

# ValleyOrtho Rehabilitation Playbook Series

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## **Surgical Procedure:** ACL Reconstruction

*The intent of this information is to inform the treating clinician on the evidence-based considerations to be used as a guideline regarding the surgery noted above. This is not a substitute for appropriate clinical decision making, but a supplement to that effect. If at any time a clinician feels uncertain about a given phase discrepancy or patient presentation they are strongly encouraged to discuss this with the referring physician and his/her team.*

*\*\*\*It is the responsibility of the therapist to read the operative report before providing care to the patient to improve treatment communication\*\*\*.*

**Therapeutic Activity Progression Disclaimer:** Progression to the next phase should be strongly based on meeting clinical criteria (not solely based on the post-operative timeframes) as appropriate and in collaboration with the referring surgeon. Exercise prescription should be clinically directed by pain and performance absent of detrimental movement patterns with respect to proper biomechanics of the spine, hip, knee and ankle.

## Communication Recommendations from Therapist to Surgical Team:

When a treating therapist feels the need to reach out to Dr. Liotta, or a member of his team, at any point for any reason they are strongly encouraged to do so. All concerns are not explicitly written and clinical judgement is paramount. Below is a handful of reasons and suggested methods of contact to promote communication:

## Urgent Red Flag Communication: the patient is in clinic and an action is required as directed by referring staff office

- Uncontrollable and unremitting pain.
- Signs of infection at incision or treated limb.
- Severe palpation tenderness, swelling, tachycardia (UE or LE DVT).
- Labored breathing (PE).
- Drastic improvement or decline in ROM (failed component/repair).
- After a fall/trauma, or near fall/trauma, resulting in a clinical change.

### **Preferred Contact Method:**

1. Immediate Telmediq Phone Call to MD.
2. Telmediq Phone call to PA.
3. If no response within 10 minutes, call consult line 970-384-7147.

## Other Patient Concerns: During Clinic Hours M-TH 9am-5pm F 9-3pm

- Abnormal pain, comorbidities or complications that may prevent attainment of established discharge criteria.
- Patient is noncompliant with rehabilitation process.
- Excessive muscle guarding/motion phobia after 1-2 outpatient visits.
- Adverse work or home practices negatively impacting recovery.
- Patient expresses discontent or concerns with the current POC established by PT and/or by MD/PA

**Preferred Contact Method:** non-emergent office or cell phone call for verbal discussion with MD &/or PA

## Preferred Updates before checkup visits with MD/PA

During Clinic Hours M-TH 9am-5pm F 9am-3pm

- Information regarding adherence/participation in rehabilitation process.
- Comments on progress and trend of the patient's rehab course.

**Preferred Contact Method:** 1. Use Telmediq Chat (informal) Text to MD and/or PA. Use patient name & DOB in subject and body of text.  
2. Complete a Progress note in Cedaron.

## Administrative Needs

- Rehabilitation Prescription needed or specific prescription change requests.
- Appointment needed with the physician office, or medication refill.

**Preferred Contact Method:** 1. Create Athena Patient Case Request  
2. Phone call to MA/ATC



## Phase 0: Pre-Operative Preparation

### Goals:

- Optimize post-surgical outcome and return to recreational activity potential<sup>2, 19, 27</sup>
- Restore ROM, decrease swelling and improve quad function<sup>34</sup>

### Precautions:

- Avoid WB activities that may further damage meniscus/articular cartilage.
- Self-optimism, self-confidence and motivation lead to improved return to sport likelihood<sup>7</sup> avoid negative and fear provoking language.

### Phase 0 Therapeutic Activities:

- Establish estimated pre-injury capacity (EPIC)<sup>35</sup>: Perform the RTS testing below on uninvolved LE as described in appendices B-E and G-I.
- Administer ACL-RSI (see Appendix J): <45% = poor self-confidence + high fear<sup>3</sup>. Needs increased encouragement/support for RTS<sup>7</sup>
- Manual work for swelling management and education for home care<sup>2</sup>
- Patient education for initial post op exercises, rehabilitation expectations and post op cryotherapy<sup>19, 27, 34</sup>
  - 15 minutes every hour x24-72 hours until active inflammation is controlled then 3x/day for 15 minutes<sup>27</sup>
- Gait training and crutch education<sup>19, 27</sup>
- A/PROM<sup>2, 27</sup>
- NMES to quad if necessary for proper activation<sup>14, 19, 24, 27</sup>
- Controlled CKC with quadriceps > HS focus<sup>19, 27</sup>
- See Appendix K for BFR Preconditioning protocol for improved quad endurance and protected micro vascularity in the 1<sup>st</sup> 4 weeks s/p ACL reconstruction<sup>42</sup>

### Ideal Pre-Surgical Criteria:

- AROM 0-120<sup>2, 34</sup>
- Little to no swelling vs uninvolved<sup>2, 27, 34</sup>
- 20 repetitions of a SLR ≠ quad lag<sup>27</sup>
- Standing march ≠ extension lag: Standing on involved knee, without UE support, patient is able to perform 10 march repetitions of uninvolved hip maintaining full knee extension on involved knee ≠ lag<sup>2</sup>
- Normal heel to toe gait pattern without AD<sup>10, 27</sup>

## Phase 1: Quadriceps, WB and ROM Recovery (weeks 1 - 2)

### Goals:

- ↓ pain/swelling (to decrease quad inhibition<sup>34</sup>) and protect the graft<sup>10, 27</sup>
- 0° A/PROM knee EXT<sup>10, 19, 24, 27, 34</sup> Gradual flexion<sup>10</sup> to ≈ 110<sup>027</sup>
- Normalize quadriceps activation/control<sup>10, 14, 19, 24, 27, 34</sup>

