>
<tr>
<td>• Active warm-up: Bike with resistance, Nu Step, Treadmill walking</td>
<td></td>
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<tr>
<td>• Stretching for full extension and flexion as needed.</td>
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<tr>
<td>- Low-load long duration stretching with heat if needed</td>
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<tr>
<td>- (1st TERT= Total End Range Time)</td>
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<tr>
<td>- Manual stretching for extension and/or flexion</td>
<td></td>
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<tr>
<td>- Leg press stretch for flexion</td>
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<tr>
<td>• Flexibility exercises as needed</td>
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<tr>
<td>• Therapeutic exercises: <strong>Focus on N-M control and strengthening exercises.</strong> Avoid dynamic valgus during strengthening and functional activities. Incorporate total leg strengthening, focus on hip/glutes, quadriceps, and hamstring. Progress with balance / proprioception exercises. Correct asymmetrical loading patterns</td>
<td></td>
</tr>
<tr>
<td>- Total leg strengthening and CV conditioning</td>
<td></td>
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<tr>
<td>- Hip and core strengthening to prevent knee valgus</td>
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<tr>
<td>- Hamstrings isotonics prone 0-90 deg.</td>
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<tr>
<td>- Quadriceps isotonics OCK knee extension</td>
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</tr>
<tr>
<td>- Balance / Proprioception training: Single leg stance activities static progressing to dynamic activities. Perturbation exercises</td>
<td></td>
</tr>
<tr>
<td>- CKC exercises: Leg press 1:1, step-ups/step downs, squats progression double to single leg, split squats lunge progression, deadlifts, sidestep/sideshuffle with SPRI</td>
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<tr>
<td>- wk 8: Hamstring curls with physio ball</td>
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<tr>
<td>- Balance exercises: add in external focus of attention (ball catch, plyo back throws)</td>
<td></td>
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<tr>
<td>- Isokinetic quadriceps/hamstrings</td>
<td></td>
</tr>
<tr>
<td>- VSRP 180-300 deg/sec sub-max to max</td>
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<tr>
<td>Wk 10: Isokinetic quadriceps/hamstring</td>
<td></td>
</tr>
</tbody>
</table>
**Phase III: 12-24 wks (3-6 months)**

<table>
<thead>
<tr>
<th>Independent strengthening</th>
<th>Advanced Strengthening and Functional Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low level foot placement drills starting at wk 9</td>
<td>• Progress muscle strength, endurance, and balance activities. Ideally 3x/week of exercises at a fitness center, step-down, or home program. Progress to higher level activities depending on functional demands and MD approval</td>
</tr>
<tr>
<td>• IFC for pain/effusion / NMES for quadriceps activation and control as needed</td>
<td>• Address fear avoidance beliefs by graded exercise progression, cuing, positive reinforcement, referral if necessary.</td>
</tr>
<tr>
<td>• Ice (in stretch if needed) 2nd TERT</td>
<td>• Initiate a return to running program at 3-4 months if passes criteria and has no compensations with running pattern.</td>
</tr>
<tr>
<td>• HEP for 3rd TERT if needed</td>
<td>• Initiate working on landing mechanics and control at 4-5 months if passes criteria on the following page</td>
</tr>
<tr>
<td>• wk 12: Can progress to independent strengthening program with monthly or bi-monthly visits if good ROM, minimal effusion, full MMT, able to SL squat, pass y-balance.</td>
<td>• Progress agility drills at 4-5 months</td>
</tr>
</tbody>
</table>

**Goals**

Make sure patient is enrolled in MyCare for IKDC survey (6M, 9M, 1Y, 2 Y, 5Y)

**Brace**

- Your MD may recommend a knee sleeve or functional brace to be used until 12 months from your surgery for higher level activities

