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Rehabilitation Protocol for Multiligamentous Knee Reconstruction Surgery

Procedures Performed:

- | | |
|--|---|
| <input type="checkbox"/> ACL reconstruction | <input type="checkbox"/> Medial Meniscus Repair |
| <input type="checkbox"/> PCL reconstruction** | <input type="checkbox"/> Root/Radial pattern** |
| <input type="checkbox"/> MCL reconstruction | <input type="checkbox"/> Lateral Meniscus Repair |
| <input type="checkbox"/> Posterior Oblique Ligament reconstruction | <input type="checkbox"/> Root/Radial pattern** |
| <input type="checkbox"/> Posterolateral Corner reconstruction** | <input type="checkbox"/> Partial Medial Meniscectomy |
| <input type="checkbox"/> LCL reconstruction** | <input type="checkbox"/> Partial Lateral Meniscectomy |
| <input type="checkbox"/> Distal Biceps Femoris Repair** | |

Specific Case Complexity and Limitations:

- Primary Procedure
- Revision Procedure

Comments: _____

Pace of Protocol:

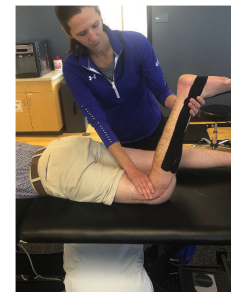
- ROUTINE
- AGGRESSIVE

Comments: _____

****Throughout protocol, please note special considerations for PCL reconstruction, Posterolateral Corner reconstruction, LCL reconstruction, Distal Biceps Femoris repair, and radial/root meniscus repairs****

PHASE I: Recovery and Protection (0-8 WEEKS AFTER SURGERY)

<p>Rehabilitation Goals</p>	<ul style="list-style-type: none"> ● Minimize pain and inflammation ● Protect integrity of repair ● Avoid postoperative adhesions ● Protected ROM <ul style="list-style-type: none"> ○ Goal 0-115+ degrees ● Quad activation (able to perform SLR without lag) ● Return to general wellness baseline (sleep, nutrition, mood, and energy) ● Patient education emphasizing compliance of post-operative restrictions
<p>Weight Bearing</p>	<ul style="list-style-type: none"> ● Non-weight-bearing for 6 weeks ● Gradually progress to WBAT by week 8
<p>Range of Motion Limitations</p>	<ul style="list-style-type: none"> ● 0-2 weeks: <ul style="list-style-type: none"> ○ Limit flexion to 90° ○ Restore full extension ● 2-8 weeks: <ul style="list-style-type: none"> ○ Progress flexion as tolerated** ○ Maintain extension <ul style="list-style-type: none"> ■ Avoid hyperextension**
<p>Brace</p>	<ul style="list-style-type: none"> ● 0-4 weeks: <ul style="list-style-type: none"> ○ Hinged knee brace locked in extension at all times except for exercises/hygiene ○ May unlock for ROM exercises ● 4-8 weeks (*if able to perform SLR without lag*): <ul style="list-style-type: none"> ○ Hinged knee brace locked in extension when ambulating ○ Brace open to motion at other times ○ May remove brace when sleeping <p><i>PCL Injury</i></p> <ul style="list-style-type: none"> ● Transition into dynamic PCL brace when swelling allows (e.g. Ossur PCL Rebound Brace)
<p>Precautions/ Guidelines</p>	<ul style="list-style-type: none"> ● Avoid open chain exercises ● Specific precautions per special considerations below
<p>**Special Considerations</p>	<p><i>PCL Reconstruction</i></p> <ul style="list-style-type: none"> ● Minimize posterior tibial translation forces on PCL graft ● ROM <ul style="list-style-type: none"> ○ Passive ROM ○ Apply anterior drawer with passive knee flexion ○ Prone ROM for 0-2 weeks ● AVOID <ul style="list-style-type: none"> ○ Stretching into hyperextension ○ Prone hangs ○ Active hamstring contraction/strengthening <p><i>Posterolateral Corner/LCL Reconstruction</i></p> <ul style="list-style-type: none"> ● Reduce tension at the fibular head (tunnel for LCL reconstruction) ● Passive ROM ● AVOID



