Arthroscopic Primary Repair of Proximal Anterior Cruciate Ligament Tears With Suture Augmentation

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Background: Historically, the midterm outcomes of open anterior cruciate ligament (ACL) repair were rather disappointing, and ACL reconstruction subsequently became the surgical standard for ACL injuries. Recent studies, however, have shown that there might be a role for arthroscopic primary repair in appropriately selected patients with proximal ACL tears.

Indications: Due to more prominent blood supply in the proximal ligament region, ACL repair should only be performed in patients with proximal tears and good-to-excellent tissue quality. Although all patients are potential candidates, this procedure is preferably performed acutely and in adult patients.

Technique Description: First, it is identified whether a proximal tear with good tissue quality is present. Then, both ACL bundles are sutured individually from distal to proximal using a Bunnell-type pattern and a self-retrieving suture passer. The posterolateral bundle is then reattached first in anatomical fashion, using a 4.75-mm vented biocomposite suture anchor. Next, the suture anchor of the anteromedial bundle is preloaded with an internal suture tape augmentation. After anchor deployment, the suture tape augmentation is channeled through a small 2.5-mm tibial tunnel in the anterior third of the tibial ACL footprint. Finally, the suture augmentation is tensioned near full extension and fixed to the tibia's anteromedial cortex using single suture anchor fixation.

Results: Recently, we have published a series of the first 113 consecutive repair patients with minimum 2-year follow-up, of which 60 received additional suture augmentation. In this cohort, the overall failure rate was 13%, which was similar to 3 other studies on modern-day ACL repair (range: 5%-15%). Subgroup analysis showed that the failure rate was much higher in patients $\leq$21 years (38%) but low in patients $>$21 years (0%). Finally, it has been shown that there is an earlier return of knee motion, complications are rare, and there is less joint awareness after ACL repair as compared with ACL reconstruction.

Conclusion: Selective, modern-day, arthroscopic primary ACL repair with suture augmentation seems to be a good alternative to ACL reconstruction in carefully selected patients, which include patients with proximal tears and good tissue quality and aged $\geq$22 years.

Keywords: anterior cruciate ligament; primary repair; reconstruction; proximal; preservation

VIDEO TRANSCRIPT

We present to you our technique of arthroscopic primary repair of the anterior cruciate ligament (ACL) with suture augmentation.

These are our disclosures.

Open ACL repair was the preferred surgical technique until the early 1990s. Anterior cruciate ligament reconstruction became the surgical standard after disappointing midterm outcomes with open repair. However, there has been a resurgence of interest in ACL repair. Specifically, with selective use of ACL repair for proximal tears, using modern arthroscopic techniques and rehabilitation protocols, ACL repair seems to be an acceptable alternative for ACL reconstruction in selective patients.

The patient is a 42-year-old man who suffered a left knee injury while playing tennis 2 months ago. He had a full range of motion of physical examination with a grade 2B Lachman, 1+ pivot shift, he was stable to varus and

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Submitted February 18, 2021; accepted March 1, 2021.

One or more of the authors has declared the following potential conflict of interest or source of funding: J.P.v.d.L. is a paid consultant for Arthrex Inc. G.S.D. is a paid consultant and receives research grants from Arthrex Inc. AOSSM checks author disclosures against the Open Payments Database (OPD). AOSSM has not conducted an independent investigation on the OPD and disclaims any liability or responsibility relating thereto.

Video Journal of Sports Medicine, 1(3), 26350254211005461
DOI: 10.1177/26350254211005461

valgus stressing, and he was neurovascular intact. He had 4.6 mm of side-to-side difference using the Lachmeter.

Here, we see representative slices from the magnetic resonance imaging (MRI), confirming this is a proximal tear with what appears to be good tissue quality.

Indications for ACL repair include proximal avulsion tears, usually type I soft tissue avulsion tears or type II proximal tears with sufficient tissue quality. Some chronic proximal ACL avulsions that have scarred to the posterior cruciate ligament can also be freed up and repaired. All age groups are candidates for ACL repair, but we tend to focus on the slightly older population as we have found increased failure rates in young cutting athletes when we use ACL repair alone. Isolated injuries of the ACL and also ACL injuries in the patients with multiligament knee injury are eligible for repair, although the optimal indications for patients with multiligament knee injury have not been elucidated fully yet. Contraindications to repair include midsubstance tear and those tears with poor tissue quality unable to hold stitches. In addition, chronic tears with tissue resorption are poor candidates.

Although this patient injury happened 2 months ago, we felt that we had a proximal avulsion tear and sufficient tissue quality based on the MRI, so our operative plan was to go in and see whether we could repair it, and if not, we would reconstruct it. Patients will undergo ACL reconstruction using various grafts when tissue length is insufficient for tensioning and reattachment to the femoral footprint and when tissue quality is inadequate to withhold intrasubstance suturing. In general, our research has shown that patients who are older than 35 years, who have surgery within 4 weeks of injury, and whose body mass index is less than 26 kg/m^2 have a higher likelihood of repairability.

In general, the patient positioning for surgery is similar to ACL reconstruction. We are in the supine position with a tourniquet high on the thigh. The operative leg is prepped and draped as for ACL reconstruction. Standard anteromedial (AM) and anterolateral portals are created for arthroscopy, and a passport cannula is placed in the AM portal for suture management.

