MEDIAL PATELLOFEMORAL LIGAMENT RECONSTRUCTION WITH FULKERSON PROCEDURE CLINICAL PRACTICE GUIDELINE

Disclaimer
The following rehabilitation guidelines are specific to patients who have undergone a medial patellofemoral ligament (MPFL) reconstruction surgical procedure. Please refer to the Ohio States Sports Medicine website for rehabilitation guidelines specific to other procedures and conditions, as appropriate.

Progression is criterion-based and dependent on soft tissue healing, patient demographics, and clinical evaluation. The time frames identified for each phase of rehabilitation are approximate times for the average patient and not recommended as guidelines for progression for the individual patient. It is recommended that progression is based upon the achievement of functional criteria demonstrating readiness for progression, noted at the end of each phase.

Background
Lateral patellar dislocation is among the most frequently identified acute knee injuries in children\(^1,2\), with an annual incidence rate of 43 per 100,000 in the US population\(^2\). First-time patellar dislocations are most common in young, active patients and can severely affect quality of life by resulting in chronic pain, loss of function, and degenerative changes of the patellofemoral joint\(^2,3\). While conservative treatment is often utilized for primary dislocations, up to 50% of individuals will go on to experience a recurrent dislocation event\(^4-7\). Surgical intervention can be indicated for individuals who experience recurrent episodes of patellar instability\(^8,9\). As the MPFL is often injured during a lateral patellar dislocation and is considered the primary static restraint to lateral translation, it is often targeted for surgical reconstruction to restore patellar stability in this patient population\(^8,9\).

Varying surgical techniques exist for performing a MPFL reconstruction with multiple autograft choices available—including but not limited to hamstring tendon, adductor magnus tendon, vastus medialis obliquus, or quadriceps tendon\(^8,9\). Allograft tissue has also been utilized with some success\(^8\). The operative procedure will secure the graft to the patella and attach it to the medial femoral condyle, with the goal of maintaining the native anatomical alignment\(^8-11\). Please refer to the surgeon’s operative note for individual specifics. Guidelines will need to be modified to respect healing tissue pending graft choice, as appropriate. New evidence suggests that adolescent athletes who are undergo a MPFL reconstruction may require prolonged rehabilitation (>8 months) to allow for safe return to sport\(^12\). As such, adherence to timeline plus criteria for progression rather than timeframe only is strongly recommended.
## Summary of Recommendations

### Precautions
- Typically, NWBing x 6 week in TROM immobilizer
  - However, this depends on the specific direction and type of osteotomy. **ALWAYS refer to the operative note to confirm WBing status, or reach out to the surgical team for confirmation**
- Protected electrical stimulation program (NMES)
- Patellar mobilizations—passive superior/medial glide only for 6 weeks
  - **NO lateral patellar glides**
- Avoid isolated strengthening of graft musculature (hamstring, etc) until 8 weeks
- No open kinetic chain (OKC) strengthening x 4 weeks

### Corrective Interventions
- Manual therapy for patellar mobility and knee ROM
- NMES for quadriceps activation
- Vasopneumatic cryotherapy for pain and edema control
- Core and LE progressive resistance strengthening
- Neuromuscular training for LE strength and mechanics
- Sport-specific activity training

### Functional Testing
- Isometric testing at 10 weeks
- Isokinetic testing at 12 weeks
- Functional hop testing at ≥ 12 weeks and once LSI of 80% or greater is achieved

### Patient Reported Outcomes
Collect at least one of the following at initial evaluation, every 6 weeks and discharge. Be consistent with which outcome tool is collected.
- Knee Injury and Osteoarthritis Outcome Score (KOOS)
- International Knee Documentation Committee (IKDC)

### Criteria to Discharge Assistive Device
1. **ROM**: Full active knee extension; no pain on passive overpressure
2. **Strength**: Able to perform strong quad isometric with full tetany and superior patellar glide and able to perform ≥ 2x10 SLR without quad lag
3. **Effusion**: 1+ or less is preferred (≥ 2+ acceptable if all other criteria are met)
4. **Weight Bearing**: Demonstrates pain-free ambulation without visible gait deviation

