TROCHLEOPLASTY

Background

A trochleoplasty is a surgical procedure that corrects the femoral trochlea to allow for normal (or more normal) movement of the patella within the trochlear groove during knee flexion and extension. It has been found that 85% of patients with recurrent patellar instability also have trochlear dysplasia, and this procedure is indicated for patients with both of these deficits. Trochlear dysplasia involves an abnormality in the shape and depth of the trochlear groove, which creates inadequate patellar tracking during knee flexion. There are 3 main types of surgical procedures that will address this issue and they are as follows:

- Lateral Facet Elevation
- Sulcus Deepening
- Recession Wedge

Lateral Facet Elevation is indicated in patients with decreased lateral facet height, causing the patella to translate laterally during knee motion. This type of procedure involves removing bone in the lateral facet and compaction of the underlying cancellous bone. A bone graft is then implanted into this space, creating a mechanical block that limits lateral patellar translation.

Sulcus Deepening involves the removal of a strip of cortical bone followed by the removal of a strip of cancellous bone. This area is then covered by a flap of bone that is shaped to create a V-shaped wedge in the groove. This process creates a deeper groove in which the patella will glide and demonstrate more appropriate tracking mechanics.

Recession Wedge Trochleoplasty focuses on reduction of a supratrochlear spur that causes the patella to move laterally during knee flexion/extension. This technique creates an even surface for patellar gliding, but does not change the groove depth or the wide sulcus angle that could be present in patients with patellar instability.

Disclaimer

Progression is time and criterion-based, dependent on soft tissue healing, patient demographics, and clinician evaluation. Contact Ohio State Sports Medicine at 614-293-2385 if questions arise.

RED/YELLOW FLAGS

Red flags are signs/symptoms that require immediate referral for re-evaluation. Yellow flags are signs/symptoms that require modification to plan of care.

Red Flags	• 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
	• Mechanical block or clunk *(Refer to surgeon for re-evaluation)*
	• Lack of full knee extension by 4-6 weeks *(Refer to surgeon for re-evaluation)*

Yellow Flags	• Persistent reactive pain or effusion following therapy or ADLs ○ *Decrease intensity of therapy interventions, continue effusion management, and provide patient education regarding activity modification until reactive symptoms resolve*

Summary of Recommendations

Expectations	• Return to sport: 9-15 months
Risk Factors	• Trochleoplasty requires extensive rehabilitation and can often exhaust insurance approved PT visits. Consider decreasing initial visit frequency, use of home NMES unit and daily self-ROM. • Long-term quadriceps strength deficits typically present >1 year post-operatively.
Concomitant Procedures	• MPFL reconstruction is typically always performed with trochleoplasty: *Do not change protocol based on concurrent MPFL reconstruction* • If trochleoplasty is performed in conjunction with osteotomy, rehab progression will be slower and RTS may be delayed. *Refer to operative note or contact physician directly for protocol deviations*
Weight Bearing Progression	• **Phase 1** *(weeks 0-4):* 25-50% BW – Brace locked at 10-15°, wear brace at all times • **Phase 2** *(weeks 4-6):* 50-75% BW with brace unlocked to patient's available flexion ROM (90-120°) • **Phase 3** *(weeks 6-8):* 75% - Full BW with completely unlocked brace. Consider discharging crutches at weeks 6-8 *(see criteria to discharge assistive device below)* • **Phase 4** *(weeks 8-12):* Full BW – Brace discharge at 8-10 weeks pending appropriate quadriceps control and normal gait mechanics. *May continue brace as needed for adverse weather conditions or ambulation on uneven ground x12 weeks* • **Phase 5** *(weeks 12-16):* Full BW, no brace • **Phase 6** *(weeks 16 – RTS):* Full BW, no brace
Range of Motion Progression	• Phase 1 *(weeks 0-4):* 0-90° • Phase 2 *(weeks 4-6):* Symmetrical hyperextension - 120° of flexion • Phase 3 - 6 *(weeks 6 - RTS):* Full AROM