	<ul style="list-style-type: none"> ○ Stretching into hyperextension ○ Active hamstring contraction/strengthening ○ Varus stress on knee ○ Hip abduction <p><i>Distal Biceps Femoris Repair</i></p> <ul style="list-style-type: none"> ● Passive ROM ● AVOID <ul style="list-style-type: none"> ○ Stretching into hyperextension ○ Active hamstring contraction/strengthening <p><i>Meniscus Repair</i></p> <ul style="list-style-type: none"> ● Standard repairs <ul style="list-style-type: none"> ○ ROM 0-90° for 4 weeks, then progress as tolerated ● Radial or Root Repairs <ul style="list-style-type: none"> ○ No ROM past 90° for 6 weeks ● For all meniscus repairs: <ul style="list-style-type: none"> ○ No ROM past 90° with a load for 12 weeks (i.e. deep squats/lunges)
Interventions	<p><i>Swelling Management</i></p> <ul style="list-style-type: none"> ● Ice/cryotherapy ● Compression ● Elevation ● Retrograde massage ● Ankle pumps <p><i>Range of motion/Mobility</i></p> <ul style="list-style-type: none"> ● Patellar mobilizations: superior/inferior and medial/lateral <ul style="list-style-type: none"> ○ *Patellar mobilizations are heavily emphasized in the early post-operative phase following patella tendon autograft* ● Follow precautions for specific procedures in progressing ROM <p><i>Strengthening</i></p> <ul style="list-style-type: none"> ● Quad sets ● NMES high intensity (2500 Hz, 75 bursts) supine knee extended 10 sec/50 sec, 10 contractions, 2x/wk during sessions—use of clinical stimulator during session, consider home units distributed immediate post op ● Straight leg raise <ul style="list-style-type: none"> ○ *Do not perform straight leg raise if you have a knee extension lag* <p><i>Cardiovascular</i></p> <ul style="list-style-type: none"> ● May begin exercise bike with no resistance at 6 weeks when adequate ROM <ul style="list-style-type: none"> ○ Can add resistance at 10 weeks ● May begin pool therapy at 6 weeks <ul style="list-style-type: none"> ○ No swimming/kicking
Criteria to Progress	<ul style="list-style-type: none"> ● ROM 0-115+ degrees ● Quad contraction with superior patella glide and full active extension ● Able to perform 30+ SLR without lag ● Tolerance for progressive intensity with strengthening exercises

PHASE II: Acclimation to Load (8-10/12 WEEKS AFTER SURGERY)

<p>Rehabilitation Goals</p>	<ul style="list-style-type: none"> ● Progress to full weight-bearing with non-analgesic gait pattern ● Prepare the knee to accept load for future strength exercise progressions
<p>Range of Motion</p>	<ul style="list-style-type: none"> ● Progress to full range of motion
<p>Brace</p>	<ul style="list-style-type: none"> ● Hinged brace for daily activities <ul style="list-style-type: none"> ○ May remove when not ambulating <p><i>PCL Injury</i></p> <ul style="list-style-type: none"> ● Continue dynamic PCL brace for 6 months with ambulating/activities
<p>Precautions/ Guidelines</p>	<ul style="list-style-type: none"> ● Avoid open chain exercises ● Specific precautions per special considerations below
<p>**Special Considerations</p>	<p><i>PCL Reconstruction</i></p> <ul style="list-style-type: none"> ● Continue to minimize posterior tibial translation forces on PCL graft ● ROM <ul style="list-style-type: none"> ○ May begin A/AAROM ● May begin <ul style="list-style-type: none"> ○ Prone hangs ● AVOID <ul style="list-style-type: none"> ○ Stretching into hyperextension ○ Active hamstring contraction/strengthening <p><i>Posterolateral Corner/LCL Reconstruction/Distal Biceps Femoris Repair</i></p> <ul style="list-style-type: none"> ● May begin gentle hip abduction with no resistance below the knee ● AVOID <ul style="list-style-type: none"> ○ Stretching into hyperextension ○ Active hamstring contraction/strengthening <p><i>Meniscus Repair</i></p> <ul style="list-style-type: none"> ● No ROM past 90° with a load for 12 weeks (i.e. deep squats/lunges)
<p>Interventions -Continue with Phase I interventions</p>	<p><i>Strengthening</i></p> <ul style="list-style-type: none"> ● May initiate basic weight bearing exercises ● Gentle hip abduction with no resistance below knee ● Wall-sits 0-45 ● Mini-squats with support 0-45 <p><i>Cardiovascular</i></p> <ul style="list-style-type: none"> ● Exercise bike with no resistance until 10 weeks ● Pool therapy - no swimming/kicking ● Treadmill walking
<p>Criteria to Progress</p>	<ul style="list-style-type: none"> ● Full weight-bearing with nonanalgesic gait pattern without crutches ● Walk 1-2 miles at 20 min/mile pace ● An effusion may still be present but must be non reactive before phase progression ● Compliance with home exercise program

