TWIN CITIES ORTHOPEDICS

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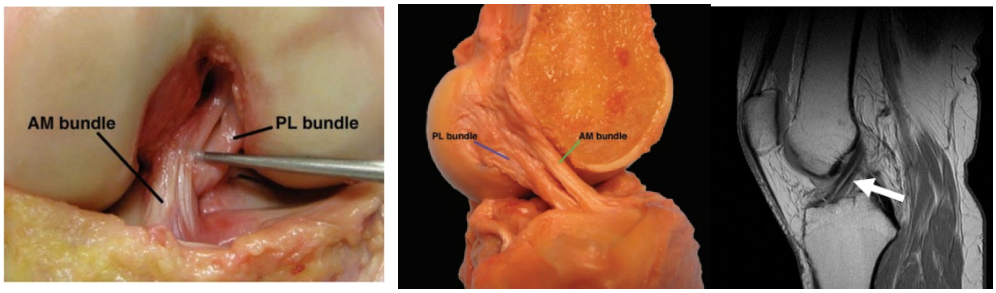
Anterior Cruciate Ligament (ACL) Injury

The ACL is an essential ligament for controlling anterior translation and rotation of the knee. Those who wish to return to pivoting sports (football, hockey, basketball, skiing, etc.) are unlikely to be able to return to their desired level of play without surgery. In addition, it is known that untreated ACL tears increase the risk of later injury to the menisci, which are essential shock absorbers in the knee.[13] That being said, older patients who wish to return to lower-impact activities, such as walking or running, may be able to return to these activities without surgery.

ANATOMY OF THE ACL

The ACL is located deep in the center of the knee and has 2 bundles that attach to the femur superiorly and the tibia inferiorly. The anatomy has been well described,[38] and we use this knowledge of the anatomy to ensure correct positioning of the ACL during surgery.



WHAT HAPPENS DURING ACL RECONSTRUCTION?

During ACL surgery, a ligament reconstruction is required to replace the torn tissue of the ACL. This means that tissue from a patient's own body (autograft) or a cadaver (allograft) is utilized to recreate the ACL tissue that has been torn. Tunnels are drilled through the tibia and femur in order to anatomically reconstruct the ACL. The importance of performing an anatomic reconstruction has been reported,[37-38] and therefore care is taken to recreate the ACL in the intended anatomic locations.

Historically, studies have shown that repairing the ACL tissue alone results in subpar outcomes, with continued instability rates of nearly 94% reported by Dr. Feagin in 1976.[7] There are some surgeons now who are doing ACL repairs for select patients, but that is not currently a part of Dr. LaPrade's practice given the lack of long-term evidence for ACL repair.

WHAT ARE THE OPTIONS FOR ACL RECONSTRUCTION?

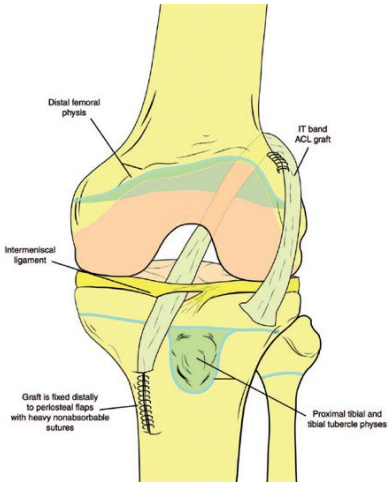
There are currently multiple options for ACL reconstruction. Each graft has different pros/cons:

1. **Patellar Tendon/Bone-Tendon-Bone (BTB) Autograft**
   This graft is the most common for Dr. LaPrade. It is considered the gold standard for college and professional athletes in the United States. It involves taking the central third of the patella tendon with a small bone block from the patella and tibial tubercle. This allows for bone-to- bone healing, which theoretically is faster and stronger than the other graft choices. There are reports of increased anterior knee pain after surgery, which in the experience of Dr. LaPrade is often related to a lack of physical therapy after surgery. There is also the rare risk of patellar fracture. Patients do have to be done growing for BTB to be an option.

2. **Quadriceps (Quad) Autograft**
   This graft is the second most common for Dr. LaPrade. It is becoming more popular in the US as a graft option. It involves taking a portion of the quadriceps tendon right before its insertion to the patella with or without a small bone block off the patella. This graft may be the best option for patients who are almost done growing but whose growth plates have not completely closed. This graft can be associated with less anterior knee pain after surgery but can result in slower return to function of the quadriceps muscle after surgery.