Functional Testing	• Isometric testing: 5 months
	• Isokinetic testing: 6, 9, 12 months and discharge
	• Hop testing (Appropriate after 80% symmetry achieved on isokinetic testing)
	  ○ SL hop for distance
	  ○ Triple hop
	  ○ Cross over hop
	  ○ Timed 6m hop
	Functional strength testing and hop testing should be reserved for patients returning high-level activity

Patient Reported Outcomes	Collect the Lower Extremity Functional Scale at each visit Consider addition 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 **Patients should be PWBing until week 6, and should continue brace compliance until week 8-10**
Criteria to Initiate Running and Jumping	***No running until the patient is 6 months post-op and meets the criteria listed below*** 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
Criteria for Return to Sport	1. ROM: full, pain free 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

PHASE 1 (Weeks 0-4)

In this phase, goal is to maintain joint mobility and muscle tone while adhering to all post-operative precautions. Emphasis is placed on ensuring proper wound healing and effusion management.	
Precautions	No OKC knee extension
Range of Motion	0-90° *Achieved though AAROM/AROM* • *Extension ROM: Seated towel stretch, prone hang (Appendix A), bag hang* • *Flexion ROM: heel slides, wall slides* • *Goal: early AROM though safe range*
Weight Bearing	25-50% BW – Brace locked at 10-15°, wear brace at all times
Suggested Interventions	• Ankle pumps • Quadriceps, hamstring and gluteal isometrics • SLR in knee brace • Diaphragmatic breathing • Effusion management strategies, including RICE • NMES (with biofeedback as needed) *Appendix B*
Blood Flow Restriction Training *Appendix D*	• Blood Flow Restriction (BFR) training can be initiated as soon as sutures are removed • Ensure patient has no contraindications (Appendix D) and if patient has any listed precautions or are at risk for a DVT, clear with physician before initiating BFR • Use BFR twice weekly for up to 10 weeks; use for 2-3 exercises per session • Can be used with any exercise that is safe for patient to perform depending on time since surgery (ex. SLR 4-way, prone TKE). *BFR should never be performed during a plyometric exercise.* • Training Load: 20-40% 1 RM (Estimated, or use OMNI-RES, see Appendix D) • Limb Occlusion Pressure= 80% (see Appendix D if patient unable to tolerate) • 4 sets for each exercise with reps of 30-15-15-15 (75 total) with a 30 second rest break between sets, keeping cuff inflated the entire duration of each exercise. Deflate between exercises, or every 8 minutes.
NMES Parameters *Appendix B*	• 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
Criteria to Progress to Phase 2	By the end of week 4: • Pain-free knee flexion of 90° • Pain-free and full passive knee extension • Proficient heel-to-toe gait with 50% BW • Compliance with brace at all times • Reduced and well-controlled post-operative pain and edema • Ability to perform a strong isometric quadriceps contraction (full tetany and superior patellar glide) • Proficiency with home-exercise program

PHASE 2 (WEEKS 4-6)

During Phase 2, the patient should achieve full and pain-free knee extension. Focus is placed on increasing LE strength, proper mechanics and effusion management.	
Precautions	No OKC knee extension
Range of Motion	Symmetrical hyperextension - 120°of flexion *Achieved though AAROM/AROM* • *Extension ROM: Seated towel stretch, prone hang, bag hang* • *Flexion ROM: heel slides, wall slides*
Weight Bearing	50-75% BW with brace unlocked to patient's available flexion ROM (90-120°)

Suggested Interventions	• Continue phase 1 interventions as needed
	• Prone TKE
	• SLR-4 way – without brace if quadriceps lag is not present
	• Double leg CKC interventions with brace
	  ○ Shuttle press
	  ○ Mini-squats
	  ○ Bridges
	  ○ Sit to stands
	  ○ Side steps
	  ○ Wall sit
	• **Patellar mobilization in superior and inferior directions only**
	  ○ Initiate medial and lateral patellar glides at 6 weeks
	• Gait training
	• Upright cycling- for ROM only
	• Trunk stability interventions
	  ○ TrA isometric progression
	  ○ Prone/side planks
	• Continue effusion management and NMES (seated with tibia fixed at 60° of knee flexion)
	• BFR (continue as in early phase, adding appropriate exercises)