### Criteria to Discharge NMES
- <20% quad deficit on isometric testing
- If Biodex not available:
  - 10 SLR without quad lag
  - Normal gait
  - 10 heel taps to 60° knee flexion with good quality
  - 10 rep max on leg press and similar effort bilaterally
  - Inability to break quad MMT (5/5)

### Criteria to Initiate Running and Jumping
1. **ROM**: Full, pain-free knee ROM, symmetrical with the uninvolved limb
2. **Strength**: Isokinetic testing 80% or greater for hamstring and quad at 60°/sec and 300°/sec
3. **Effusion**: 1+ or less
4. **Weight Bearing**: normalized gait and jogging mechanics
5. **Neuromuscular Control**: Pain-free hopping in place

### Criteria to Return to Sports Participation
1. **ROM**: full, pain-free knee ROM, symmetrical with the uninvolved limb
2. **Strength**: Isokinetic testing 90% or greater for hamstring and quad at 60°/sec and 300°/sec
3. **Effusion**: No reactive effusion ≥ 1+ with sport-specific activity
4. **Weight Bearing**: normalized gait and jogging mechanics
5. **Neuromuscular Control**: appropriate mechanics and force attenuation strategies with high level agility, plyometrics, and high impact movements
6. **Functional Hop Testing**: LSI 90% or greater for all tests
7. **Physician Clearance**: return to sport expectation—4.5-9 months
RED/YELLOW FLAGS

Red Flags
Require immediate referral for re-evaluation

- Signs of DVT → Refer directly to ED
  - Localized tenderness along the distribution of deep venous system
  - Entire LE swelling
  - Calf swelling >3cm compared to asymptomatic limb
  - Pitting edema
  - Collateral superficial veins
- Lack of full knee extension by 4 weeks post-op → Refer to surgeon for re-evaluation
- Mechanical block or clunk → Refer to surgeon for re-evaluation
- Reported episode of instability → Refer to surgeon for re-evaluation

Yellow Flags
 Require modifications to plan of care

- Persistent reactive effusion or pain following therapy or ADLs
  - Decrease intensity of rehab interventions, continue effusion management, educate patient regarding activity modifications until symptoms resolve

FULKERSON PROCEDURE: WB AND BRACE PROGRESSION
Defer to operative note & surgeon to confirm WBing status and progression

Weeks 0-6

- Typically, NWBing x 6 week in TROM immobilizer
  - However, this depends on the specific direction and type of osteotomy. ALWAYS refer to the operative note to confirm WBing status, or reach out to the surgical team for confirmation

Weeks 6-8

- Open knee brace to available range ~6 weeks
- Work to normalize gait mechanics
- Criteria to discharge brace:
  - Able to ambulate 500 ft or greater without obvious gait deviation or gait decompensation with fatigue/longer distances
  - No evidence of quad lag during 3x10 SLR
# Phase IA: Protection (Post-Operative—2 weeks)

## Goals Phase IA
- Protect Repair
- Reduce pain and inflammation
- Achieve normal knee ROM
- Prevent muscle atrophy—regain active quadriceps contraction

## Gait
- NWBing in TROM immobilizer

## ROM
- Begin passive, active-assisted, and active ROM as tolerated
  - ROM can be progressed as tolerated unless otherwise noted by surgeon
    - No forced flexion beyond 90° with concomitant meniscal repair
- Intervention suggestions:
  - Bag hangs (Appendix A)
  - Biking—begin with ½ revolutions and progress to full revolutions
  - Heel slides
  - Stretching—IT band; gastroc/soleus in seated
  - Patellar mobilizations—NO lateral mobilization (superior/inferior only)