3. **Hamstring Autograft**
   This graft involves taking 2 of the hamstring muscle tendons and then folding them on each other to make them larger in diameter. Studies have shown that hamstring tendons that are too small can be a risk factor for a retear after ACL reconstruction.[29] Using this graft is usually less painful when kneeling than a BTB or quadriceps. Some studies have shown a higher retear rate in these grafts vs BTB.[31] In addition, these grafts can lead to issues with later revision if the initial ACL reconstruction fails. Therefore, Dr. LaPrade largely reserves hamstring ACL for those over 40 years.

4. **Iliotibial Band (Micheli-Kocher)**
   This technique is reserved solely for young patients with wide open growth plates, but it can be a good option for those in which it is not safe to drill the typical ACL tunnels. This is a relatively uncommon graft choice given that ACL tears are not as common in this young of a patient.[32]



5. **Allograft**
   There are multiple choices for allograft (cadaver) grafts. These grafts allow for faster surgery (less anesthesia) and less pain but have considerably higher failure rates than autograft tissue, with rates of up to 26% for allograft (versus 8% for autograft).[3] Other studies have reported 5 times higher failure rates for allografts.[14] Therefore, it is quite rare for Dr. LaPrade to recommend these grafts.

WHAT IS THE SUCCESS RATE FOR ACL RECONSTRUCTION?

The literature suggests a retear rate around 5 to 8% for a first-time ACL reconstruction. This website (https://acltear.info/acl-reinjury-risk/) has a calculator for the risk of retear based on multiple factors.

There are also anatomic factors that may predispose a patient to an ACL injury or retear. These include:

a. Age

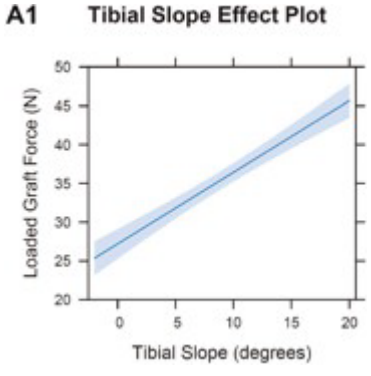
i. Younger patients have a higher rate of retear, which is why we ensure that one has a near full return of strength and can pass return-to-sport testing before returning to activities

b. Hyperlaxity

i. We will test how flexible you are in clinic (heel heights > 5 cm off the table)
ii. Hyperlaxity reported to increase failure rate by 3 times[27]

c. Increased posterior tibial slope

i. Increased slope of your tibia (>12 degrees) can put additional stress on the ACL graft[39] and lead to increased rates of failure[34]
ii. We will get X-Rays in clinic to measure the posterior tibial slope



WHAT OTHER INJURIES MAY BE PRESENT?

The ACL usually does not become injured without another concurrent injury in the knee. There are many other structures that are essential to evaluate at the time of surgery and will always be evaluated by Dr. LaPrade prior to surgery, as well as during surgery:

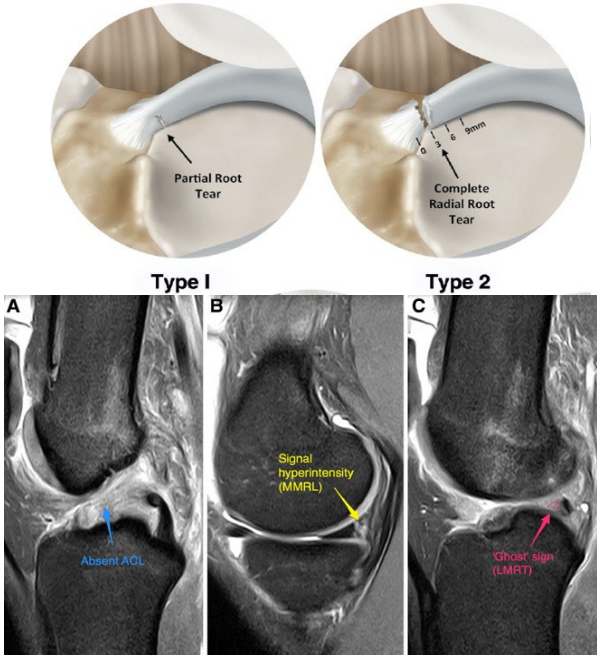
a. Cartilage/Menisci

i. Both of the menisci and all the cartilage surfaces will be evaluated on MRI scan and during surgery

ii. Medial Meniscus: Studies have shown the importance of doing an anatomic repair of root or ramp tears of the medial meniscus[2,4-6,16,19,21]
- Ramp tears reported to be present in 16-40% of ACL tears[4,35]
- Not repairing a ramp tear has been reported to have a very high rate of a later medial meniscus bucket handle tear (29%)[33]