After removing some of the fat pad and ligamentum to improve visualization, we begin by assessing the tear type and tissue quality to confirm the MRI findings.

Here, you can see that we have a proximally torn ACL with excellent tissue quality.

After performing a small notchplasty to induce some bleeding, we begin suturing the AM bundle from distal to proximal.

After taking a low bite as distal as possible, using the self-retrieving suture passer and a high-tensile strength suture, we begin alternating the limbs moving proximally to create a Bunnell-type suture. Typically, we can get 3 to 5 passing going up the AM bundle before exiting as proximal as possible on either side of the ligament.

After making a low inferomedial accessory portal, we retrieve the AM bundle sutures out of that portal to aid in suture management.

Next, we will repeat the suturing steps for the posterolateral (PL) bundle, using a different colored stitch. In the same manner as with the AM bundle, a low pass is performed, and then, we alternate hitches using each limb of the suture proceeding proximally in a Bunnell-type fashion. In contrast, however, we will exit both limbs of the suture toward the wall for the PL bundle.

Tensioning and fixation of the PL bundle is performed first, and therefore, we must switch the sutures at the inferomedial portal.

With the knee at 115° of flexion, our drill sleeve is placed into the PL bundle origin on the femur, and then, we drill, tape, and place our vented biocomposite anchor to tension up the PL bundle toward the wall.

After cutting the PL bundle sutures and switching the AM bundle sutures to the inferomedial portal, the same procedure is then repeated with the knee at 90°. We drill, tape, and then place our bented biocomposite anchor to tension the AM bundle back up to the wall. The difference here is that our suture augmentation has been passed through the eyelet of the anchor prior to placement. The core stitches are then removed, and the repair stitches are cut short. The repaired ACL is then evaluated, and you can see it has been tensioned up nicely.

A standard ACL guide is then used to localize ourselves in the anterior third of the tibial insertion of the ACL, similar to creating a tibial tunnel for reconstruction. We will then drill up through the tibia with our 2.4-mm cannulated drill. Distally on the drill, our cannulation is removed, and then, a nitinol wire is threaded up through to help us to retrieve the suture augmentation. It is important to back up the drill gently by hand, rather than using power, to avoid winding up the nitinol wire onto the teeth of the drill prior to passing your suture augmentation.

The final step of the procedure is to tension and fixate our suture augmentation distally. To that end, we will drill and tap a second hole perpendicular to the tibia about a centimeter distal to our first.

Gentle tension is now placed distally on our suture augmentation to remove any slack, while the knee is brought through a range of motion. The suture augmentation, which functions as a checkrein, is then fixated at the tibia distally using our final biocomposite suture anchor.

Now that the procedure is complete, and we can go back into the knee and examine the repaired ligament along with the tensioned suture augmentation. In addition, the knee can be brought to a range of motion, and a Lachman examination will confirm restored stability to the knee.

Some pearls to avoid complications during this procedure: Avoid transecting previously placed sutures by monitoring the resistance when sutures are passed. In addition, use a low accessory inferomedial portal to aid in suture management and also to optimize the angle for suture anchor placement. Place the PL bundle anchor first with the knee in 115° of flexion to optimize the angle to the wall and avoid posterior perforation. Follow this by placing the AM anchor second with the knee in 90° of flexion. Finally, remember that the suture augmentation is only a backup to the repair and avoid overconstraining the knee by tensioning this at near full extension.

Regarding the postoperative management of these patients, we tend to focus on early mobilization and edema

control, and we will have a low threshold to drain the bloody effusion within the first week. A knee brace is used for the first 4 weeks. At first, it is locked in extension when ambulating until return of quadriceps control, at which point we will unlock it. Weight-bearing is as tolerated unless there has been a meniscal repair.

Crutches can be used during the first postoperative weeks, but usually patients only need these during the first few days after surgery as recovery after ACL repair has been shown to be must faster and easier than after a reconstruction. The majority of patients have full range of motion and are walking normally within 2 weeks. To be cautious, we usually start formal physical therapy after 4 weeks using an accelerated ACL reconstruction protocol. However, we use a milestone-based approach rather than a timeline-based approach moving forward.

Regarding return-to-sport guidelines, a return to pivoting sports is generally based on sports-specific assessments. We endeavor to have each patient evaluated by formal return-to-sport testing, especially for the higher level athletes. The majority return to sport by 6 months postoperatively. It is important that full range of motion has been obtained and that the leg has sufficient muscle strength when compared with the opposite leg.

Regarding patient outcomes using this technique, we have recently published on our first 113 patients with minimum 2-year follow-up, of which 60 received additional suture augmentation. In this cohort, the overall failure rate was 13%, which was similar to 3 other studies on modern-day ACL repair. However, the failure rate differed significantly by age, with those older than 21 years having a 0% failure rate but those younger than 21 years, which also happens to be the smallest group, having a 38% failure rate. Finally, it has been shown that there are significant advantages of ACL primary repair as compared with reconstruction. First of all, we have shown that there is an earlier return of range of motion, complications are rare, and there is less joint awareness after 2 years when compared with ACL reconstruction patients. Finally, if an ACL repair happens to fail, revisioning it to an ACL reconstruction is often like doing a primary reconstruction.

Thank you for your attention.

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