## Strengthening
- Quad Sets—long-sitting, prone, standing
- Glute Sets
- SLR in flexion, abduction; *Avoid extensor lag*
- Neuromuscular electrical stimulation (NMES) to quadriceps at 60°-90° flexion if quad inhibition present (Appendix B)
  - Multi-angle knee extensor isometrics from 60°-90° are also appropriate for those patients who cannot tolerate high-intensity NMES

## Pain & Effusion
- Ice/cryotherapy, compression, elevation to reduce post-operative effusion

## Criteria to Discharge Assistive Device
- **ROM:** Full active knee extension; no pain on passive overpressure
- **Strength:** Able to perform strong quad isometric with full tetany and superior patellar glide and able to perform 2x10 SLR without quad lag
- **Effusion:** 1+ or less is preferred (2+ acceptable if all other criteria are met)
- **Weight Bearing:** Demonstrates pain-free ambulation without visible gait deviation

## NMES Parameters (Appendix B)
- NMES pads are placed on the proximal and distal quadriceps
- Patient: Seated with the knee in at least 60° flexion, shank secured with strap and back support with thigh strap preferred. The ankle pad/belt should be two finger widths superior to the lateral malleoli
- The patient is instructed to relax while the e-stim generates at least 50% of their max volitional quadriceps contraction OR maximal tolerable amperage without knee joint pain
- 20 seconds on/ 50 seconds off x 15 min

## Goals to Progress to Next Phase
1. Full active quadriceps contraction with superior patellar glide
2. Full passive knee extension
3. Effusion ≤ 2+ (effusion can at least be swept out of medial sulcus)
4. SLR x 10 seconds without extensor lag
5. Tolerates FWB without increased pain or 3+ effusion
6. Walks without obvious gait deviations (may still use assistive device)
### Phase IB: Protection (2-4 Weeks)

#### Goals Phase IB
- Protect Repair
- Reduce pain and inflammation
- Achieve normal gait mechanics
- Prevent muscle atrophy—regain active quadriceps contraction
- No OKC strengthening until 4 weeks post-op

<table>
<thead>
<tr>
<th>Gait</th>
<th>NWBing in TROM immobilizer</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>However, this depends on the specific direction and type of osteotomy. ALWAYS refer to the operative note to confirm WBing status, or reach out to the surgical team for confirmation</td>
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<table>
<thead>
<tr>
<th>ROM</th>
<th>Continue passive, active-assisted, and active ROM as tolerated</th>
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<tbody>
<tr>
<td></td>
<td>No forced flexion beyond 90° with concomitant meniscal repair</td>
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<tr>
<td></td>
<td>Intervention suggestions:</td>
</tr>
<tr>
<td></td>
<td>Biking—no resistance, full revolutions</td>
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<td></td>
<td>Bag hangs (Appendix A)</td>
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<tr>
<td></td>
<td>Patellar mobilizations—<strong>NO</strong> lateral mobilization (superior/inferior only)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Strengthening</th>
<th>Continue weeks 0-2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quad Sets—long-sitting, prone, standing</td>
</tr>
<tr>
<td></td>
<td>SLR in flexion, abduction, adduction (if tolerated and appropriate) and extension</td>
</tr>
<tr>
<td></td>
<td>Avoid extensor lag</td>
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<tr>
<td></td>
<td>Continue NMES</td>
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<tr>
<td></td>
<td>Multi-angle knee extensor isometrics from 60°-90° are also appropriate for those patients who cannot tolerate high-intensity NMES</td>
</tr>
<tr>
<td></td>
<td>Hamstring activation—heel slides, hamstring sets, bridges</td>
</tr>
<tr>
<td></td>
<td>Begin trunk and lumbopelvic strengthening—planks, pelvic tilts, abdominal bracing</td>
</tr>
</tbody>
</table>

| Pain & Effusion | Ice/cryotherapy, compression, elevation PRN to reduce effusion |

#### Goals to Progress to next phase
1. Effusion: ≤ 2+
2. FWB without increased pain or effusion
3. Ambulate on level surfaces without assistive device and with normal mechanics
4. Single leg stance > 30 seconds without loss of balance