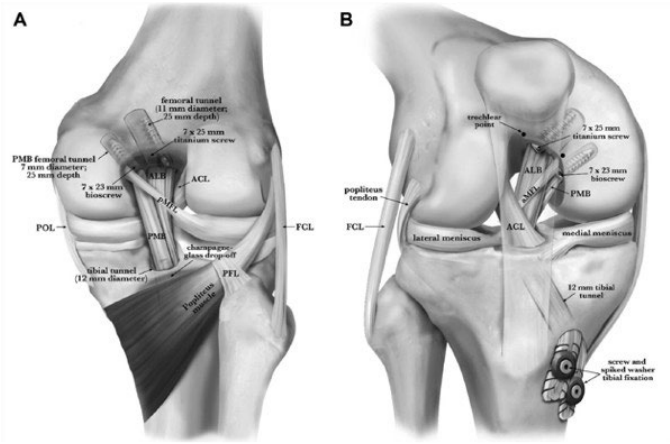
iii. Lateral Meniscus: Studies have shown the importance of repairing root tears of the lateral meniscus9,20-21
- Lateral root tears are reported in up to 12% of ACL tears[4]
- It has also been reported that 4-6% of ACL tears have medial meniscus ramp tears AND lateral meniscal root tears[22]

b. Ligaments

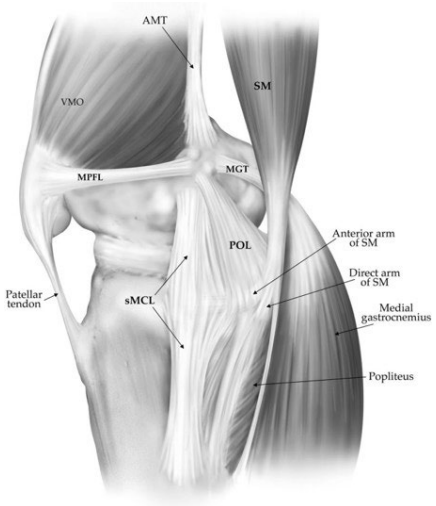


i. There are 3 other important regions of ligaments in the knee that may be injured in combination with an ACL injury. Dr. LaPrade will evaluate for these injuries on clinical exam and MRI, with the use of stress X-Rays in clinic if any concern

- **Posterior Cruciate Ligament (PCL)**
  - The PCL is an essential ligament for preventing posterior translation and rotation of the knee, and it is much less commonly injured than the ACL. It rarely is injured in isolated and will be reconstructed if deemed necessary[18]

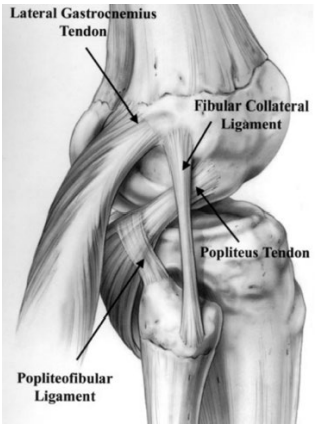


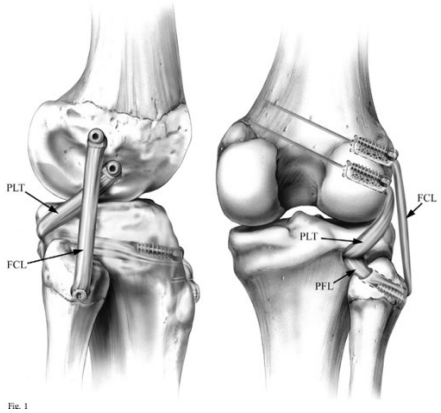
- Medial Collateral Ligament (MCL)/Posteromedial Corner[26]
  - MCL injuries are quite common with ACL injuries (67%)[36] but many will heal without surgery
  - Surgery may be indicated in certain cases to avoid the increased strain on the ACL if not healed[29]



- Posterolateral Corner/Fibular Collateral Ligament (FCL/LCL)
  - Unlike MCL injuries, many posterolateral corner injuries will not heal without surgery, and they may require an anatomic reconstruction as repairs have a high failure rate of up to 40%[28]