PHASE III: Rebuild (10-24 WEEKS AFTER SURGERY)

<p>Rehabilitation Goals</p>	<ul style="list-style-type: none"> ● Fully resolving any remaining ROM deficits ● Initiate cardiovascular and work capacity training ● Reestablish tolerance to joint and tissue loading ● Build muscle mass with progressive resistance exercise
<p>Brace</p>	<ul style="list-style-type: none"> ● Hinged Brace ● Criteria for discontinuing brace: <ul style="list-style-type: none"> ○ Able to perform 30+ SLR without lag ○ ROM 0-90+ degrees ○ Ambulating with normalized gait ● If returning to sport, fit for custom functional brace by 5 months <p><i>PCL Injury</i></p> <ul style="list-style-type: none"> ● Continue dynamic PCL brace for 6 months with ambulating/activities
<p>Precautions/ Guidelines</p>	<p><u>Before Four Months</u> <i>PCL and/or PLC reconstruction</i></p> <ul style="list-style-type: none"> ● Avoid open-chain hamstring strengthening ● Strengthening from 6 weeks to 4 months with submaximal effort exercises in shallow knee flexion angles ● Open-chain quadriceps strength exercises are critical to isolate the muscle and recover strength. ● Closed-chain or weight-bearing quadriceps strengthening through squat, step-up, or lunge drills is limited to a depth of 70 of knee flexion <ul style="list-style-type: none"> ○ Squat technique should ensure adequate knee over toe mechanics to maximize quadriceps muscle activation ○ Gradual progressions that honor joint or tendon symptoms. <p><u>After Four Months</u></p> <ul style="list-style-type: none"> ● All postoperative exercise restrictions lapse ● Single-leg loading is a focus of early strength training to minimize potential movement compensations <p><i>PCL and/or PLC reconstruction</i></p> <ul style="list-style-type: none"> ● Hamstring exercises are progressed gradually per the required muscular demand of the exercise <ul style="list-style-type: none"> ○ Nordic hamstring exercise is incorporated last due to the kneeling position and high levels of muscle activation ○ Progress closed chain knee flexion loading (i.e., squatting) deeper than 70 degrees
<p>Interventions <i>-Continue with Phase I-II interventions</i></p>	<ul style="list-style-type: none"> ● At 5 months, may begin low intensity sport-specific activities <p><i>Strengthening</i></p> <ul style="list-style-type: none"> ● Begin low-intensity plyometrics at 4 months ● Progress strengthening exercises within precautions/restrictions <p><i>Cardiovascular</i></p> <ul style="list-style-type: none"> ● Exercise bike ● Pool therapy