### Phase IIA: Moderate Protection (4-6 Weeks)

#### Goals Phase IIA
- Good quadriceps control
- Controlled effusion
- Improving tolerance to loading progression

<table>
<thead>
<tr>
<th>Gait</th>
<th>NWBing x 6 week in TROM immobilizer</th>
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<tr>
<td></td>
<td>Gait training</td>
</tr>
<tr>
<td></td>
<td>Focus on equal weight distribution bilaterally and normalization of gait mechanics</td>
</tr>
<tr>
<td></td>
<td>Begin with 2 crutches, progress to 1 crutch, and then no support once gait mechanics are normalized</td>
</tr>
</tbody>
</table>
**ROM**
- Continue passive, active-assisted, and active ROM as tolerated
  - **Concerns with limited ROM should be communicated directly with surgeon**
- Higher grade superior/inferior patellar mobilizations and gentle overpressure to end ranges if ROM is a concern
- Biking — light resistance
- Continue with thigh and calf flexibility PRN

**Strengthening**
- Continue NMES
- Resistance exercises for gluteal strengthening
  - Resisted side-stepping and backward walking, clamshells, reverse clamshells
  - Initiate OKC progression
  - SAQ → LAQ (modified range → full range LAQ)
- Progress SL stability
- Heel/toe raises

**Pain & Effusion**
- Ice/cryotherapy, compression, elevation PRN to reduce effusion

**Goals to Progress to next phase**
1. Effusion: ≤ 2+
2. FWB without increased pain or effusion
3. Ambulate on level surfaces without assistive device and with normal mechanics
4. Single leg stance > 15 seconds without loss of balance
5. Good volitional quad activation with TKE and no lag with SLR

**Phase IIB: Moderate Protection (6-10 Weeks)**

**Goals Phase IIB**
- Achieve normal gait mechanics
- Improve thigh and hip strength and neuromuscular control
- Pain-free functional movements

**Gait**
- Open brace at ~6 weeks
- Goal: Discharge brace completely with normal ambulation by 8 weeks post-op
- Gait training
  - Focus on equal weight distribution bilaterally and normalization of gait mechanics
  - Begin with 2 crutches, progress to 1 crutch, and then no support once gait mechanics are normalized
  - Evaluate for symmetrical joint loading during stance phase, heel strike with full knee extension at initial contact, appropriate push-off at toe of

**ROM**
- Continue with stretching and bike PRN

**Strengthening**
- Continue NMES if indicated (See NMES d/c criteria below)
- Shuttle/Leg Press—begin 90°-0° and progress per pain and technique
  - Bilateral → single leg per patient tolerance and mechanics
- Squat progressions (DL and SL) on stable and unstable surfaces
- Single leg stance—eyes open → eyes closed
  - Progress to dynamic movements and/or unstable surface
- Progress WB strengthening exercises for quadriceps and hamstring per patient’s tolerance
  - Early phase: step ups, step downs (heel taps)—progress height as tolerated
  - Late phase: SL RDL’s, SL squats—begin partial range
- Continue to progress OKC interventions
  - Begin sub-maximal leg extensions in protected range (90°- 45°)
- Endurance: low impact activities → treadmill walking, stepper, elliptical

<table>
<thead>
<tr>
<th>Pain &amp; Effusion</th>
<th>Ice/cryotherapy, compression, elevation PRN to reduce effusion</th>
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</thead>
<tbody>
<tr>
<td>Functional Testing</td>
<td>Isometric testing at 10 weeks</td>
</tr>
<tr>
<td>Criteria to Discharge NMES</td>
<td>&lt;20% quad deficit on isometric testing</td>
</tr>
<tr>
<td>OR if Biodex machine is not available:</td>
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</tr>
<tr>
<td></td>
<td>Inability to break quad MMT</td>
</tr>
<tr>
<td>Goals to Progress to Next Phase</td>
<td>1. Effusion: ≤ 1+</td>
</tr>
<tr>
<td></td>
<td>2. Tolerates therex program without increased pain or effusion grade</td>
</tr>
<tr>
<td></td>
<td>3. Maintains full, pain-free ROM symmetric to uninvolved LE</td>
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<td></td>
<td>4. Normal patellar mobility without apprehension</td>
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<tr>
<td></td>
<td>5. Demonstrates normal mechanics with CKC exercises (squats, lunges, etc) and early jumping activities (PWB on shuttle, step holds, double leg partial range, etc)</td>
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</table>