### Precautions/Restrictions:

- WBAT ≠ brace<sup>27</sup>
- AROM/RRROM: CKC is the preferred LE loading strategy<sup>10,11,19, 34, 43</sup>  
CKC: ≤90° knee flexion wk 0-3<sup>10</sup>
- OKC Knee Ext: in knee flexion ROM 90-45 deg until wk 6, Weight of leg AROM only until week 2<sup>38</sup> then RRROM OK ≤5# resistance<sup>43</sup> wk 2-6<sup>19</sup> (delay any OKC until wk 4 for HS/ allograft<sup>11, 19, 43</sup>) Then can progress OKC EXT as the knee tolerates at wk 6<sup>10, 11, 19, 24, 27, 34</sup>
- RRROM OKC Flexion: Delay until wk 8 with HS graft<sup>34, 43</sup>
- Avoid pivot/twisting training until week 12<sup>10</sup>, No plyometrics<sup>10, 22, 27, 34</sup>
- See Meniscal Repair Playbook & RX when involved for more restrictions
- With PCL/LCL/MCL/PLC REPAIR: limit flexion to 120° until week 6<sup>10</sup>

### Phase 1 Therapeutic Activities:

- Heel to toe gait progression from bilateral crutches to single crutch ≠ limp<sup>14, 19</sup> d/c AD once 20 SLR + 10 TKE stance marches is possible ≠ lag
- Strengthening: CKC HS, calf, and TKE focused Quad<sup>10, 11, 14, 19, 24, 27, 34</sup>, CKC/OKC Hip<sup>27</sup>. CKC preferred due to decreased graft strain<sup>34, 43</sup> SLR in all planes ≠ quad lag. Knee OKC within restrictions mentioned above. Isometric knee ext at 90° and 60° knee flexion angles<sup>34</sup>
- NMES to quad with volitional contraction as needed<sup>14, 19, 24, 27, 34</sup>
- Manual & self-management for flexibility, swelling and ROM
- Uninvolved LE or UE aerobics help to maintain fitness in weeks 1-6<sup>14</sup>
- Scar mobilizations on healed incisions<sup>27</sup>
- BFR can be combined with phase appropriate ACL activity (isometrics, concentric/eccentric, OKC or CKC) using ≈ 20-30% of a 1 Rep Max<sup>39, 40, 41</sup>
- BFR occlusion periods range from 3-5 minutes with rest periods of 45 seconds to 3 minutes<sup>40</sup> Using individualizing occlusion pressures based on % of total arterial occlusion between 60-80% has important implications for safety and effectiveness<sup>40</sup>

### Criteria for Progression to Phase 2:

- 0° EXT<sup>10</sup>, ≥ 110° Flexion (meniscus repair flexion only to 90°)<sup>27, 38</sup>
- 20 SLR<sup>27</sup> and 10 standing marches<sup>2</sup> ≠ Quad Lag
- Normalize Gait ≠ AD and WB tolerance ≈ Day 10<sup>11, 14, 19</sup>



## Phase 2: Total LE Strengthening & Balance (weeks 3 - 5)

### Goals:

- Restore 100% LSI knee A/PROM and normalize balance<sup>27</sup>
- Restore complete patellar mobility<sup>34</sup>
- Improve LE<sup>10, 27</sup> and core strength/control<sup>2, 28</sup>

### Precautions:

- **AROM/RROM: CKC is the preferred LE loading strategy**<sup>10,11,19, 34, 43</sup>
- **OKC Knee Ext:** endurance focus only<sup>11</sup> ≤ 5# resistance<sup>43</sup>; BPTB/QT 90°-45°<sup>11, 34, 43</sup> (delay until wk 4 for HS/allograft<sup>11, 19, 43</sup>) then all grafts can progress OKC EXT as the knee tolerates at wk 6<sup>10, 11, 19, 24, 27, 34</sup>
- **RROM OKC Flexion:** Delay until wk 8 with HS graft<sup>34, 43</sup> or Allograft
- Avoid pivot/twisting training until week 12<sup>10</sup>, No plyometrics<sup>10, 22, 27, 34</sup>
- See Meniscal Repair Playbook & RX when involved for more restrictions
- With PCL/LCL/MCL/PLC REPAIR: limit flexion to 120° until week 6<sup>10</sup>

### Phase 2 Therapeutic Activities:

- Bike/elliptical warm ups<sup>10, 27</sup> can do stair master training<sup>27</sup>
- Reduced BW Leg press or reduced WB Eccentric focused CKC quad training<sup>11, 14, 19, 24</sup> slow eccentric control out of 0° TKE.
- Exercises with knee alignment focus<sup>2</sup>: Step ups<sup>2, 10, 27</sup> and resisted walking forwards, backwards, and lateral as tolerated.
- Can begin RROM OKC knee flexion with BPTB/QT<sup>14</sup>
- Core strength and control,<sup>28</sup> Side plank progressions<sup>2</sup>
- Scar mobilizations<sup>27</sup> and patellar superior tilt mobilizations<sup>34</sup>
- Manual for flexibility, swelling and ROM improvements as appropriate to normalize LE Flexibility<sup>27</sup>
- BFR can be combined with phase appropriate ACL activity (isometrics, concentric/eccentric, OKC or CKC) using ≈ 20-30% of a 1 Rep Max<sup>39, 40, 41</sup>
- Continue BFR use if patient is only tolerating low load activity as moderate to high loads with BFR showed less additional benefit vs control groups using moderate to high loads without BFR<sup>41</sup>
- Balance with altered surfaces/balance boards<sup>10, 27</sup> and perturbations<sup>34</sup>
- Resisted side stepping with gluteal focus<sup>10</sup>