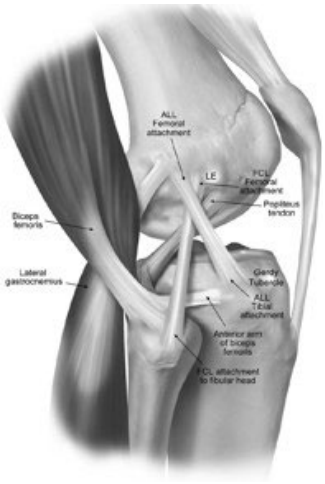
c. Studies have demonstrated the increased stress on an ACL in the setting of a posterolateral corner injury[23-25] with improvement after anatomic reconstruction

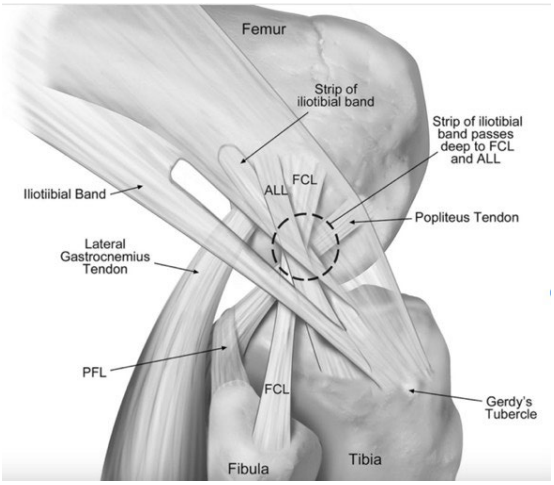




WHAT IS A LET OR ALL, AND IS IT NECESSARY?

Oftentimes with an ACL injury, the anterolateral complex or anterolateral ligament (ALL) is injured, which may increase the risk for rotational instability even after ACL reconstruction. There are 2 types of lateral augmentation, a lateral extra-articular tenodesis (LET) or an ALL reconstruction, that are designed to recreate the injured anterolateral complex. In high-risk patients, adding a lateral augmentation procedure has been shown to have a short-term decrease in failure rates after ACL.[1,8,10,15]





A lateral augmentation procedure does involve an additional incision and may increase the risk of stiffness after surgery, although it does not slow down the ultimate return to sports.[17] Most of the current high-level evidence on lateral augmentation is in the setting of hamstring grafts as well, which are not as common of a graft choice in the US.

In Dr. LaPrade's practice, a LET is preferred over an ALL reconstruction due to the lack of need for cadaver allograft tissue. The ideal patient for a LET would be a patient with multiple risk factors, which can include any of the below:

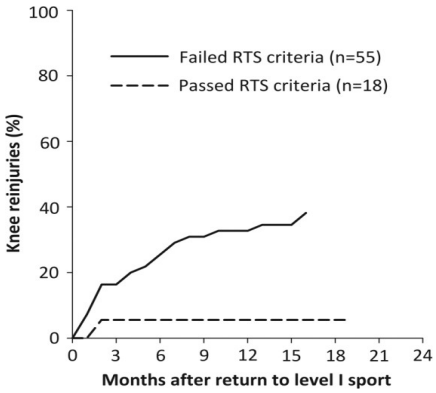
- Hyperlaxity (heel height > 5 cm)
- Contact or pivoting athlete (such as football, hockey, soccer, skiing, etc.)
- Posterior tibial slope > 12 degrees in first-time ACL tear
- Unexplained high-grade clinical examination (pivot shift or Lachman)
- Revision ACL reconstruction or history of failed ACL on the other knee
- Open growth plates needing a soft tissue quadriceps or hamstring graft

WHAT IS THE RECOVERY FOR ACL RECONSTRUCTION?

First, prior to surgery, we have to make sure that the knee is ready for surgery. This includes "prehab" to decrease the inflammation after the injury and regain full motion of the knee. This is essential to prevent stiffness after surgery. This can take up to 4-6 weeks.

After surgery, you will begin physical therapy (PT) within 1-2 days. PT will be essential to ensuring that you regain your range of motion of the knee and build up the strength to safely return to sport. PT is just as important if not more important than everything that occurs during surgery.
We will see you in the office at 2 weeks after surgery, and then 6 weeks, 3 months, 4.5 months, 6 months, and 9 months. We will have most patients undergo formal return-to-sport testing at around 4 months, 6-7 months and then again at 9-10 months to ensure recovery is staying on schedule and ultimately allow for safe return to sport.