Criteria to Progress to Phase 3	By the end of week 6: • Pain-free Symmetrical hyperextension - 120°of flexion • Proficient heel-to-toe gait with 75% BW with brace unlocked to 120°of flexion • Reduced and well-controlled post-operative pain and edema • Ability to perform SLR without quadriceps lag without knee brace • Proficiency with home-exercise program

PHASE 3 (WEEKS 8-12)

During Phase 3, the patient works toward movement independent of ambulation devices. Full ROM should be achieved and balance/proprioception interventions are initiated. Progression towards SL CKC interventions is appropriate during Phase 3.	
Precautions	No OKC knee extension
Range of Motion	Full AROM
Weight Bearing	75% - Full BW with completely unlocked brace. Consider discharging crutches at weeks 6-8 *(see criteria to discharge assistive device)*

Suggested Interventions	• Continue Phase 1 and 2 interventions
	• SLR-Flexion progressions
	  ○ Semi-reclined or seated
	  ○ Add ER
	  ○ Perform with eyes closed (cortical training)
	  ○ Speed
	  ○ Isometric holds at end-range
	• Initiate single leg CKC interventions with brace on
	  ○ Single leg sit to stand
	  ○ Single leg wall sit
	• Initiate SL balance and proprioceptive interventions
	• Upright cycling for strength and endurance
	• Continue effusion management strategies and NMES (seated with tibia fixed at 60° of knee flexion)
	• BFR (continue as in early phase, adding appropriate exercises)

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) *Appendix C* 4. Weight Bearing: Demonstrates pain-free ambulation without visible gait deviation
Criteria to Progress to Phase 4	By the end of week 8: • Pain-free full AROM • Pain-free gait with full BW with unlocked brace • Discharged crutches, pain-free ambulation without visible gait deviation • Proficiency with home exercise program

PHASE 4 (WEEKS 8-12)

During Phase 4, the majority of patients return to work either on a part-time or full-time basis. Patients should continue skilled physical therapy to progress functional, CKC strengthening (DL and SL).	
Precautions	No running or impact activities
Range of Motion	Full AROM
Weight Bearing	Full BW – Brace discharge at 8-10 weeks pending appropriate quadriceps control and normal gait mechanics. *May continue brace as needed for adverse weather conditions or ambulation on uneven ground x12 weeks*
Suggested Interventions	• Continue Phase 2 and 3 interventions • Continue ROM interventions until symmetrical ROM is achieved • Continue to progress single leg interventions per patient's tolerance • Progress proprioceptive and core interventions per patient's tolerance • Multi-angle isometrics • SAQ • Unresisted LAQ • Continue NMES (seated with tibia fixed at 60° of knee flexion) • Continue effusion management strategies as needed • BFR (continue as in early phase, adding appropriate exercises)
Criteria to Progress to Phase 5	By week 12: • Full and pain-free active ROM • Pain-free ambulation without visible gait deviation • Full and pain-free ADLs (including stair negotiation), with proper technique • Able to perform single leg balance x60 seconds without complaints of pain • Able to perform x5 single leg squats 60-90° • Proficiency in home exercise program

PHASE 5 (WEEKS 12-16)

During Phase 5, patient progresses OKC interventions and can initiate cardio training via elliptical or stair stepper. Full return to unrestricted IADLs and vocational duties should be achieved during this phase.	
Precautions	No running or impact activities. Continued emphasis on mechanics to avoid patellofemoral pain.
Range of Motion	Full AROM
Weight Bearing	Full BW, no brace

Suggested Interventions	• Continue Phase 3 and 4 interventions
	• Continue to progress single leg interventions per patient's tolerance
	• Progress proprioceptive and core interventions per patient's tolerance
	• Bridging
	• Resisted OKC quadriceps strengthening
	  ○ Partial ROM (90-45°) – weeks 12-13
	  ○ Full ROM – weeks 14-16
	• Lunges
	• Step Ups
	• Heel Taps
	• Elliptical/stair stepper
	• Outdoor cycling if desired
	• Rowing ergometry as tolerated
	• Continue NMES until 80% symmetry is obtained (seated with tibia fixed at 60° of knee flexion)
	• Continue effusion management as needed