**Modalities**

- Cryotherapy 15 minutes 1x/day or after strenuous activity

**Treatment Recommendations**

**Return to Running Benchmarks:**
- 4 months
- Passes testing criteria - See next page

**Return to Landing Drills Benchmarks:**
- 4 months
- Passes testing criteria - See next page

**During Landing drills:**
- 4 months-5 months: continue with strengthening and dynamic balance
Focus on:
1. Soft landing with knee flexion > 30 deg
2. no medial collapse/knee valgus
3. no hip IR/ pelvic drop
4. Dynamic postural control

progress to the following exercises if clinical appropriate (see side bar)
- Landing drills: Low amplitude sub-max drills
  Shallow jump landings, double to single line jumps, squat jumps
  progress to higher level if meets criteria (see sidebar)
- Agility drills: Low amplitude low velocity drills:
  skipping F/B, jogging F/B, skaters, carioca
  progress to higher level with speed and complexity (when appropriate)
  agility ladder drills, cutting/pivoting (changing directions), changing speeds, anticipated to un-anticipated

<table>
<thead>
<tr>
<th>Phase IV: 6-9 months</th>
<th>Return to Higher Level Activities and Sport Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>Continue to progress with strengthening, landing and agility drills to pass return to sports criteria – see testing algorithm</td>
</tr>
<tr>
<td></td>
<td>Progress to sport specific drills</td>
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<tr>
<td></td>
<td>Address fear avoidance beliefs by graded exercise progression, cuing, positive reinforcement, referral if necessary.</td>
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<tr>
<td></td>
<td><strong>Return to sports at 9-12 months if passes criteria – see testing algorithm.</strong> Sports progression may take 2-4 weeks for full clearance back to full competition</td>
</tr>
</tbody>
</table>

| Brace                | Your MD may recommend a knee sleeve or functional brace to be used until 12 months from your surgery for higher level activities |

<table>
<thead>
<tr>
<th>Treatment recommendations</th>
<th>Specific interventions and treatments will depend on the testing results. Address areas of deficits and sport specific demands.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Strengthening exercises (if strength scores &lt;90%)</td>
</tr>
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<td></td>
<td>• Dynamic balance exercises if indicated (Y balance &lt;4cm, poor control)</td>
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<tr>
<td></td>
<td>• Landing/jumping/hopping drills if limb symmetry &lt;90% on hop test and/or faulty movement patterns (stiff knee landing, asymmetrical loading, knee valgus, poor postural control)</td>
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<tr>
<td></td>
<td>• Progress agility drills</td>
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<tr>
<td></td>
<td>• Progress to sport specific exercises and drills</td>
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</tbody>
</table>

9 months+: possible clearance for return to sport, depending on testing - see next pages for testing algorithm
**Return-to-Sports Progression:** (2-4 weeks, depending on tolerance)

<table>
<thead>
<tr>
<th>Step 1:</th>
<th>1 on 1 drills (non-contact) sport specific activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 2:</td>
<td>1 on 1 drills (contact) full speed sport specific activities</td>
</tr>
<tr>
<td>Step 3:</td>
<td>Team scrimmage (non-contact)</td>
</tr>
<tr>
<td>Step 4:</td>
<td>Team scrimmage no restrictions</td>
</tr>
<tr>
<td>Step 5:</td>
<td>Game activities with restricted playing time</td>
</tr>
<tr>
<td>Step 6:</td>
<td>Game activities with no restrictions</td>
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</tbody>
</table>

**ACL Return-to-Running and Return-to-Sport Testing Algorithm:** Determined by:
Time out from surgery, Testing performance, PT/MD approval

<table>
<thead>
<tr>
<th>6 weeks</th>
<th>1. Knee ROM</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Hip strength:</td>
<td>Abduction MMT</td>
</tr>
<tr>
<td>3. SL 30 deg Stork test</td>
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<tr>
<td>4. FOTO</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>8 weeks:</th>
<th>1. Knee ROM</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Hip strength:</td>
<td>Abduction MMT/dynamometry</td>
</tr>
<tr>
<td>Hip Abduction Side plank test</td>
<td></td>
</tr>
<tr>
<td>3. SL 30 Stork test</td>
<td></td>
</tr>
<tr>
<td>4. Y balance</td>
<td></td>
</tr>
<tr>
<td>5. Squat WB symmetry: Force plate</td>
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</table>

