# Is Double-Bundle ACL Reconstruction Necessary?

# 11

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## Contents



## 11.1 The Impetus for Changing to the Double-Bundle ACL Technique

The surgical technique for anterior cruciate ligament (ACL) reconstruction has evolved through the years, and the results with using various graft sources, such as a hamstring tendon graft, patellar tendon graft, or allograft, have varied considerably. An open technique for ACL surgery using an ipsilateral patellar tendon graft was the gold standard for ACL surgery in the 1980s. Stability was predictably obtained, but lack of knee range of motion and donor site morbidity was common enough for surgeons that they sought other graft sources and different surgical techniques. There was a shift to arthroscopically assisted ACL reconstruction, but knee stiffness and donor site morbidity problems persisted.

During the same time that arthroscopically assisted ACL reconstruction was becoming more common, there was an emphasis in healthcare to provide outpatient surgery whenever possible. This change led to even more rehabilitation problems because patients had to travel home after surgery and then they had to travel again the next few days after surgery to attend rehabilitation sessions. What physical therapists then had to deal with during the first few weeks of rehabilitation were patients who had a large hemarthrosis in their knees, poor leg control, and a lot of pain, which caused more donor site morbidity and knee range of motion complications.

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Surgeons initially used hamstring grafts for older, less active patients, and they observed that rehabilitation was easier than with the patellar tendon graft, although stability was harder to achieve. As new fixation devices became available, surgeons began using hamstring grafts for patients of all ages because they wanted to reduce donor site morbidity and make rehabilitation as easy as possible after outpatient ACL surgery.

Initially, femoral graft placement with arthroscopically assisted ACL reconstruction was done through a tibial tunnel, but this led to many grafts being placed too far anteriorally in the intercondylar notch because the deep position where the tunnel needed to be placed was difficult to reach with a transtibial approach. This technique often left patients with an intact graft but with more laxity than desired. The lack of ability to achieve stability reliably with hamstring grafts was one of the reasons the double-bundle ACL technique was introduced. However, inferior stability also led surgeons to adding a medial portal with the arthroscopically assisted approach to be able to place the femoral tunnel in a more ideal location deeper in the intercondylar notch.

The same change in surgical approach for the femoral tunnel was made with the double-bundle ACL technique that has evolved since the 1980s and 1990s. Some early comparative studies between single-bundle and double-bundle surgery showed little or no differences in results between the two surgery types [1, 7, 14–16, 27, 30]. However, the concern with these comparison studies was that the double-bundle surgeries were not performed anatomically correct, as the femoral tunnels were drilled through the tibial tunnel, causing imperfect position of the femoral tunnels. Thus, the procedure has changed to where it is recommended that the femoral tunnel be drilled from a medial portal to provide a more "anatomic" tunnel placement [26, 31].

The long transition from surgeons predominantly using patellar tendon autografts for ACL reconstruction in the 1980s to predominantly using hamstring grafts currently is an example of how surgeons tend to find surgical answers to problems. My approach has been to continue to use the patellar tendon autograft, which I believe is the best graft source available, and work to determine the best possible rehabilitation program to achieve excellent stability and minimize donor site morbidity and postoperative complications [20].

## 11.2 Double-Bundle ACL Techniques Compared with Single-Bundle Techniques with Patellar Tendon Graft

Anatomy studies showed that the fibers of the ACL function differently depending on location, with the anteriomedial (AM) portion becoming more taut with knee flexion and the posterolateral (PL) portion becoming more taut with knee extension [2, 8].

All of the double-bundle ACL techniques include drilling two distinct tunnels on the femur that has a 1–3-mm bony bridge between the bundles. The native ACL has a small elevated ridge of bone near the middle of the ACL insertion site, but there is no complete bony bridge that separates two distinct bundles of the ACL. Therefore, the "anatomic" double-bundle surgical technique is not completely anatomic, but it may be an improvement upon a single-bundle approach when the femoral tunnel is drilled transtibially.

I have been performing ACL reconstruction using patellar tendon autograft since 1982 with over 6,000 ACL reconstructions. I use a mini-open ACL technique where I can directly see the anatomical landmarks and place both the tibial and femoral tunnel precisely at the anatomical landmarks. The patellar tendon graft has triangular bone plugs on each end and the tendon and is 10 mm wide and, on average, 5 mm thick (range 4–11 mm; Shelbourne KD, 2012, unpublished data). This 10-mm × 5-mm graft is larger than the patient's normal ACL in most cases, so a notchplasty is usually performed to allow this graft to fit.

