Rehabilitation Guidelines for Knee Multi-Ligament Repair/Reconstruction

The knee joint is comprised of an articulation of three bones: the femur (thigh bone), tibia (shin bone), and patella (knee cap). The femur has a medial (inside) and a lateral (outside) condyle that forms a radial or rounded bottom that comes together, forming a trochlear groove for the patella to move. The medial and lateral condyle sit on top of the tibia, which has a flat surface called the tibial plateau.

The knee also is comprised of two menisci, which are fibro-cartilaginous structures and each meniscus is thinner towards the center of the knee and thicker toward the periphery of the knee, giving it a wedge-shaped appearance. The medial meniscus forms a "c" shape and is located between the medial femoral condyle and the medial aspect of the tibia. The lateral meniscus forms an oval shape and is located between the lateral femoral condyle and the lateral aspect of the tibia. The menisci act to improve stability between the tibia and the femur secondary to its wedge shape that acts to limit translation.

The knee also has four major ligaments, which connect bone to bone and provide stability to the joint. These ligaments are termed the medial collateral ligament (MCL) (Figure 1a), lateral collateral ligament (LCL) (Figure 1b), anterior cruciate ligament (ACL) (Figure 2a) and posterior cruciate ligament (PCL) (Figure 2b). The MCL connects the femur and tibia medially (on the inside) and resists valgus (knee buckling in) knee motion. A common mechanism of injury to the MCL occurs when a force is applied to the outer knee while the foot is planted, causing the knee to move inward. The LCL connects the femur and the fibula laterally (on the outside) and resists varus (knee buckling out) knee motion. A common mechanism of injury to the LCL occurs when a force is applied to the inner knee while the

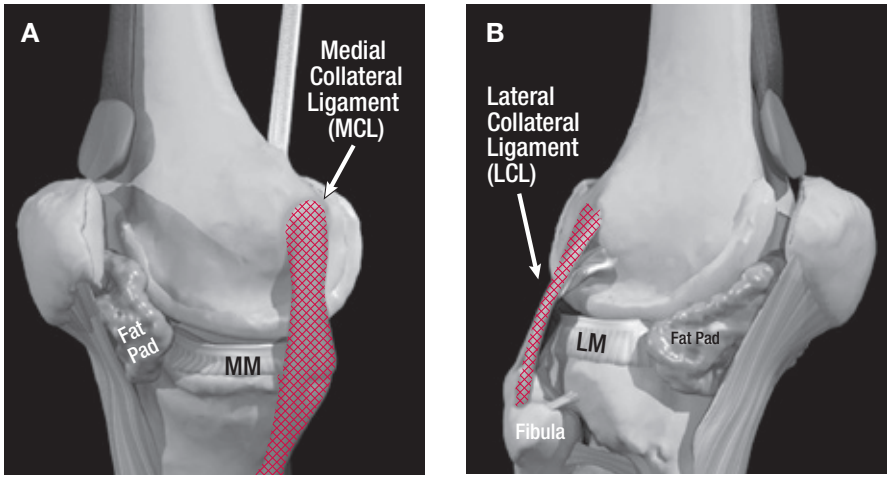

***Figure 1 a**: Medial or inner view of the knee showing the medial collateral ligament, **b**: Lateral or outer view of the knee showing the lateral collateral ligament.*