Criteria to Progress to Phase 6	By 4 months: • Ability to negotiate stairs and mild gradients without pain or reactive effusion • Return to work, depending on the demands of the job • Ability to perform 3x10 heel tap on 6" step with neutral frontal and sagittal plane alignment • Proficiency in home exercise program

PHASE 6 (WEEKS 16 - RTS)

In Phase 6, strength assessments are utilized to determine readiness to return to running/jumping. Care is taken to emphasize mechanics and functional movement patterns to safely transition back to sport.	
Precautions	Running should not be initiated until 6 months post-op. The surgeon must provide final clearance for RTS
Range of Motion	Full AROM
Weight Bearing	Full BW, no brace

Suggested Interventions	• Continue phase 2-5 interventions
	• Progress and increased difficulty of OKC exercises
	• Continue to progress SL eccentric strengthening through body weight and machine interventions
	
	• Once strength criteria have been met:
	  ○ PBW jumping on the shuttle
	  ○ Step-hold progression to SL hop progressions
	  ○ Walk-jog program
	  ○ Sports-specific training
	  ○ Agility
	  ○ Plyometric training

Functional Testing *Appendix E-G*	Isometric testing is appropriate at 5 months Isokinetic testing is appropriate at 6, 9 and 12 months, and RTS SL hop testing battery *(appropriate once the patient has achieved 80% LSI on isokinetic testing)* • SL hop for distance • Triple hop for distance • Cross over hop for distance • 6m timed hop **Functional strength testing and hop testing should be reserved for patients returning high-level activity**
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
Criteria to Return to Sport	1. ROM: full, pain free 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
Most patients who undergo this procedure have limited sports goals and have not routinely engaged in jumping and pounding sports. Define patient goals and expectations upfront, and work with the surgeon to modify protocol accordingly. *Full RTS expected between 9-15 months post-operatively*	

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

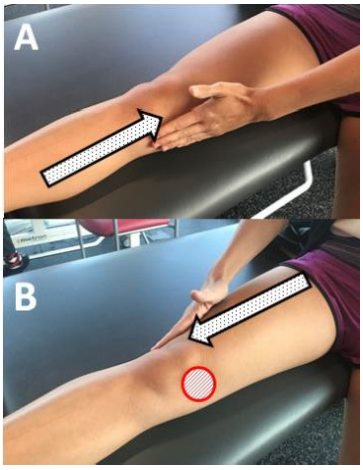
Appendix C: Stoke Test / Swelling Assessment

The Stroke Test

The stroke test is a great way to assess your swelling independently. The results of this assessment will help you decide what exercises are appropriate.

A. Using one hand, gently sweep the inside portion of your knee 2-3 times (pushing toward the hip joint).

B. On the outside portion of the knee, immediately sweep downward (toward the ankle). Watch the inside portion of the knee *(indicated by hashed circle in photo)* for a wave of fluid to appear during the downstroke.



Grading System

(Table adapted from Sturgill L et al, Journal of Orthopaedic & Sports Physical Therapy, 2009)

Test Result	Grade
No wave produced on downstroke	Zero
Small wave on inside aspect of knee with downstroke	Trace
Large bulge on inside aspect of knee with downstroke	1+
Swelling spontaneously returns to inside aspect of knee after upstroke (no downstroke necessary)	2+
So much fluid that it is not possible to move the swelling out of the inside aspect of the knee	3+