### Criteria for Progression to Phase 3:

- Full Knee A/PROM<sup>10, 27, 34</sup>
- No Swelling<sup>10, 27</sup>
- Performing functional ADLs without discomfort<sup>10, 27</sup>

## Phase 3: Single Leg & Core Stability & Strength (weeks 6 - 11)

### Goals:

- Be prepared for return to running/jumping activity in BPTB ≈ week 12<sup>22</sup>
- HS graft delay ≈ week 16<sup>34</sup>
- Improve strength, coordination, confidence and biomechanical control with single leg activity<sup>10</sup>
- Improve cardiovascular endurance on bike/elliptical/stepper<sup>10, 27</sup>
- **In prepubescent patients:** focus Primarily on form control and movement patterns instead of muscle hypertrophy as their bodies will not put on muscle growth as in older patients<sup>2, 28</sup>

### Precautions:

- Accelerated OKC programs with HS graft has potential to widen graft tunnels<sup>11</sup> Use caution with progressions that add strain/shear to ACL.
- **RROM:** No OKC Flexion until week 8 with HS autograft<sup>34, 43</sup>
- Avoid pivot/twisting training until week 12<sup>10</sup>
- Avoid full BW single leg plyometrics until return to running criteria is met<sup>22, 27</sup> Delay until week 16 with HS autograft<sup>34</sup>
- See Meniscal Repair Playbook & RX when involved for more restrictions

### Phase 3 Therapeutic Activities:

- Can begin slow progressive double leg plyometrics.
- Single leg CKC with proper knee alignment up to 90° as tolerated<sup>10, 27</sup>
- Front and side plank variations<sup>28</sup>
- Posterior chain<sup>28</sup> and pronation control<sup>34</sup> emphasized for knee control
- Perturbation single leg stance training to proper form tolerance<sup>10, 27, 28, 34</sup>
- ↓ BW Double to single leg jumping and landing progressions<sup>6, 10, 27</sup>
- Delay HS graft to start at 10 weeks<sup>34</sup>
- Continue BFR use if patient is only tolerating low load activity as moderate to high loads with BFR showed less additional benefit vs control groups using moderate to high loads without BFR<sup>41</sup>
- Reduced BW Sub-max impact activities with dynamic valgus control<sup>10</sup>

### Criteria for Phase 4 & Initiation of Straight Line Jogging:

**\*\*Do not progress test sequence if pain is experienced with test\*\***

1. Knee AROM ≤ 0° EXT and flexion to 95% LSI<sup>22</sup>
2. Stork test LSI ≥ 70%<sup>5, 6, 25, 27</sup> (page 5 & Appendix A).
3. Isometric leg press<sup>2</sup> at 60° of knee flexion LSI ≥ 70% (See Appendix G).
4. Isometric quad and HS LSI ≥ 70% at 60° of flexion<sup>5, 6, 22</sup> without pain<sup>10</sup>  
□ 12 weeks with HS autograft<sup>19</sup> / meniscus repair (See Appendices H & I).
5. Timed Single Leg Squat Test 0°-60°: LSI ≥ 70% (page 5 & Appendix B).
6. Single leg hop test LSI ≥ 70%<sup>22</sup> (described on page 5 & Appendix C).



## Phase 4: Advanced Training & Plyometrics (weeks 12 - 15)

### Goals:

- Increase confidence and form with jumping and landing<sup>27</sup>
- Straight line running and figure 8 running without pain<sup>6, 10, 27</sup>
- Improve total LE strength and coordination<sup>10, 27</sup>

### Precautions:

- No swelling or pain >2/10 with 10 minutes of jogging<sup>22</sup>
- **Be Aware:** Vascularization to autografts increases between 3-6 months leading to a weaker graft tensile strength, with allografts this process starts at 6 months<sup>16</sup> Form and control with training are extremely important.
- Can begin RROM OKC EXT with HS Autograft<sup>19</sup> and allografts<sup>8, 13, 21</sup>
- MENISCUS REPAIR: No squats past  $\approx 90^{\circ}$  for 24 weeks<sup>10</sup>

### Phase 4 Therapeutic Activities:

- Sport specific drills/patterns at 50% effort<sup>27</sup>
- Easy single leg plyometric progressions without valgus<sup>6, 10, 27</sup>
- Ladder drills and progressive agility at 50-75% effort as tolerated<sup>10, 27</sup>
- High level balance training<sup>10, 27</sup>
- Continue core strengthening<sup>10, 27, 28</sup>

### Criteria for Progression to Phase 5:

- Double leg jump  $\geq 75\%$  patient height<sup>5, 6, 10, 27</sup>
- Single leg hop testing  $\geq 75\%$  LSI<sup>5, 6, 10, 27</sup>
- Able to run at 50-75% effort in straight line and figure 8 pattern without discomfort<sup>5, 6, 10, 27</sup>

## Phase 5: Return to Sport Prep and Final HEP(weeks 16 – 24)

### Goals:

- Increasing strength.
- Optimize biomechanics at the hip, knee and ankle.
- Establish patient self-confidence with RTS activity.
- Establish patient specific HEP relative to resources and goals.

### Precautions:

- MENISCUS REPAIR: No squats past  $\approx 90^{\circ}$  for 24 weeks<sup>10</sup>

### Phase 5 Therapeutic Activities:

- Administer ACL-RSI:  $<56\%$  = poor self-confidence + high fear<sup>3</sup>. Needs increased encouragement/support for RTS<sup>7</sup>
- Increase in unplanned tasks watching for dynamic valgus control<sup>1, 5, 6</sup>
- Plyometrics as tolerated<sup>10, 27</sup>
- Increase cutting/pivot and decelerating intensity as tolerated<sup>5, 10, 27, 28</sup>
- Continue total lower extremity strengthening based on remaining deficits.