**Phase III: Return to Function (10-12 Weeks)**

<table>
<thead>
<tr>
<th>Goals Phase III</th>
<th>Improve strength, balance, and endurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROM</td>
<td>Maintain ROM symmetric to uninvolved limb</td>
</tr>
<tr>
<td>Strengthening</td>
<td>FWB strengthening exercises</td>
</tr>
<tr>
<td></td>
<td>Progress resistance and from stable to unstable surface as tolerated</td>
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<tr>
<td></td>
<td>OKC knee extension exercises—progress as tolerated without pain</td>
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<tr>
<td></td>
<td>Begin B shuttle jumping ≤ 50% BW (shuttle, Total Gym, etc.)</td>
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<td></td>
<td>Emphasis on symmetry in takeoff and landing phase</td>
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<td></td>
<td>Plyometric progression and walk-jog progression once criteria are met (see below)</td>
</tr>
<tr>
<td>Pain &amp; Effusion</td>
<td>Ice/cryotherapy, compression, elevation PRN to reduce effusion</td>
</tr>
<tr>
<td>Functional Testing (Appendix C &amp; D)</td>
<td>Isometric testing at 10 weeks</td>
</tr>
<tr>
<td></td>
<td>Isokinetic testing at 12 weeks</td>
</tr>
</tbody>
</table>
### Criteria to Initiate Running and Jumping

1. **ROM**: full, pain-free knee ROM, symmetrical with the uninvolved limb  
2. **Strength**: Isokinetic testing 80% or greater for hamstring and quad at 60º/sec and 300º/sec  
3. **Effusion**: 1+ or less  
4. **Weight Bearing**: normalized gait and jogging mechanics  
5. **Neuromuscular Control**: Pain-free hopping in place

### Goals to Progress to Next Phase

1. **Effusion**: ≤ 1+  
2. Maintains full, pain-free ROM symmetric to uninvolved LE  
3. Normal patellar mobility without apprehension  
4. Isometric or isokinetic quadriceps and hamstring strength ≥ 80% LSI  
5. Tolerates therapeutic program, including initial jogging progression, without increased pain or effusion grade

### Phase IV: Return to Sport/Activity (12+ Weeks)

#### Goals Phase IV
- Good multi-planar dynamic neuromuscular control, including plyometrics  
- Sport/activity-specific training—avoid post-activity soreness >24 hours  
  - Hopping, cutting, agility drills as appropriate  
- Cardiovascular endurance fit for activity  
- Normal strength and flexibility of core and B LE

#### ROM
- Maintain ROM symmetric to uninvolved limb

#### Strengthening
- Emphasize performance of the quadriceps, hamstrings, and trunk dynamic stability  
- Emphasize muscle power generation and absorption  
- Focus on activities that challenge muscle demand in intensity, frequency, & duration  
- Emphasize sport-specific and position-specific activities

**Consider:**  
- DL and SL transitions  
- Various planes of movement  
- Changes of direction  
- Perturbations & varied surfaces  
- Multiple muscle groups simultaneously  
- Quad Sets—long-sitting, prone, standing

**Examples:**  
- SL hop downs from increasing height (up to 12” box)  
- SL hop-holds progressing from stable to unstable (i.e. Airex) surface  
- DL and SL hops progressing from stable to unstable (i.e. Airex) surface and progressing from unidirectional to changing direction (i.e. 90° turn)  
- Tuck jumps (focus on increasing multi-joint flexion during landing and holding stable position)  
- 90° to 180° hops and jumps