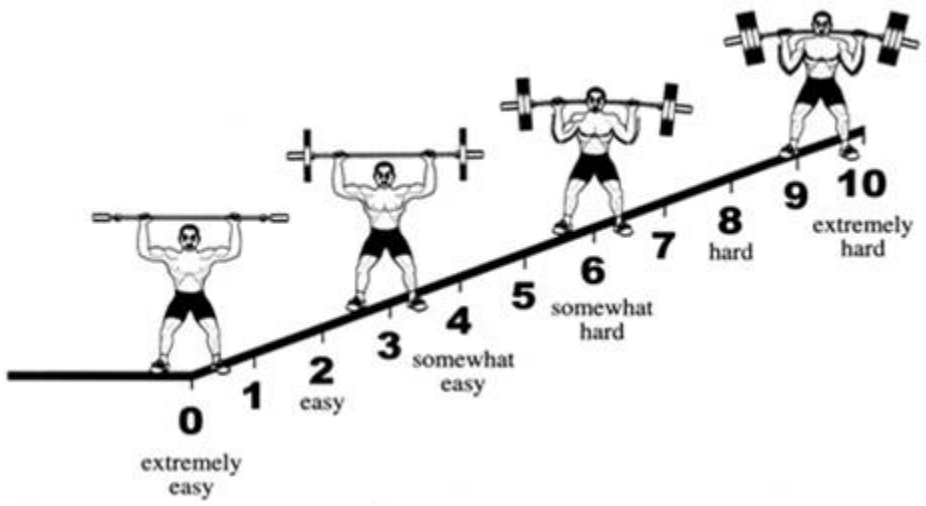
Indications for Activity

3+ or 2+	1+	Trace or Zero
Red Light	**Yellow Light**	**Green Light**
• No running, jumping or cutting or heavy lifting until swelling decreases to 1+ or less • Do not progress program until you speak with your therapist • Utilize swelling management strategies (ice, compression, elevation, NSAIDs)	• Proceed with caution • You may participate in running, jumping and normal lifting routine. • Check effusion before and after workouts • Utilize swelling management strategies (ice, compression, vation, NSAIDs)	• May participate in running, jumping and normal lifting routine without restriction • Continue to monitor swelling after activity

Appendix D: Blood Flow Restriction Training

Precautions (must get permission from MD)	Contraindications
▪ Patients with poor circulatory systems (Indicators: shining or scaly skin, brittle dry nails, extremity hair loss, increased capillary filling time, and presence of varicose veins) ▪ Patients who are obese or with limb tissue that is loose ▪ Arterial claudification ▪ Abnormal clotting times ▪ Diabetes ▪ Sickle cell trait ▪ Tumor ▪ General infection ▪ Hypertension ▪ Cardiopulmonary conditions ▪ Renal compromise ▪ Clinically significant acid-base imbalance ▪ Atherosclerotic vessels ▪ Taking anti-hypertensive medications	▪ Venous thromboembolism ▪ Impaired circulation or peripheral vascular compromise ▪ Previous revascularization of the extremity ▪ Extremities with dialysis access ▪ Acidosis ▪ Sickle cell anemia ▪ Extremity infection ▪ Tumor distal to the tourniquet ▪ Medications/supplements known to ↑ clotting risk ▪ Open fracture ▪ Increased intracranial pressure ▪ Open soft tissue injuries ▪ Post-traumatic hand reconstructions ▪ Severe crushing injuries ▪ Severe hypertension ▪ Elbow surgery with excessive swelling ▪ Skin grafts in which all bleeding points distinguished ▪ Secondary or delayed procedures after immobilization ▪ Vascular grafting lymphectomies ▪ Cancer

Training Intensity: 20-40% 1RM or use the Omnibus Resistance Exercise Scale (below). Patient chooses weight/resistance that corresponds to 2-3