	<ul style="list-style-type: none"> ○ No breast stroke ● Return to run progression <ul style="list-style-type: none"> ○ Can start at 5 months if within 2 degrees of full extension
Sport Performance Testing <i>Baseline - 4 months</i>	<p><i>Basic Clinical measures</i></p> <ul style="list-style-type: none"> ● Knee joint ROM <ul style="list-style-type: none"> ○ Goal: extension 0°, flexion ≤10° SSD ● Ankle joint ROM <ul style="list-style-type: none"> ○ Goal: CKC ankle DF ROM ≥40° DF, relative symmetry (≤5° SSD) ● Circumferential limb measures-muscle girth ● Swelling measures <ul style="list-style-type: none"> ○ Goal: ≤1+ effusion ● Hip strength with HHD (omit if s/p FCL or Posterolateral corner reconstruction) <ul style="list-style-type: none"> ○ Goal: ≥75% LSI <p><i>Lower Extremity Functional Testing</i></p> <ul style="list-style-type: none"> ● Y-balance test squat - anterior <ul style="list-style-type: none"> ○ Goal: ≤8 cm SSD ● One leg rise test (from 60° knee flexion) <ul style="list-style-type: none"> ○ Goal: @ 60 bpm: able to complete 25 consecutive reps <p><i>Biomechanics Lab Tests</i></p> <ul style="list-style-type: none"> ● Isometric dynamometer quadriceps muscle strength ● Quad strength goals: <ul style="list-style-type: none"> ○ ≥65-70% LSI ○ ≥65%-70% peak torque/BW ● Squatting goals: (force plates, motion capture) <ul style="list-style-type: none"> ○ Double leg squat: <10% loading asymmetry ○ Single leg squat: >75° peak knee flexion angle
Criteria to Progress	<ul style="list-style-type: none"> ● Full, pain-free motion ● No effusion ● Sufficient hamstring and quadriceps strength to progress agility exercises ● Tolerance of strengthening progressions ● Walk 1-2 miles at 15 min/mile pace

PHASE IV: Restore (6 MONTHS - 1+ YEAR)

Rehabilitation Goals	<ul style="list-style-type: none"> ● Reintegration into sporting environment ● Control-Chaos continuum <ul style="list-style-type: none"> ○ Progress athlete from slow, controlled, pre planned movements to fast, chaotic, reactive, sport-specific movements ● Athlete should gradually increase volume of load, skill, and physical fitness training ● Alternate difficult days with recovery days
Brace	<ul style="list-style-type: none"> ● Functional brace for returning to sport
Interventions <i>-Continue with Phase</i>	<p><i>Strengthening</i></p> <ul style="list-style-type: none"> ● Progress strengthening exercises

<p><i>I-III interventions</i></p>	<ul style="list-style-type: none"> ● Progress plyometrics, agility drills <ul style="list-style-type: none"> ○ Slide boards ○ Figure 8's ○ Gentle loops ○ Large zig zags <p><i>Progressions</i></p> <ul style="list-style-type: none"> ● Multi-plane sport specific plyometrics program ● Multi-plane sport specific agility program ● Include hard cutting and pivoting depending on the individuals' goals (~7 mo) ● Non-contact practice→ Full practice→ Full play (12+ months) <p><i>Cardiovascular</i></p> <ul style="list-style-type: none"> ● Exercise bike with increasing resistance ● Pool therapy/swimming ● Running progression
<p>Sport Performance Testing Follow up 1 7 months</p>	<p><i>Basic Clinical measures</i></p> <ul style="list-style-type: none"> ● Repeat baseline tests ● Knee joint ROM <ul style="list-style-type: none"> ○ Goal: symmetrical extension, flexion $\leq 5^\circ$ SSD ● Ankle joint ROM <ul style="list-style-type: none"> ○ Goal: symmetrical ● Circumferential limb measures-muscle girth ● Swelling measures <ul style="list-style-type: none"> ○ Goal: 0 effusion ● Hip strength with HHD (for all surgery types) <ul style="list-style-type: none"> ○ Goal: $\geq 85\%$ LSI <p><i>Lower Extremity Functional Testing</i></p> <ul style="list-style-type: none"> ● Repeat baseline tests ● Y-balance test squat - anterior <ul style="list-style-type: none"> ○ Goal: ≤ 4 cm SSD ● One leg rise test (from 90° knee flexion) <ul style="list-style-type: none"> ○ Goal: 25 consecutive reps ● Add hop tests as appropriate per recovery status <ul style="list-style-type: none"> ○ Single leg hop for distance, triple hop for distance ○ Goal: $\geq 80\%$ LSI <p><i>Biomechanics Lab Tests</i></p> <ul style="list-style-type: none"> ● Repeat/add <ul style="list-style-type: none"> ○ Isometric quad strength ○ Isokinetic quad and hamstring strength ● Add: hop testing with motion capture over force plates as appropriate ● Quad strength goals: <ul style="list-style-type: none"> ○ $\geq 80\%$ LSI ○ $\geq 75-80\%$ peak torque/BW ● Hamstring strength goals: <ul style="list-style-type: none"> ○ $\geq 75\%$ LSI ● Squatting/hopping (force plates, motion capture)