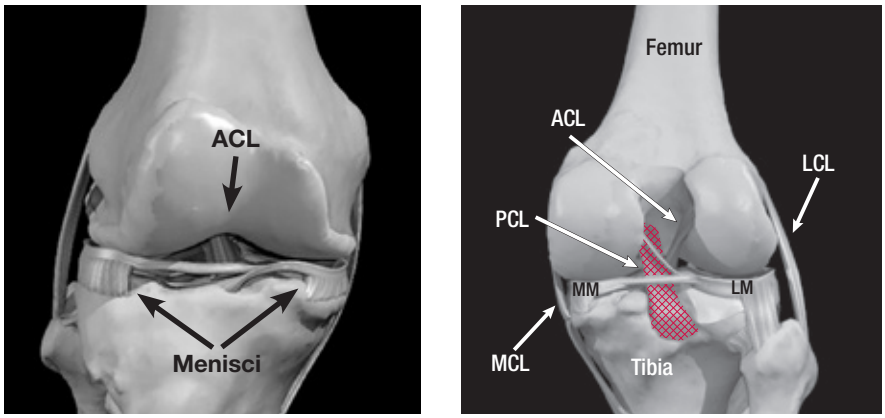

***Figure 2 a**: Anterior or front view of the knee showing the anterior cruciate ligament (ACL), **b**: Posterior or back view of the knee showing the posterior cruciate (PCL)*

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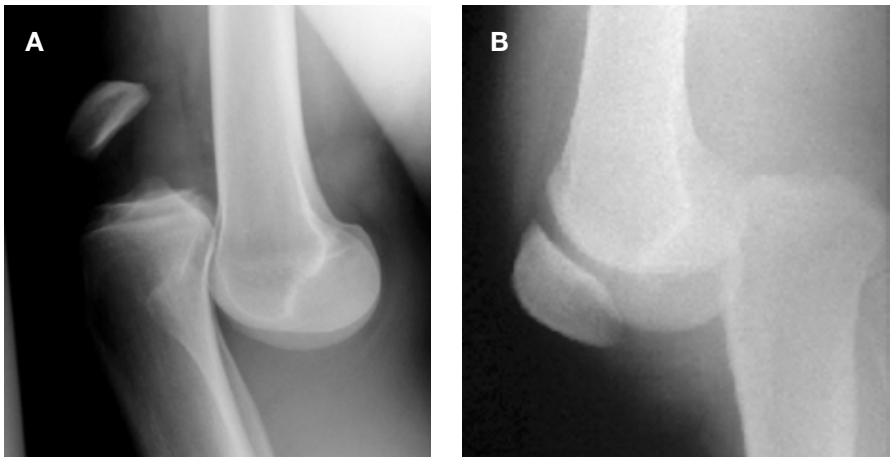

***Figure 3 – a**: Radiograph showing an example of anterior knee dislocation, **b**: Radiograph showing an example of posterior knee dislocation*

foot is planted, causing the knee to move outward. The ACL and PCL attach the tibia and femur deep inside the knee joint and cross one another like guide wires. The ACL restrains the tibia from moving forward and rotating excessively on the femur. Most ACL injuries occur without contact and are most common when an individual plants their foot and changes direction while participating in sports. The PCL resists the tibia from moving back excessively on the femur. PCL injuries most commonly occur when an anterior force is applied on the tibia such as when the lower leg hits the dashboard of a car during a car accident or landing on the knee with the knee flexed approximately 90 degrees.

Ligamentous injuries are termed sprains and are graded based on the severity of the injury. A grade 1 ligament sprain is a minimal injury with little to no increase in laxity to the ligament whereas a grade 3 sprain is a complete rupture to the ligament. Knee injuries that involve one of the four ligaments are somewhat common. Injuring two or more of the four major knee ligaments is uncommon and usually occurs from a high energy trauma such as an automobile accident, fall or a significant sports injury. When two or more of the ligaments are ruptured the tibia and the femur may lose contact from one another and spontaneously come apart or dislocate. A knee dislocation between the femur and the tibia is named by the direction the tibia is orientated from the femur in a dislocated position.