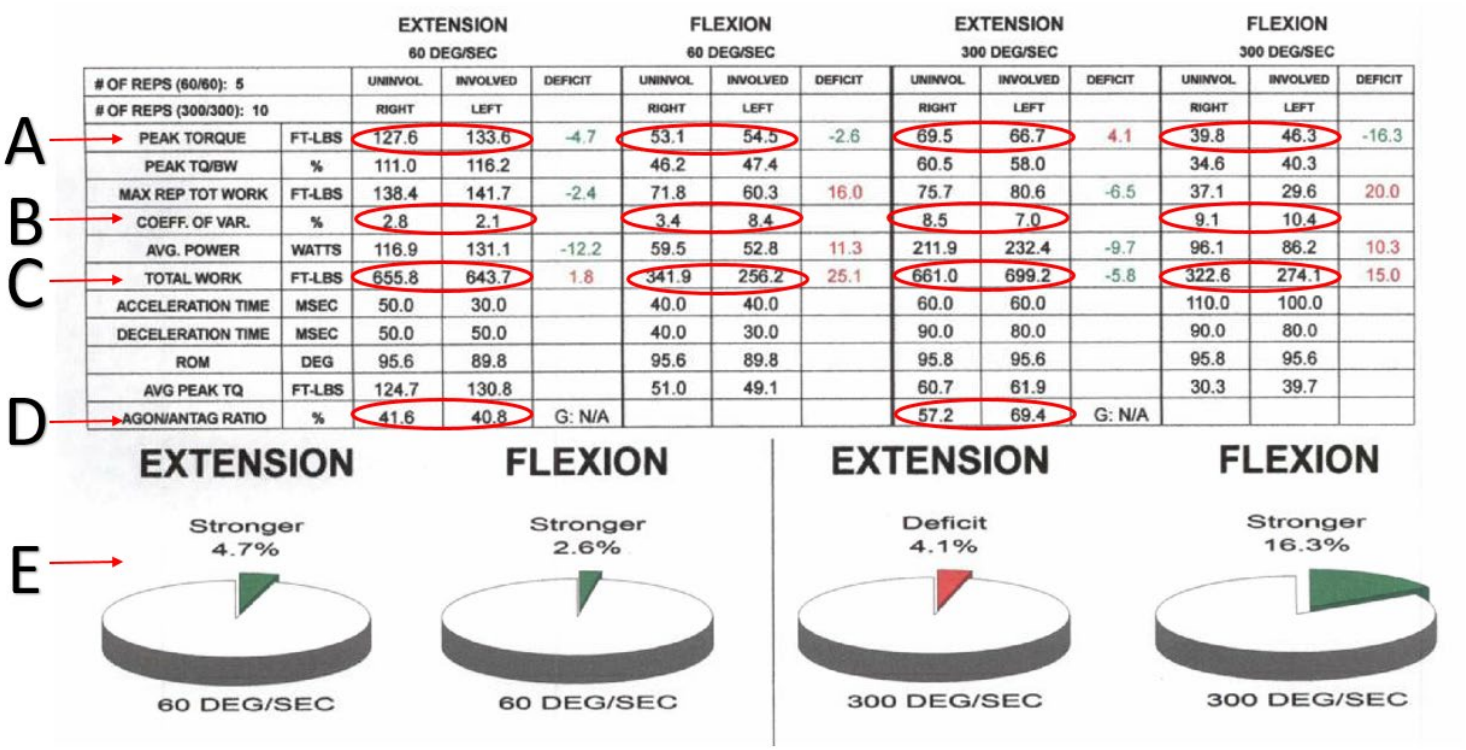


Exercise Prescription:

- If Patient achieves:
  - 75 repetitions: continue with training, re-assess intensity within 1-3 sessions and change as strength improves
  - 60-74 repetitions: continue with training, but extend rest period between sets 3 and 4 to 45 seconds until 75 repetitions is completed
  - 45-59 repetitions: continue with training, but extend rest period between all sets to 45-60 seconds
  - <44 repetitions: reduce load by approximately 10% until repetitions are achieved
- If patient is forced to stop before 75 repetitions due to undue pain, soreness, or general uncomfortable feeling underneath the cuff→ reduce tourniquet pressure by 10mmHg at each training session until cuff tolerance is achieved.

Ramp cuff pressure back up by 10 mmHg to target limb occlusion pressure if patient can tolerate.