### Criteria for RTS Testing (Phase 6):

- No complaints with functional or exercise tasks.
- Reports confidence with all running and jumping tasks.

### Progression Note:

- If comorbidities create unattainable goals for discharge, discuss this with the treating physician group.



## Phase 6: Return to Activity/Sport Participation Testing *wks 24+*

### Goals:

- Identify those patients ready to return to non-contact sport participation and slow integration into competitive sport at 9 – 12 months<sup>2,6</sup> depending on return to activity testing<sup>37</sup>

### Graft Healing Considerations for RTS:

- Graft rupture occurs in 6%-12% of cases<sup>8</sup>
- Some HS autograft ACL patients are not to normal levels of strength compared to control groups at 24 weeks<sup>13</sup>
- Delayed in the onset of the vascularization period in HS autograft and allografts compared to autografts with bony attachments may necessitate prolonged RTS training in HS and allografts<sup>13, 17, 43</sup>
- BPTB Grafts begin vascularization period at 1 month and can continue to be seen on MRI until month 16-18, then the graft will look similar to a native ACL, HS autografts show slower maturation at month 6 but ultimately return to a native ACL around the same time as BPTB grafts<sup>8</sup>
- Graft maturation research supports return to sport closer to 9 months for decreased re-injury rates<sup>2, 6</sup>. Similar studies suggest up to 2 years due to continued remodeling of graft tissue<sup>6, 8</sup>. It is important to note that these studies do not look at strength/function and return to sport readiness when assessing re-injury rates.

### Return to Sport Disclaimer:

- Pain free running in a predictable and controlled environment is not the same as returning to sport. Proficiency in Phase 5, meeting all RTS criteria and slow deliberate integration into athletic competition (non-contact to contact progressions) and improving confidence in those environments are critical to help reduce the risk of re-injury.
- Meeting goals of LSI, functional performance on hop tests, subjective readiness and movement quality may not be enough to eliminate sufficient risk of re-tear based on patient specific non-modifiable risk factors. If the patient also has low performing return to sport testing and unaddressed modifiable risk factors for ACL tears there is a higher need for a risk benefit analysis and discussion for returning to sport before 12 months.

## The Premiere Athletic & Sport Screening (PASS) Program

### Criteria for Return to Recreational Activity:

#### General Ortho Patient:

- Patient meets all return to running criteria in previous phase.
- Max single leg press LSI  $\geq 90\%$ <sup>6, 10, 11, 19</sup>

#### Recreational Athlete Sequence (includes above):

- Max Isometric Quad and HS LSI = 90-100%,<sup>5, 6</sup> and/or EPIC  $\geq 90\%$ <sup>35</sup> OKC at 60° of knee flexion.
- Single leg hop test for distance: Females  $\geq 70\%$  of patient height  
Males  $\geq 80\%$  of patient height<sup>5, 6</sup> and Both sexes LSI  $\geq 90\%$ , and/or EPIC  $\geq 90\%$ <sup>35</sup>
- Timed single leg squat test: LSI = 90-100% and/or EPIC  $\geq 90\%$ <sup>35</sup> at 60° of knee flexion.

#### Competitive Athlete (includes above):

- All testing performed with the patient in a bilaterally fatigued state<sup>6</sup>
  - Patient to run or bike 15 minutes at a level 8 on the Modified Borg Rate of Perceived Exertion scale immediately prior to testing
- Max single leg press LSI = 95-100%<sup>6, 10, 11, 19</sup> and/or EPIC  $\geq 90\%$ <sup>35</sup>
- Max Isometric Quad and HS LSI = 95-100%<sup>5, 6</sup> and/or EPIC  $\geq 90\%$ <sup>35</sup> OKC at 60° of knee flexion
- Single Leg hop test for distance: Males 90% patient height / Females 80%. Both sexes LSI  $\geq 95\%$ <sup>5, 6</sup> and/or EPIC  $\geq 90\%$ <sup>35</sup>
- Side Hop test: LSI  $\geq 90\%$ ,<sup>36</sup> and/or EPIC  $\geq 90\%$ <sup>35</sup>
- Crossover hop test for distance<sup>30, 31</sup>  $\geq 90\%$  of normative data & 95% LSI,<sup>5, 6</sup> and/or EPIC  $\geq 90\%$ <sup>35</sup>
  - College Age +:  $\geq$  Males 197in / Females 157.5in
  - High School Age:  $\geq$  Males 185in / Females 134in
- Meets normative Agility T-Test:  $\leq 11$  seconds Males,  $\leq 13$  seconds Females<sup>30, 32</sup>



## Return to Activity Test Descriptions:

### **Stork Balance Test<sup>25</sup>:** (See Appendix A for diagram)

- Hands on hips. NWB foot: medial distal femur or medial proximal tibia.
- Timer starts when the patient lifts heel of the stance foot off the ground.
- Timer stops if/when the patient removes hands from hips, NWB foot from medial stance leg or the heel comes in contact with the ground.

### **Timed Single Leg Squat Test:** (See Appendix B for diagram)

- Mark heel line 6 inches forward of seated surface. Sit on edge of seat, heels on heel line, adjust knee to 60° flexion by adjusting seat height.
- Patient performs single leg squats from 0° extension to tapping surface.
- Count the number of completed squats in 2 minutes per leg.

### **Single Leg Hop Test for Distance<sup>6</sup>:** (See Appendix C for diagram)

- Measure patient's standing height in cm for pass/fail.
- Hands on hips to prevent arm swing momentum during jump.
  - Arms can release for landing assistance after leaving ground.
- 4 progressive warm up jumps ≈ 25%, 50%, 75% and 100% intensity.
- Patient must "stick" the landing ≠ significant knee valgus (concentric or eccentric).
- Use the best of 3 maximum effort jump tests.
- Distance is measured from toe at start line to the landed heel.