The intercondylar notch is normally filled with the posterior cruciate ligament (PCL) and the ACL, with the PCL encompassing about 60 % of the notch [5]. I drill the 10-mm tunnel so that the medial edge of the tunnel is located just lateral to the PCL and the inferior edge is located about 1 mm from the posterior wall of the notch

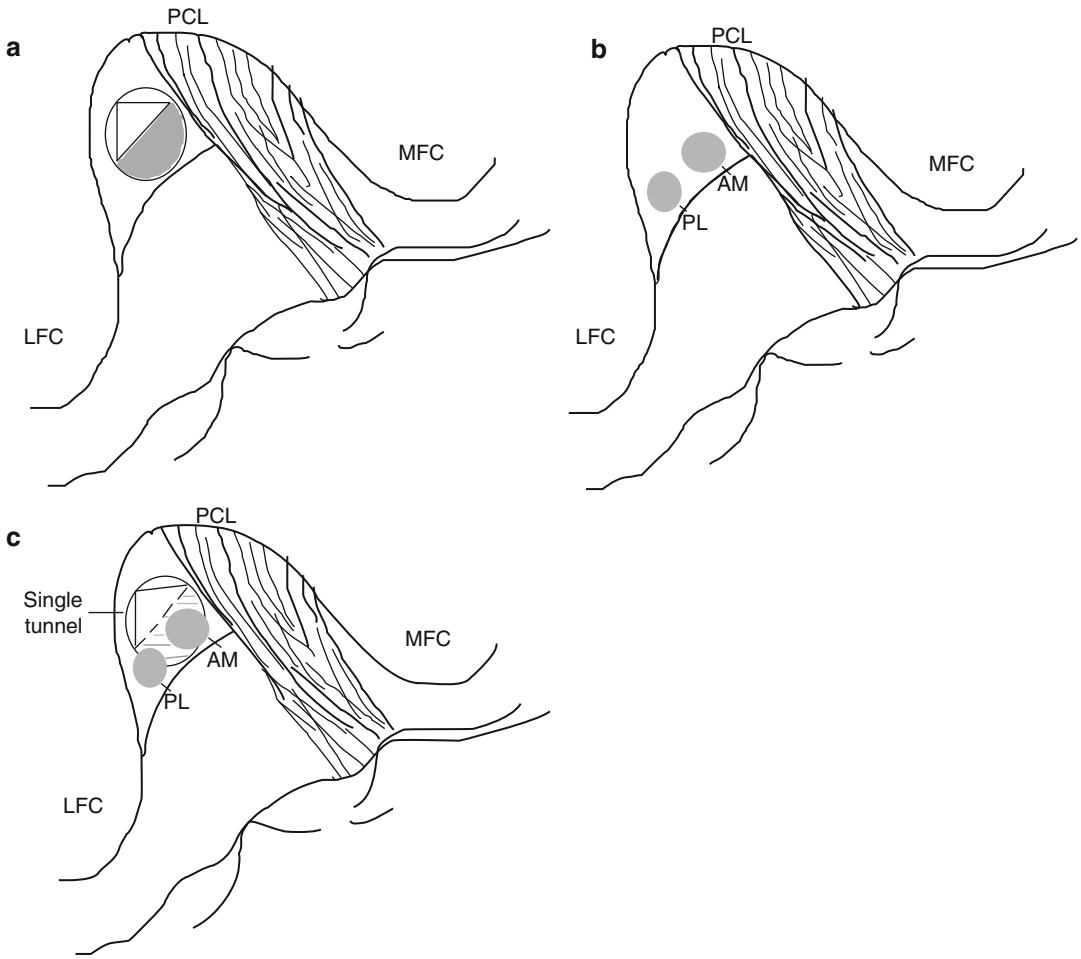


**Fig. 11.1** This illustration shows the knee flexed about 90° and rotated about 45° counterclockwise from vertical. (**a**) The 10-mm-wide femoral tunnel is drilled so that the medial edge of the tunnel is located just lateral to the PCL and the inferior edge is located about 1 mm from the posterior wall of the notch. The tunnel is filled with the bone block (*triangular piece*), and the ligamentous portion is shown in *gray shading*; (**b**) with a double-tunnel procedure, two tunnels are drilled along the ACL footprint with about a 3-mm gap between tunnels, and the posterolateral (*PL*) tunnel usually created slightly smaller than the anteriomedial (*AM*) tunnel. (**c**) The single 10-mm tunnel is shown superimposed upon two tunnels frequently used for a double-tunnel ACL technique, and it shows that the single tunnel covers most of the area. *LFC* lateral femoral condyle, *PCL* posterior cruciate ligament, *MFC* medial femoral condyle, *PL* posterolateral tunnel, *AM* anteromedial tunnel

(Fig. 11.1a). The tibial bone plugs are triangular in shape, and the patellar end of the graft is placed in the tibial tunnel at the level of the joint line. The remainder of the graft is taken up in the femoral tunnel so that the bone plug is deep into the femoral tunnel and the ligamentous graft lies posteriorly in the tunnel.

When a double-tunnel procedure is performed, two tunnels are drilled along the ACL footprint with about a 3-mm gap between tunnels, and the PL tunnel usually created slightly smaller than the AM tunnel (Fig. 11.1b) [29]. Double-bundle sizes of most hamstring grafts are two round bundles of 4–7 mm in diameter [6]. Figure 11.1c shows the single 10-mm tunnel superimposed with the two tunnels frequently used for a double-tunnel technique, and this figure shows that the single-bundle technique with a patellar tendon graft covers the ACL footprint for the AM bundle and part of the footprint that is usually used for the PM bundle of

a double-bundle technique when the tunnel is drilled through a medial portal. The 10-mm-wide and 5-mm-thick patellar tendon autograft reproduces the native ACL more anatomically correct than the double-tunnel soft tissue graft because it does not have the complete bony bridge gap between the two constructs of the ACL.