	<ul style="list-style-type: none"> ○ ≤10% loading asymmetry with bilateral vertical jump
Sport Performance Testing <i>Follow up 2</i> <i>10+ months</i>	<p><i>Basic Clinical measures</i></p> <ul style="list-style-type: none"> ● Repeat baseline tests ● Knee joint ROM <ul style="list-style-type: none"> ○ Goal: symmetrical extension, flexion ≤5° SSD ● Circumferential limb measures-muscle girth <ul style="list-style-type: none"> ○ Goal: <2 cm SSD ● Swelling measures <ul style="list-style-type: none"> ○ Goal: 0 effusion ● Hip strength with HHD <ul style="list-style-type: none"> ○ Goal: ≥90% LSI <p><i>Lower Extremity Functional Testing</i></p> <ul style="list-style-type: none"> ● Repeat baseline tests ● Y-balance test squat - anterior <ul style="list-style-type: none"> ○ Goal: ≤4 cm SSD ● One leg rise test (from 90° knee flexion) <ul style="list-style-type: none"> ○ Goal: 25 consecutive reps ● Add/repeat hop tests <ul style="list-style-type: none"> ○ Single leg hop for distance, triple hop for distance ○ Goal: ≥90% LSI <p><i>Biomechanics Lab Tests</i></p> <ul style="list-style-type: none"> ● Repeat <ul style="list-style-type: none"> ○ Isometric quad strength ○ Isokinetic quad and hamstring strength ● Repeat/add: hop testing with motion capture over force plates ● Quad strength goals: <ul style="list-style-type: none"> ○ ≥90% LSI ○ ≥90% peak torque/BW ● Hamstring strength goals: <ul style="list-style-type: none"> ○ ≥75% LSI ● Squatting/hopping (force plates, motion capture) <ul style="list-style-type: none"> ○ ≤10% loading asymmetry with bilateral vertical jump ○ ≥75° peak knee flexion angle with Single Leg Forward Hop (SLFH) landing ○ Peak knee flexion angle (SLFH landing) within 90% of contralateral limb
Criteria for Return to Sports	<ul style="list-style-type: none"> ● Not before 9 months, and may take 12-18+ months ● Full, painless range of motion ● No effusion ● Quadriceps and hamstring strength 90% of contralateral side ● No apprehension with all sports specific drills ● Functional bracing is used for sports or work activities that put the reconstruction at risk until the patient reaches 18 months post op ● Cleared by physician

Monson J, Schoenecker J, Schwery N, Palmer J, Rodriguez A, LaPrade RF. Postoperative Rehabilitation and Return to Sport Following Multiligament Knee Reconstruction. *Arthrosc Sports Med Rehabil.* 2022 Jan 28;4(1):e29-e40. doi: 10.1016/j.asmr.2021.08.020. PMID: 35141534; PMCID: PMC8811527.