### **Single Leg Timed Side Hop Test<sup>36</sup>:** (See Appendix D for diagram)

- Set up: 2 parallel lines on floor, with outer edges of lines 40cm apart.
- Start position: standing on single test leg with hands on hips.
- Action: Patient hops from outside of one line to outside of the other.
- Record the total number of completed foot strikes in 30 seconds.
  - Completed foot strikes = foot lands completely outside the line, without touching the line, while maintaining hand position.

### **Crossover Hop Test<sup>30, 31</sup>:** (See Appendix E for diagram)

- Patient starts on one leg with center line just lateral to stance leg.
- Patient is instructed to maximally hop forwards 3 times on the same stance leg, alternately crossing a ≈15cm wide line.
- Distance is measured from toe of start line to heel of 3<sup>rd</sup> landed hop.

### **Agility T-Test<sup>30</sup>:** (See Appendix F for diagram)

- 1.) Sprint forward, touch the cone with left hand.
- 2.) Side shuffle right (without crossing feet) and touch cone with right hand.
- 3.) Side shuffle left to furthest cone to touch with left hand.
- 4.) Side shuffle to center cone to touch with right hand.
- 5.) Back pedal sprint to starting line.

## Abbreviation List:

|   |  |
|---|--|
| <b>AAROM:</b> Active assisted range of motion | <b>MD:</b> Medical doctor                |
| <b>ABD:</b> Abduction                         | <b>NWB:</b> Non weight bearing           |
| <b>AD:</b> Assistive device                   | <b>OKC:</b> Open kinetic chain           |
| <b>ADL:</b> Activity of daily Living          | <b>PA:</b> Physician assistant           |
| <b>AROM:</b> Active range of motion           | <b>PCL:</b> Posterior cruciate ligament  |
| <b>BFR:</b> Blood Flow Restriction            | <b>PE:</b> Pulmonary embolism            |
| <b>BPTB:</b> Bone patellar tendon bone        | <b>PLC:</b> Posterior lateral corner     |
| <b>BW:</b> Body Weight                        | <b>PROM:</b> Passive range of motion     |
| <b>CKC:</b> Closed kinetic chain              | <b>QT:</b> Quad Tendon                   |
| <b>DVT:</b> Deep vein thrombosis              | <b>ROM:</b> Range of motion              |
| <b>ER:</b> External rotation                  | <b>RP:</b> Resting position              |
| <b>EXT:</b> Extension                         | <b>RROM:</b> Resisted range of motion    |
| <b>FWB:</b> Full weight bearing               | <b>RTS:</b> Return to sport/activity     |
| <b>GHJ:</b> Gleno-humeral joint               | <b>SLR:</b> Straight leg raise           |
| <b>HEP:</b> Home exercise program             | <b>UE:</b> Upper extremity               |
| <b>HS:</b> Hamstring                          | <b>TKE:</b> Terminal knee extension      |
| <b>IR:</b> Internal rotation                  | <b>WB:</b> Weight bearing                |
| <b>LCL:</b> Lateral collateral ligament       | <b>WBAT:</b> Weight bearing as tolerated |
| <b>LE:</b> Lower extremity                    | <b>#:</b> Pounds                         |
| <b>MA:</b> Medical assistant                  | <b>≠:</b> Absent/Without                 |
|   | <b>≈:</b> Approximately                  |

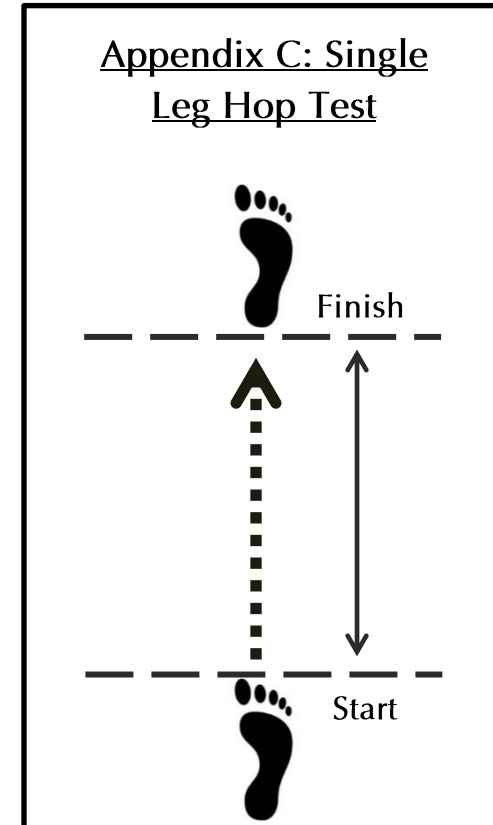
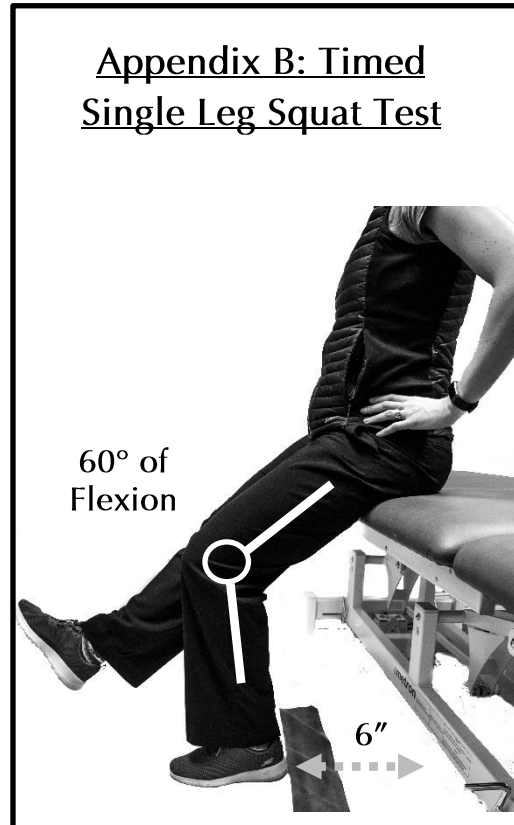
**EPIC:** Estimated pre-injury capacity ( *Average score of the involved leg divided by the average score of the uninvolved leg pre-op test scores then multiply by 100 to get the % of the involved leg's performance compared to the uninvolved leg's performance for that specific test* )