Secondary injuries such as nerve damage and or vascular injury are common following a knee dislocation. Often the vascular or nerve injuries require emergency attention to save the limb or possibly the individual's life. Once the knee is evaluated and secondary injuries are repaired, the initial treatment of the multi-ligament injuries includes immobilization, which is followed by continued evaluation and diagnostic testing to determine the extent of the ligament damage. Treatment options include surgical and nonsurgical approaches to care. Treatment decisions often are made based-on each individual's pre-injury function and the extent of the ligament damage. Recent studies have suggested patients receiving operative treatment have improved functional outcomes when compared with non-operative treatment. The timing of surgery is critical with evidence that shows if surgery is done immediately following the injury, an individual may experience increased post-operative stiffness and scarring. Research has shown that outcomes of multi-ligament reconstruction are best when the surgery is done within three weeks from injury after the patient can reduce the swelling from the initial injury. Surgery will vary depending on the extent of the ligament damage and the specific ligament(s) involved. If the ligament is avulsed from the bone (pulled off the bone) then the surgeon may be able to perform a primary repair of attaching the ligament back to the bone. When a ligament is ruptured it often needs to be reconstructed, which means replacing the ligament with other tissue. This can be done by using an autograft (donor tissue from an injured person) or an allograft (donor tissue from a cadaver).

Rehabilitation following multi-ligament reconstruction is vital to regaining motion, strength and function. Initially after surgery the knee is braced and individuals use crutches with minimal to no weight bearing for the first six weeks. Gradually more weight bearing and mobility will be allowed to prevent stiffness post-operatively. The rehabilitation will slowly progress into strengthening, gait and balancing activities. The UW Health sports rehabilitation guidelines are presented in a criterion based progression. General time frames refer to the usual pace of

rehabilitation. However, individual patients will progress at different rates depending on their age, associated injuries, pre-injury health status, rehab compliance, tissue quality and injury severity. Specific time frames, restrictions and precautions may also be given to enhance wound healing and to protect the surgical repair/reconstruction.

PHASE I (surgery to 8 weeks after surgery)

Appointments	• Begin rehabilitation 1-3 days after surgery and continue 2-3 times per week
Rehabilitation Goals	• Protect the post-surgical knee • Restore normal knee extension and improve scar and patellar mobility • Eliminate effusion (swelling) • Restore leg control Initiate regaining knee flexion
Precautions	• Non weight bearing (NWB) for 6 weeks • 25-50% weight bearing beginning week 7 post-operatively • 50% to 100% weight bearing beginning week 8 post-operatively • Must wear the brace locked for all weight bearing activities to allow ligaments to heal • Use axillary crutches for normal gait at all times • No open chain hamstring strengthening or isolated hamstring exercises • No hamstring stretching • Passive range of motion (PROM) only with posterior support to protect PCL repair
Range of Motion Exercises	• Range of Motion (ROM): Parameters allow for full extension (avoid hyperextension) with no flexion limits • Extension: Knee extension on a bolster, avoid prone hangs secondary to hamstring guarding • Flexion: PROM only. Perform in a seated position with posterior support or perform in a prone position
Suggested Therapeutic Exercise	• Soft tissue mobilization to anterior knee • Patellar mobilization • Electric stimulation as necessary to stimulate quad control • Quad sets • Leg lifts in standing with brace on for balance and hip strength – avoid hip extension secondary to hamstring restrictions • Straight leg raise (SLR) with brace locked • Ankle dorsiflexion (DF) and plantarflexion (PF) with manual resistance
Cardiovascular Exercise	• Upper body circuit training or upper body ergometer (UBE)
Progression Criteria	• Pain free initiation of weight bearing • Mild to no effusion (swelling) • Knee flexion 100-125°

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PHASE II (begin after meeting Phase I criteria, usually 8 weeks after surgery)