<table>
<thead>
<tr>
<th>12 weeks (3 months)</th>
<th>1. Knee ROM</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. SL 60 deg Stork test</td>
<td></td>
</tr>
<tr>
<td>3. Hip strength:</td>
<td>Abduction MMT/ dynamometry / Hip Abduction Side plank test</td>
</tr>
<tr>
<td>4. Biodex test:</td>
<td>20 deg extension block</td>
</tr>
<tr>
<td>2 speeds: 180 deg/sec (5 reps) 300 deg/sec (30 reps)</td>
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</tr>
<tr>
<td>5. Y balance test</td>
<td></td>
</tr>
<tr>
<td>6. Squat WB symmetry: Force plate</td>
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</tr>
<tr>
<td>7. FOTO</td>
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</tbody>
</table>

**Return to Running Benchmarks:**
1. Time: at least 4 months post-op:
2. MD / PT clearance
3. No knee joint effusion
4. ROM: limb symmetry:
   - extension within 5 deg
   - flexion within 10 deg
5. Biodex: Limb symmetry of PT:
   - Quad: 75%
   - Hams: 75%
6. Anterior lateral hop to stabilization drill completed with no apprehension and good movement control
7. Assess running form: Treadmill running (sub-max at self selected speed)

**Recommendations:**
1. Biodex:
   - Quad PT/BW: +/- 5%
   - Males: 95%, 75%, 50% at 60, 180, 300 deg/sec
   - Females: 85%, 65%, 35% at 60, 180, 300 deg/sec
   - H/Q ratio: +/- 5%: 65%, 75%, 90% at 60, 180, 300 deg/sec
   - Total work at 300 deg/sec:
     - Quad: limb symmetry 75%
     - Hams: limb symmetry: 75%
2. SL 60 deg stork test:
   - Limb symmetry: 90%
3. Hip Abductor strength: MMT 5/5 or dynamometry 90%
4. Squat WB symmetry with near equal WB
5. Y balance: Limb symmetry: < 4cm
16 weeks (4 months) – RETURN to RUNNING
Repeat previous tests not passed
For Biodex test:
   20 deg extension block
   3 speeds:  60 d/sec (5 reps)
   180 d/sec (5 reps) 300 d/sec (30 reps)
*if adequate strength scores for return to running
   (quads at least 75%, hamstrings: at least 75%)
1. Anterior lateral hop to stabilization
2. Sub-Max Jump test: no arm swing
3. Sub-Max Single Hop Assessment: no arm swing
   For apprehension and control
4. Trial of running
5. Screen for fear avoidance/kinesiophobia
   (ACL-RSI survey)

---

Return to Jumping/Landing Drills

Benchmarks:
1. Time: at least 4-6 months
2. MD/ PT clearance
3. No knee joint effusion
4. Biodex: Limb symmetry of PT:
   Quadriceps and hamstrings: 75-85% = sub-max landing drills
   Quadriceps and hamstrings: 85-90% = max landing drills
Minimize the following 4 variables with landing drills:
   1. Stiff landing (< 30 deg knee flexion)
   2. Knee valgus
   3. Hip IR / pelvic drop
   4. Loss of Dynamic balance

---

ACL Return-to-Running and Return-to-Sport Testing Algorithm

24 weeks (6 months)
Repeat previous tests not passed
1. Biodex test: Full ROM with no ext block
   3 speed test:  60 deg/sec (5 reps),
   180 deg/sec (5 reps),
   300deg/sec (30 reps)
2. Squat WB symmetry: force plate
3. Landing Assessment: qualitative*
   a. Broad jump - 2D – no arm swing
   a. Land Vertical Jump – 2D (front and side)
   b. Sub-max Single leg Hop –2D (front and side) – no arm swing
      progress to max if:
      
      strength 90%
      limited landing mechanic variable
4. FOTO and IKDC (Mycare)
5. Screen for fear avoidance/kinesiophobia
   (ACL-RSI survey)

*Landing mechanic variables at impact for potential injury risk:
   1. Stiff landing (< 30 deg knee flexion)
   2. Knee valgus
   3. Hip IR / pelvic drop
   4. Decreased dynamic balance
      (poor trunk control, increased # reps to complete)