**LSI:** Limb Symmetry Index = ( *Average score of the involved leg divided by the average score of the uninvolved leg for a specific test* )

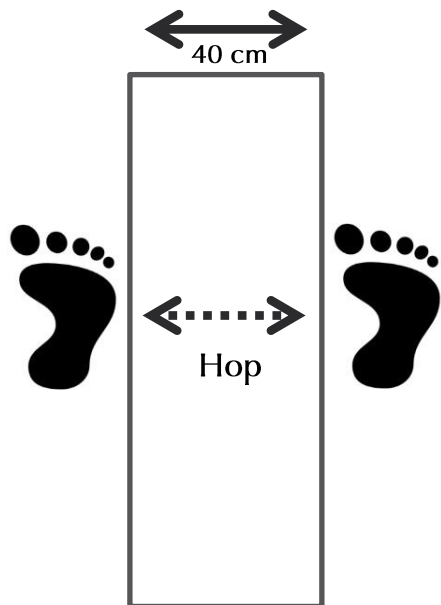


## Quick Reference Activity Timeline:

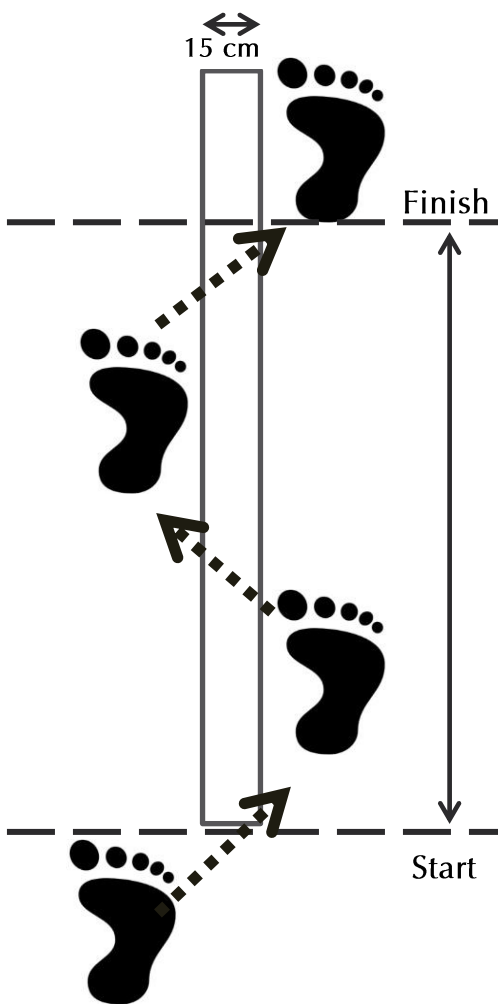
| Activity                      | Activity Restrictions   |
|-------------------------------|---|
| Knee ROM                      | <ul style="list-style-type: none"> <li>• <math>0^{\circ} \approx 110^{\circ}</math> until week 3</li> <li>• Return to symmetrical ROM <math>\approx</math> week 5-6</li> </ul>  |
| CKC Squats                    | <ul style="list-style-type: none"> <li>• Limit to <math>90^{\circ}</math> until week 3</li> </ul>   |
| RROM OKC knee Flexion         | <ul style="list-style-type: none"> <li>• HS graft: week 8</li> </ul>  |
| RROM OKC Knee EXT             | <ul style="list-style-type: none"> <li>• BPTB/QT graft: <math>90^{\circ}</math>-<math>45^{\circ}</math> week 2-6</li> <li>• HS graft/Allograft: <math>90^{\circ}</math>-<math>45^{\circ}</math> week 4-6</li> </ul>   |
| Plyometrics                   | <ul style="list-style-type: none"> <li>• BPTB/QT Double Leg: week 6</li> <li>• BPTB/QT <math>\downarrow</math> BW Single Leg: Week 8</li> <li>• BPTB/QT Full BW Single Leg: <math>\approx</math> week 12</li> <li>• HS graft Double Leg: week 10</li> <li>• HS graft <math>\downarrow</math> BW Single Leg: week 12</li> <li>• HS graft Full BW Single leg: <math>\approx</math> week 16</li> </ul> |
| Running                       | <ul style="list-style-type: none"> <li>• BPTB/QT <math>\approx</math> week 12 having met return to run criteria</li> <li>• HS Graft <math>\approx</math> week 16 having met return to run criteria</li> </ul>   |
| CKC Pivot/Twisting            | <ul style="list-style-type: none"> <li>• Avoid until Week 12+</li> </ul>  |
| Return to Sport Cleared by MD | <ul style="list-style-type: none"> <li>• Having met all return to activity testing criteria related to level of desired intensity on page 5</li> </ul>  |