Appointments	• Rehabilitation appointment are 1-2 times per week
Rehabilitation Goals	• Normalize gait • Single leg stand control • Quad control with functional movements, including step up/down, squat, partial lunge (making sure that knee flexion does not exceed 60°) • ROM: Full knee extension to greater than 125 flexion
Precautions	• Unlock the brace at 8 weeks post-operatively and discontinue brace over post-operative weeks 8-12 as the patient gains leg control and balance without pain • No open chain hamstring strengthening or isolated hamstring exercises • No hamstring stretching • No bike • Follow ROM guidelines: No forced hyper-extension
Range of Motion Exercises	• Extension: Knee extension on a bolster; may perform prone hangs • Flexion: Use gravity or assistance to maximize hamstring activity, including supine wall slides or seated knee flexion; if flexion needs to be forced then continue to support posterior knee
Suggested Therapeutic Exercise	• Soft tissue mobilization to anterior knee and incisions • Patellar mobilizations • Quad strengthening-SLR in standing using resistive tubing; short arc quads (SAQs); terminal knee extension (TKE); step ups; step backs; squats; other closed chain exercises-make sure knee flexion does not exceed 60° • Heel slides/ wall slides actively • Gait drills • Balance drills with brace • Hip and core strengthening • Stretching for patient specific muscle imbalances
Cardiovascular Exercise	• Upper body circuit training or UBE
Progression Criteria	• Normal gait on all surfaces • Ability to carry out functional movements without pain while demonstrating good leg control • Single leg stance greater than 15 seconds • Equal squat through 60° • Full ROM

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PHASE III (begin after meeting Phase II criteria, usually about 16 weeks after surgery)

Appointments	• Rehabilitation appointments are 1-2 times per week • Rehabilitation appointment prior to 4-month post-operative visit with the surgeon needs to include a single leg press test
Rehabilitation Goals	• Single leg control-open and closed chain • Good control and no pain with functional movements, including step up/downs and squats
Precautions	• No open chain hamstring strengthening or isolated hamstring exercises
Suggested Therapeutic Exercise	• Quad strengthening closed chain (progressing to multi-plane) and open chain exercises • Non-impact balance and proprioceptive drills • Hip and core strengthening • Stretching for patient specific muscle imbalances
Cardiovascular Exercise	• Upper body circuit training or UBE • Swimming with a pull buoy • Stairmaster • Stretching for patient specific muscle imbalances
Progression Criteria	• Normal gait on all surfaces • Single leg stance greater than 30 seconds • Ability to carry out multi-plane functional movements without unloading affected leg or pain, while demonstrating good control

PHASE IV (begin after meeting Phase III criteria, usually 24-28 weeks after surgery))

Appointments	• Rehabilitation appointments are once every 2-4 weeks • Rehabilitation appointment prior to 6-month post-operative visit with the surgeon needs to include a Biodex test • Rehabilitation appointment prior to 9-month post-operative visit with the surgeon needs to include a Biodex test as well as a vertical hop, horizontal hop and a crossover hop, if appropriate
Rehabilitation Goals	• Good dynamic neuromuscular control and no pain with multi-planar impact activities • Functional sports specific progression
Precautions	• Post-activity soreness should resolve within 24 hours • Avoid post-activity swelling • Initiation of impact may occur if the involved leg has at least 80% of the strength of the uninvolved leg when measured using a single leg press test or Biodex

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Suggested Therapeutic Exercise	• Specific balance and proprioceptive drills • Sports/work specific balance and proprioceptive drills • Progress impact control exercises to reactive strengthening and plyometrics; initiate a running program as appropriate • Continue quad strengthening • Movement control exercise beginning with low velocity, single plane activities and progressing to higher velocity, multi-plane activities from 1 foot to other and then 1 foot to same foot • Hip and core strengthening • Stretching for patient specific muscle imbalances
Cardiovascular Exercise	• Biking, Stairmaster, elliptical machine, walking, upper body circuit • Replicate sport/work specific energy demands
Progression Criteria	• Dynamic neuromuscular control with multi-plane activities, without instability, pain or swelling • Ability to land from a sagittal, frontal and transverse plane; leap and jump with good control and balance

These rehabilitation guidelines were developed collaboratively by UW Health Sports Rehabilitation and the UW Health Sports Medicine Physician group.

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