Studies have demonstrated the importance of waiting 9 months after surgery before unrestricted return to sport to minimize the risk of re-injury. One study even reported that every month that return-to-play was delayed after ACL reconstruction decreased the risk of failure by 51%.[11]
In addition, the importance of passing formal return-to-sport testing has been shown as well. Studies have reported a decrease in failure rates by 84-92% if return-to-sport testing is passed before returning to full competition.[11-12] After 9 months and passing return-to-sport testing, the vast majority of patients are able to return to their desired sports.



PHYSICAL THERAPY PROTOCOL

Given all of the above considerations for ACL reconstruction, the PT protocol will be dependent on the presence of any other injuries, with the final protocol being determined after surgery.

The general guidelines for return-to-play are listed below. Examples of PT protocols are on Dr. LaPrade's website: https://tcomn.com/physicians/christopher-laprade/.
Dr. LaPrade has utmost trust in the Twin Cities Orthopedics physical therapists, who helped design the PT protocols that he uses. He will generally recommend at least one visit with them postoperatively, even if a patient will do their PT at a non-TCO location.

POST-KNEE SURGERY RETURN TO ACTIVITY GUIDELINES/CRITERIA	
Return to run guidelines	≥16 weeks post-op, YBT-Anterior ≤8 cm SSD, walk ≥1 mile no limp/no pain, Quad strength ≥70% LSI, ≥60% peak torque/BW
Return to jump guidelines	≥20 weeks post-op, YBT(A) ≤4 cm SSD, Quad strength ≥80% LSI, ≥80% peak torque/BW, tolerate hopping/skipping drills with no increased soreness/swelling, tolerate lunge/squat/step single leg training progressions
Return to sport guidelines	In addition to TRAC testing goals (listed below), patient must achieve the following: >9 months post-op 16+ weeks progressive strength training 10+ weeks neuromotor training program 6+ weeks within-sport practice progression (per MD/PT team clearance) 3+ weeks graduated return to competition (per MD/PT team clearance)

POST-KNEE SURGERY "TRAC" PHYSICAL PERFORMANCE TESTING - TIMELINES & GOALS
(Will be performed at TCO/Training HAUS in Eagan, MN)

TRAC Test Activity	4 Month Goals	7 Month Goals	10 Month Goals
Knee Extension ROM	≤5° SSD	≤0° SSD	≤0° SSD
Knee Flexion ROM	≤10° SSD	≤5° SSD	≤0° SSD
YBT(A) Squat SSD	≤8 cm SSD	≤4 cm SSD	≤4 cm SSD
Max YBT(A) squat depth relative to LL	*≥55% of LL*	*≥70% of LL*	*≥70% of LL*
Repeated single leg squat (one leg rise test)	25 reps to 60° KF	25 reps to 90° KF	25 reps to 90° KF
2 leg squat symmetry (over force plates)	≤10% off-shift	≤5% off-shift	≤5% off-shift
Hip ABD strength LSI	≥80% LSI	≥90% LSI	≥90% LSI
Hip ABD strength relative to BW	*≥20% of BW*	*≥25% of BW*	*≥30% of BW*
Quad strength LSI	≥70% LSI	≥80% LSI	≥90% LSI
Quad strength relative to BW	*≥70% of BW*	*≥80% of BW*	*≥90% of BW*
Hamstring strength LSI		≥75% LSI	≥90% LSI
Single leg hop (SLH) test LSI		≥80% LSI	≥90% LSI
SLH distance relative to LL (norm comparison)		*≥80% of norms*	*≥90% of norms*
Triple hop test LSI		≥80% LSI	≥90% LSI
Triple hop distance (norm comparison)		*≥80% of norms*	*≥90% of norms*
2 leg jump (off shift at take-off/landing)		≤20% off shift	≤10% off shift
Peak knee flexion angle SSD with hop landing		≤20° SSD	≤10° SSD

Abbreviations for both tables above: (ABD) abduction, (BW) body weight, (ISO) isometric, (LL) leg length, (LSI) limb symmetry index, (norm) age & sex-matched normative data, (PRE) progressive resistance exercise, (ROM) range of motion, (SLR) straight leg raise, (SSD) side to side difference, (TRAC) testing to return to athletic competition, (UE) upper extremity, (YBT(A)) Y-balance test anterior reach

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