Appendix E: Isokinetic Data Interpretation



		EXTENSION 60 DEG/SEC			FLEXION 60 DEG/SEC			EXTENSION 300 DEG/SEC			FLEXION 300 DEG/SEC		
# OF REPS (60/60): 5		UNINVOL	INVOLVED	DEFICIT	UNINVOL	INVOLVED	DEFICIT	UNINVOL	INVOLVED	DEFICIT	UNINVOL	INVOLVED	DEFICIT
# OF REPS (300/300): 10		RIGHT	LEFT		RIGHT	LEFT		RIGHT	LEFT		RIGHT	LEFT	
A → PEAK TORQUE	FT-LBS	127.6	133.6	-4.7	53.1	54.5	-2.6	69.5	66.7	4.1	39.8	46.3	-16.3
PEAK TQ/BW	%	111.0	116.2		46.2	47.4		60.5	58.0		34.6	40.3	
MAX REP TOT WORK	FT-LBS	138.4	141.7	-2.4	71.8	60.3	16.0	75.7	80.6	-6.5	37.1	29.6	20.0
B → COEFF. OF VAR.	%	2.8	2.1		3.4	8.4		8.5	7.0		9.1	10.4	
AVG. POWER	WATTS	116.9	131.1	-12.2	59.5	52.8	11.3	211.9	232.4	-9.7	96.1	86.2	10.3
C → TOTAL WORK	FT-LBS	655.8	643.7	1.8	341.9	256.2	25.1	661.0	699.2	-5.8	322.6	274.1	15.0
ACCELERATION TIME	MSEC	50.0	30.0		40.0	40.0		60.0	60.0		110.0	100.0	
DECELERATION TIME	MSEC	50.0	50.0		40.0	30.0		90.0	80.0		90.0	80.0	
ROM	DEG	95.6	89.8		95.6	89.8		95.8	95.6		95.8	95.6	
AVG PEAK TQ	FT-LBS	124.7	130.8		51.0	49.1		60.7	61.9		30.3	39.7	
D → AGON/ANTAG RATIO	%	41.6	40.8	G: N/A				57.2	69.4	G: N/A			

		Definition	Clinical Impact	What to do
A	Peak Torque (ft-lbs)	Peak torque during repetitions	Symmetry criteria (see 'E'- this is the data represented in pie charts)	If <80%; continue unilateral, high resistance strength training
B	Coefficient of Variance (%)	Between repetition variability	Goal: < 15%	If >15%, consider retest
C	Total Work (ft-lbs)	Torque over all repetitions	Possible indicator of fatigue	If >10%; consider high volume training
D	Agonist/Antagonist Ratio (%)	Hamstring/Quadriceps Ratio	Goal: >60%	<60%; ensure 1:1 quadriceps:hamstring exercise ratio
E	Limb Symmetry Pie Charts	Strength relative to involved limb	Goal: <10% asymmetry (either direction- deficit OR stronger on involved limb)	If <80%, continue NMES in addition to strength training If <90%, continue unilateral > bilateral strength training emphasis

Appendix F: Isokinetic Testing and Appropriate Alternatives

Sinacore, J. A., Evans, A. M., Lynch, B. N., Joreitz, R. E., Irrgang, J. J., & Lynch, A. D. (2017). Diagnostic accuracy of handheld dynamometry and 1-repetition-maximum tests for identifying meaningful quadriceps strength asymmetries. *Journal of orthopaedic & sports physical therapy*, *47*(2), 97-107.

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

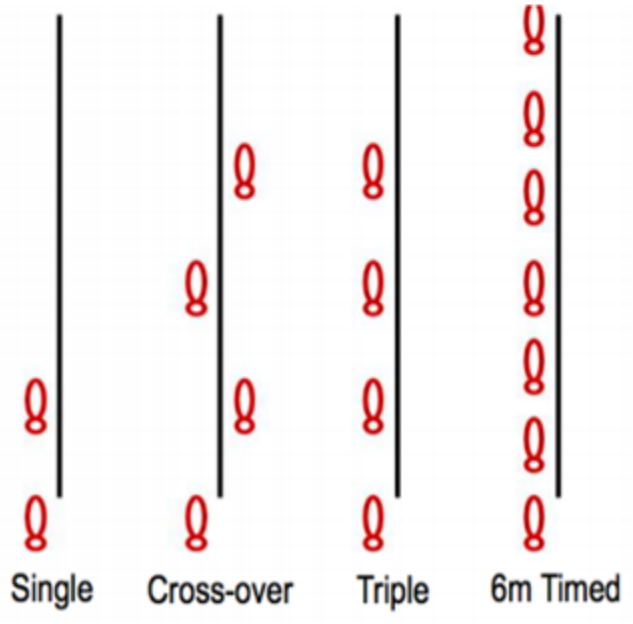
Appendix G: Single Leg Hop Series

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 distanced 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 distanced 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 distanced 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 distanced hopped for each limb. The Limb Symmetry Index: Involved limb time/Uninvolved limb time X 100%.



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Date Revised: April 2023

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