---

Return to sport depends on:
Timeframe from surgery
Test performance
MD and PT approval

---

Gundersen Lutheran Medical Center, Inc. | Gundersen Clinic, Ltd.
9 months - Possible return to sport
Repeat previous tests not passed
1. Biodex test: Full ROM with no ext block
   3 speed test: 60 deg/sec (5 reps),
     180 deg/sec (5 reps),
     300 deg/sec (30 reps)
2. Landing Assessment: quantitative for limb symmetry
   qualitative for landing mechanics variables
   a. Single leg hop (no arm swing) – 2D (front and side)
   b. Triple hop (arm swing) – 2D (front)
   c. Cross-over hop (arm swing) – 2D (front)
3. Agility test: LEFT test components or time
4. FOTO and IKDC (Mycare)
5. screen for fear avoidance/kinesiophobia
   (ACL-RSI survey)

2 year/ 5 year
IKDC (mycare)

Return to Sport Benchmarks:
1. Time: at least 9-12 months
2. MD/ PT clearance
3. No knee joint effusion
4. ROM: limb symmetry:
   extension within 5 deg
   flexion within 10 deg
5. Biodex: Limb symmetry of PT:
   Quad: 90%
   Hams: 90%
6. Landing Assessment:
   (Single Hop/ Triple Hop/ Cross-over Hop)
   Quantitative: Limb symmetry: 90%
   Qualitative variables - no faulty landing
      mechanics – see previous column*
7. Agility components with no compensation
8. No evidence of fear avoidance

Recommendations:
1. Biodex:
   *Quad PT/BW: (+/-5%)
      Males: 95%, 75%, 50% at 60, 180, 300 deg/sec
      Females: 85%, 65%, 35% at 60,180,300 deg/sec
   H/Q ratio: (+/- 5%)
      65%, 75%, 90% at 60, 180, 300 deg/sec
   Hams PT/BW: (+/- 5%)
      Males: 60%, 35%, 25% at 60, 180, 300 deg/sec
      Females: 60%, 35%, 25% at 60, 180, 300 deg/sec
   Total work: 300 deg/sec
      Quads: Limb symmetry: 90%
      Hams: Limb symmetry: 90%
2. Hip Abductor strength: MMT 5/5 or dynamometry 90%
3. Y balance: Limb symmetry: < 4cm
4. Jump test:
   Males: 90%-100% height
   Females: 80%-90% height
5. Single hop test:
   Males: 80-90% height
   Females: 70-80% height
Accelerated Rehabilitation Following ACL Reconstruction using Ipsilateral Patellar Tendon Graft


Davies GJ, Zillmer DA: Functional progression of exercise during rehabilitation in Knee Ligament Rehabilitation, Ellenbecker, 2000; 345-360


Rehab, 1997; 6: 157-181


Martinek MV, Friederich NF. To brace or not to brace? How effective are knee braces in rehabilitation. Orthopade, 1996; 28(6): 565-570

Neitzel JA, Kernozek TW, Davies GJ: Loading response following ACL reconstruction during the parallel squat exercises. Clinical Biomechanics, 2002; 17(7): 551-554


Mikkelsen C, Werner S, Eriksson E. Closed kinetic chain alone compared to combined open and CKC exercises for quads strengthening after ACL reconstruction with respect to return to sports: a prospective matched follow-up study. Knee Sur, Sports Trau, Arthr, 2000; 8: 337-42


Risberg MA, Mork M, Jenssen HK, Holm I. Design and implementation of a neuromuscular training program following ACL reconstruction. J of Ortho and Sports Phy Ther, 2001; 31: 620-31

Sapecga AA, Quedenfeld TC. Biophysical factors in range of motion exercises. Physician and Sports Medicine, 1981; 9: 57-65


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Englander ZA, Garrett WE, Spritzer CE, DeFrate LE. In vivo attachment site to attachment site length and strain of the ACL and its bundles during the full gait cycle measured by MRI and high-speed biplanar radiography. J Biomech. 2020;98:109443.