**Examples:**  
- Begin agility exercises at 50-75% effort—utilize visual feedback to improve mechanics
- Side shuffles
- Hopping
- Zig zags
- Carioca
- Figure 8’s
- Back pedaling
- T, I, or box drill
- Resisted jogging (Sport Cord) in straight planes

**Functional Testing (Appendix C, D, E)**
- Isokinetic testing at 12 weeks and beyond
- Functional hop testing at ≥ 12 weeks and once LSI of 80% or greater is achieved

**Criteria to Return to Sports Participation**
1. **ROM**: full, painfree knee ROM, symmetrical with the uninvolved limb
2. **Strength**: Isokinetic testing 90% or greater for hamstring and quad at 60º/sec and 300º/sec
3. **Effusion**: No reactive effusion ≥ 1+ with sport-specific activity
4. **Weight Bearing**: normalized gait and jogging mechanics
5. **Neuromuscular control**: appropriate mechanics and force attenuation strategies with high level agility, plyometrics, and high impact movements
6. **Functional Hop Testing**: LSI 90% or greater for all tests
7. **Physician Clearance**

**Appendix A: Bag Hang**
*Emphasis on low load, long duration stretching*
- Goal: 60 minutes of bag hang time total per day.
- Ideally: 4x15 minutes (or greater) per day

**Appendix B: NMES Set Up**
*2 or 4 pad set-up is appropriate*
- NMES pads are placed on the proximal and distal quadriceps
- Patient: Seated with the knee in at least 60º flexion, shank secured with strap and back support with thigh strap preferred. The ankle pad/belt should be two finger widths superior to the lateral malleoli
- The patient is instructed to relax while the e-stim generates at least 50% of their max volitional contraction against a fixed resistance OR maximal tolerable amperage without knee joint pain
- 10-20 seconds on/ 50 seconds off x 15 min
Appendix C: Isokinetic Data Interpretation

<table>
<thead>
<tr>
<th></th>
<th>Extension 60 Deg/Sec</th>
<th>Flexion 60 Deg/Sec</th>
<th>Extension 300 Deg/Sec</th>
<th>Flexion 300 Deg/Sec</th>
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<tbody>
<tr>
<td></td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
<td>Left</td>
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<tr>
<td># OF REPS (30/30): 5</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A PEAK TORQUE</td>
<td>FT-LBS</td>
<td>127.6</td>
<td>133.5</td>
<td>-4.7</td>
</tr>
<tr>
<td>B PEAK TQBW</td>
<td>%</td>
<td>111.0</td>
<td>116.2</td>
<td>46.2</td>
</tr>
<tr>
<td>C DIF tout WORK</td>
<td>FT-LBS</td>
<td>138.4</td>
<td>141.7</td>
<td>-2.4</td>
</tr>
<tr>
<td>D COEFF. OF VAR</td>
<td>%</td>
<td>2.8</td>
<td>2.1</td>
<td>3.4</td>
</tr>
<tr>
<td>E TOTAL WORK</td>
<td>WATTS</td>
<td>116.9</td>
<td>131.1</td>
<td>-12.2</td>
</tr>
<tr>
<td>F COEFF. OF VAR</td>
<td>%</td>
<td>116.9</td>
<td>131.1</td>
<td>-12.2</td>
</tr>
<tr>
<td>G ACCELERATION TIME</td>
<td>MSSEC</td>
<td>50.0</td>
<td>50.0</td>
<td>40.0</td>
</tr>
<tr>
<td>H DECCELERATION TIME</td>
<td>MSSEC</td>
<td>50.0</td>
<td>50.0</td>
<td>40.0</td>
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<tr>
<td>I AVG. PEAK TO</td>
<td>FT-LBS</td>
<td>124.7</td>
<td>130.8</td>
<td>51.0</td>
</tr>
<tr>
<td>J ASGINANT. RATIO</td>
<td>%</td>
<td>41.6</td>
<td>40.8</td>
<td>G: N/A</td>
</tr>
</tbody>
</table>