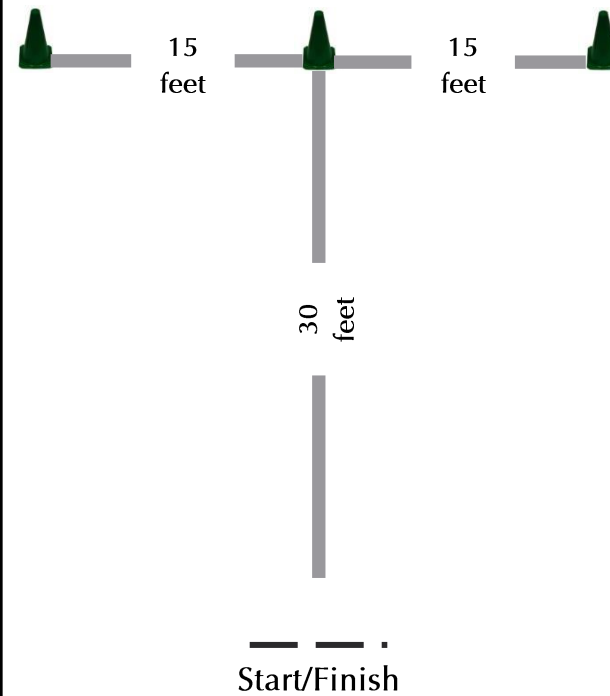
Appendix D: Single Leg  
Timed Side Hop Test



Appendix E: Crossover Hop

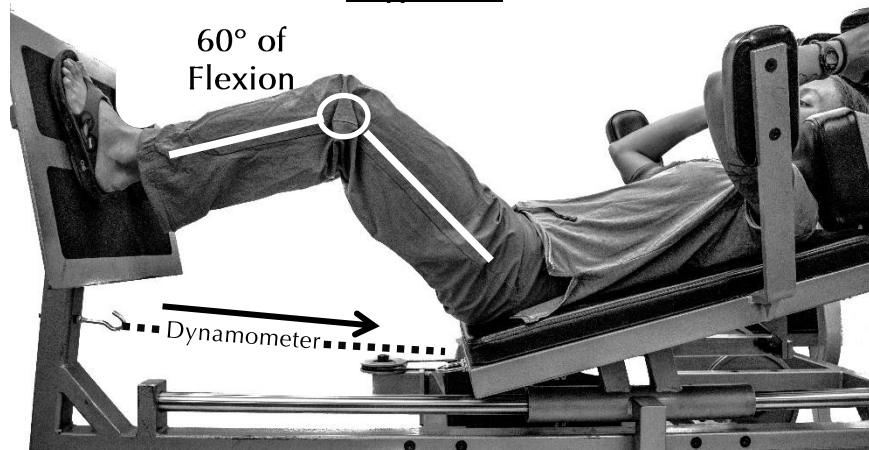


Appendix F: Agility T-Test



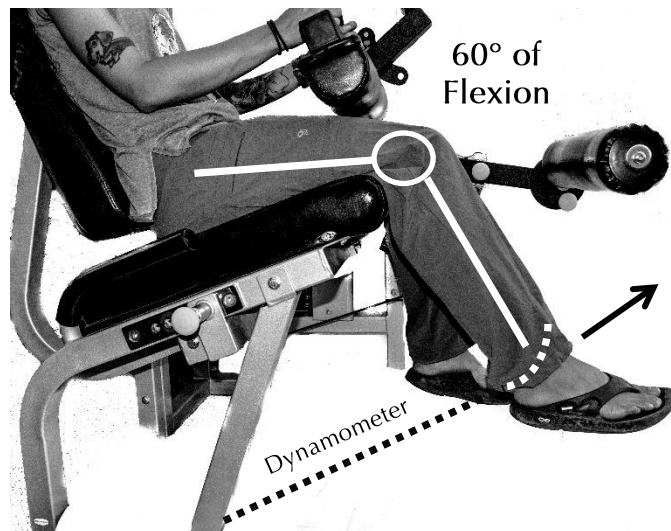


### Appendix G: Isometric Single Leg Leg Press



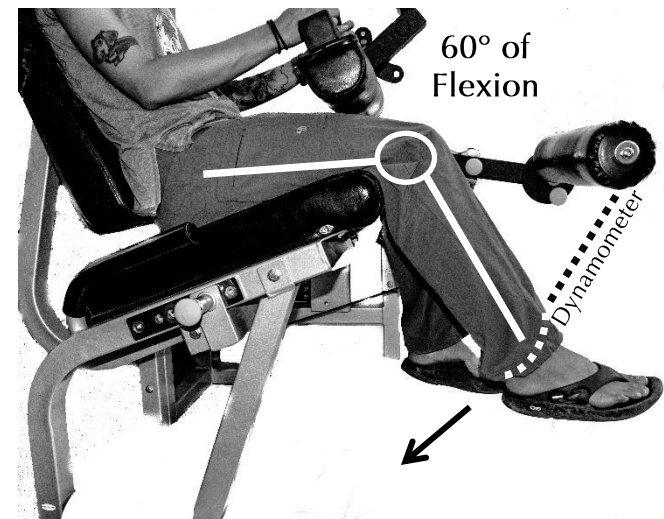
- Adjust foot and leg press position so that the knee is in 60 degrees of knee flexion when there is no slack in the dynamometer attachment.
- Perform maximal effort isometric tests per leg.
- $\text{Involved} \div \text{uninvolved} \times 100 = \text{LSI}$

### Appendix H: Isometric Single Leg Quadriceps Test



- Adjust seat position and dynamometer length so that there is no slack in the dynamometer attachment when the knee is in 60° knee flexion.
- Perform maximal effort isometric tests per leg.
- $\text{Involved} \div \text{uninvolved} \times 100 = \text{LSI}$

### Appendix I: Isometric Single Leg Hamstring Test



- Adjust seat position and dynamometer length so that there is no slack in the dynamometer attachment when the knee is in 60° knee flexion.
- Perform maximal effort isometric tests per leg.
- $\text{Involved} \div \text{uninvolved} \times 100 = \text{LSI}$



## Appendix J: ACL-RSI

### ACL-RSI

Name \_\_\_\_\_ Date \_\_\_\_\_

Instructions: Place a mark on the line, which best describes you in relation to the descriptors for surgical expectation.

#### 1. Are you confident that you can perform at your previous level of sport participation?

Not at all confident Fully confident

**0** **1** **2** **3** **4** **5** **6** **7** **8** **9** **10**

#### 2. Do you think you are likely to re-injury your knee by participating in your sport?

Extremely likely Not likely at all

**0** **1** **2** **3** **4** **5** **6** **7** **8** **9** **10**

#### 3. Are you nervous about playing your sport?

Extremely nervous Not nervous at all

**0** **1** **2** **3** **4** **5** **6** **7** **8** **9** **10**

#### 4. Are you confident that your knee will not give way by playing your sport?

Not at all confident Fully confident

**0** **1** **2** **3** **4** **5** **6** **7** **8** **9** **10**

#### 5. Are you confident that you could play your sport without concern for your knee?

Not at all confident Fully confident

**0** **1** **2** **3** **4** **5** **6** **7** **8** **9** **10**

#### 6. Do you find it frustrating to have to consider your knee with respect to your sport?

Extremely frustrating Not at all frustrating

**0** **1** **2** **3** **4** **5** **6** **7** **8** **9** **10**



**7. Are you fearful of re-injuring your knee by playing your sport?**

Extremely fearful

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"/> |
| <b>0</b>                 | <b>1</b>                 | <b>2</b>                 | <b>3</b>                 | <b>4</b>                 | <b>5</b>                 | <b>6</b>                 | <b>7</b>                 | <b>8</b>                 | <b>9</b>                 | <b>10</b>                |

**8. Are you confident about your knee holding up under pressure?**

Not at all confident

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"/> |
| <b>0</b>                 | <b>1</b>                 | <b>2</b>                 | <b>3</b>                 | <b>4</b>                 | <b>5</b>                 | <b>6</b>                 | <b>7</b>                 | <b>8</b>                 | <b>9</b>                 | <b>10</b>                |

**9. Are you afraid of accidentally injuring your knee by playing your sport?**

Extremely afraid

Not at all afraid

|                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| <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"/> |
| <b>0</b>                 | <b>1</b>                 | <b>2</b>                 | <b>3</b>                 | <b>4</b>                 | <b>5</b>                 | <b>6</b>                 | <b>7</b>                 | <b>8</b>                 | <b>9</b>                 | <b>10</b>                |

**10. Do thoughts of having to go through surgery and rehabilitation prevent you from playing your sport?**

All of the time

None of the time

|                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| <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"/> |
| <b>0</b>                 | <b>1</b>                 | <b>2</b>                 | <b>3</b>                 | <b>4</b>                 | <b>5</b>                 | <b>6</b>                 | <b>7</b>                 | <b>8</b>                 | <b>9</b>                 | <b>10</b>                |

**11. Are you confident about your ability to perform well at your sport?**

Not at all confident

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"/> |
| <b>0</b>                 | <b>1</b>                 | <b>2</b>                 | <b>3</b>                 | <b>4</b>                 | <b>5</b>                 | <b>6</b>                 | <b>7</b>                 | <b>8</b>                 | <b>9</b>                 | <b>10</b>                |

**12. Do you feel relaxed about playing your sport?**

Not at all relaxed

Fully relaxed

|                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |                          |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| <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"/> |
| <b>0</b>                 | <b>1</b>                 | <b>2</b>                 | <b>3</b>                 | <b>4</b>                 | <b>5</b>                 | <b>6</b>                 | <b>7</b>                 | <b>8</b>                 | <b>9</b>                 | <b>10</b>                |



Calculated Score: \_\_\_\_\_ / 120 = \_\_\_\_\_ %

## Appendix K: Pre-Operative Blood Flow Restriction Preconditioning

*Apply this preconditioning strategy with discretion if limitations in insurance visits or self-pay will impact follow up care accessibility after surgery:*

- **Goal:** provide 5 exercise days in the final 8 days before surgery, with the last pre surgical training session in the 24-48 hours before surgery<sup>42</sup>
- **Preconditioning BFR protocol<sup>42</sup>**
  - o Establish LAQ on knee extension machine 40 repetition max at 1<sup>st</sup> training session without BFR
  - o Tourniquet in this study set to 150mmHg during BFR for all participants (using individualizing occlusion pressures based on % of total arterial occlusion between 60-80% has important implications for safety<sup>40</sup>)
  - o Initial warm up on knee extension machine 10-15 reps at 1lb
  - o Patient will perform 6 sets of OKC knee extension to volitional failure at 56 BPM via metronome with one beat for concentric and one beat for eccentric phase of muscle contraction. Weight was set at a patient's individual 40 repetition max from 1<sup>st</sup> session without BFR<sup>4</sup>
  - o Inflate tourniquet to desired pressure, rest at initial occlusion for 30 seconds before beginning training series
  - o Training Series:
    - Perform 1<sup>st</sup> set to volitional failure
    - After the 1<sup>st</sup> set rest for 45 seconds set without reperfusion
    - After the 2<sup>nd</sup> set deflate tourniquet for reperfusion for 90 seconds
    - After the 3<sup>rd</sup> set rest for 45 seconds set without reperfusion
    - After the 4<sup>th</sup> set deflate tourniquet for reperfusion for 90 seconds
    - After the 5<sup>th</sup> set rest for 45 seconds set without reperfusion
    - Deflate tourniquet after final 6<sup>th</sup> set

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 VALLEY VIEW