**Graphs**

- **Extension**
  - Stronger: 4.7%
  - Flexion: 2.6%

- **Flexion**
  - Deficit: 4.1%
  - Stronger: 16.3%
<table>
<thead>
<tr>
<th></th>
<th>Definition</th>
<th>Clinical Impact</th>
<th>What to do</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Peak Torque (ft-lbs)</td>
<td>Peak torque during repetitions</td>
<td>If &lt;80%; continue unilateral, high resistance strength training</td>
</tr>
<tr>
<td>B</td>
<td>Coefficient of Variance (%)</td>
<td>Between repetition variability</td>
<td>If &gt;15%, consider retest</td>
</tr>
<tr>
<td>C</td>
<td>Total Work (ft-lbs)</td>
<td>Torque over all repetitions</td>
<td>If &gt;10%; consider high volume training</td>
</tr>
<tr>
<td>D</td>
<td>Agonist/Antagonist Ratio (%)</td>
<td>Hamstring/Quadriceps Ratio</td>
<td>&lt;60%; ensure 1:1 quadriceps:hamstring exercise ratio</td>
</tr>
<tr>
<td>E</td>
<td>Limb Symmetry Pie Charts</td>
<td>Strength relative to involved limb</td>
<td>If &lt;80%, continue NMES in addition to strength training If &lt;90%, continue unilateral &gt; bilateral strength training emphasis</td>
</tr>
</tbody>
</table>
### Appendix D: Isokinetic Testing and Appropriate Alternatives


| Isokinetic Dynamometry | • Considered the “gold standard”  
|                        | • 60°/sec for strength and power assessment  
|                        | • 300°/second for speed and endurance assessment |
| Hand Held Dynamometry with Static Fixation at 90° | • Appropriate alternative  
|                                                      | • Results may overestimate quadriceps strength symmetry: be cautious with data interpretation |
| SL 1RM Knee Extension Machine: 90° - 45° | • Appropriate alternative  
|                                                      | • Recommended to decrease stress on PF joint and limit strain on reconstructed ACL for up to 6 months  
|                                                      | • Results may overestimate quadriceps strength symmetry: be cautious with data interpretation |
| SL 1RM Leg Press | • Fair alternative  
|                                                      | • Results in significant overestimation of quadriceps strength symmetry due to compensation from other LE muscle groups |
| SL 1RM Knee Extension Machine: 90° - 0° | • Fair alternative  
|                                                      | • May be uncomfortable and/or inappropriate due to PF stress |
Appendix E: Single Leg Hop Series

1) **Single hop for distance**: Have the subject line their heel up with the zero mark of the tape measure, wearing athletic shoes. The subject then hops as far as he/she can, landing on the same push off leg, for at least 3 seconds. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distance hopped for each limb. The Limb Symmetry Index: Involved limb distance/Uninvolved limb distance X 100%.

2) **Cross-over hop for distance**: The subject lines their heel up with the zero mark of the tape measure and hops 3 times on one foot, crossing fully over the center line each time. Each subject should hop as far forward as he/she can on each hop, but only the total distance hopped is recorded. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distance hopped for each limb. The Limb Symmetry Index: Involved limb distance/Uninvolved limb distance X 100%.

3) **Triple hop for distance**: The subject lines their heel up with the zero mark of the tape measure and hops 3 times on one foot. Each subject should hop as far forward as he/she can on each hop, but only the total distance hopped is recorded. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distance hopped for each limb. The Limb Symmetry Index: Involved limb distance/Uninvolved limb distance X 100%.

4) **Timed 6-meter hop**: The subject lines their heel up at the zero mark of the tape measure and hops, on cue with the tester, as fast as they can the length of the 6-meter tape. The arms are allowed to move freely during the testing. Allow him/her to perform 2 practice hops on each leg. Then, have the subject perform 2 testing trial, recording each distance from the starting point to the back of the heel. Average the distance hopped for each limb. The Limb Symmetry Index: Involved limb time/Uninvolved limb time X 100%.
References