## 11.3 Will Double-Bundle ACL Techniques Provide Better Long-Term Results Than Single-Bundle Techniques?

Many surgeons switched from using a patellar tendon autograft because it is more difficult to rehabilitate the donor site from the graft harvest. The use of hamstring tendon grafts helped surgeons reduce complications with the donor site but the stability that was reliably achieved with the patellar tendon graft was more difficult to achieve. The change from using the patellar tendon graft to other graft sources led to decreased stability and then to new surgical techniques to include the double-bundle surgical approach.

It is believed that, if better rotational stability is achieved with ACL reconstruction, patients would have less osteoarthritis (OA) in the long term after surgery, but this theory has not been verified. Improving rotational stability, with the hope of reducing the incidence of OA in the long term after surgery, has been the motivation behind performing double-bundle ACL reconstruction. My concern with the use of double-bundle ACL reconstruction is that, if some surgeons have difficulty with performing a single-bundle technique properly, will they not then have more difficulty with double-bundle technique?

Also, we need to ask whether these changes with different graft sources and surgical techniques have led to better results. Stability is the main outcome being considered in the short term, and less evidence of OA is the main outcome being considered in the long term. The thought is that the double-bundle procedure provides better stability than the single-bundle technique. However, is there any evidence to show that obtaining better stability will achieve the goal of preventing OA?

Changes with ACL surgery need to be made with a specific focus on where we are failing patients, and the question is, “Are we failing patients with a single-bundle ACL technique using the PTG?” It is true that some patients do develop OA after ACL reconstruction, but have we been able to determine what factors cause the OA? Each surgeon needs to know his or her own success rate with surgery, and the only way to accomplish that goal is to obtain long-term follow-up on patients, and this is something that very few surgeons do as a routine. It is difficult to know what aspect needs improving without a systematic follow-up of results. As surgeons, we tend to always try to find a surgical solution to our patients’ problems, and this is done many times without the surgeon really knowing what factors are important.

Some of the causes of OA in the long term after ACL reconstruction have been studied in depth and are quite obvious. Patients who undergo partial or total meniscectomy or have existing articular cartilage damage in the knee have been found to have a higher incidence of OA after surgery [11–13, 17–19, 21, 22, 25]. These factors are difficult to control, and we may not be able to prevent the OA that develops from existing meniscal and articular cartilage damage.

I have continued to use the patellar tendon autograft because bone-to-bone healing occurs quickly and the graft provides reliable stability and allows for unrestricted rehabilitation. The patellar tendon graft is a more reliable graft for stability than hamstring grafts or allografts, especially for young competitive athletes and women [3, 4]. The average age of patients undergoing ACL reconstruction in my orthopedic practice is 21 years old. Thus, I choose to continue to use the patellar tendon autograft because I believe that my patient population needs to receive the best graft possible to achieve stability so they can return to high-level sporting activity.

Analysis of our data in the 1980s showed us that knee stability was not a problem but that obtaining full knee range of motion was a problem. We found that delaying surgery after the acute injury to allow the knee to become calm and obtain full knee range of motion before

surgery drastically reduced the complication rate of ROM problems after surgery. We also found that introducing exercises to obtain full knee extension immediately after surgery along with elevation, cold, and compression to prevent a hemarthrosis was key [20]. Most importantly, these improvements in our rehabilitation through the years did not result in less knee stability. Furthermore, as patients were more comfortable with their knee earlier in the rehabilitation process, they returned to functional activities and sports sooner. The earlier return to sports did not cause a higher reinjury rate after surgery [23, 24].

Many rehabilitation programs prescribed for surgery with soft tissue grafts and allografts recommend bracing, limiting knee ROM in the early post-op period, and delaying the return to activities. These rehabilitation restrictions may lead to deficits in knee extension and/or knee flexion that can affect the long-term results of ACL surgery. Shelbourne and Gray [22] found that the most important factor related to lower subjective scores at a mean of 14 years after surgery was a knee extension deficit >2° or flexion deficit >5°. Furthermore, patients who had meniscectomy or articular cartilage damage also had statistically significantly lower scores if they also had ROM deficits. In another study that evaluated the radiograph ratings of patients at a mean of 10 years after surgery, Shelbourne et al. [25] found that patients who obtained normal extension and flexion after surgery and then maintained it through final follow-up had a statistically significantly lower prevalence of OA (39 %) versus patient who had less than normal ROM throughout follow-up (53 %).

There have been some prospective randomized studies comparing various results between single-bundle, nonanatomic double-bundle, and anatomic double-bundle ACL reconstruction. Although some of the studies found that rotational stability was improved with anatomic double-bundle ACL reconstruction compared with single-bundle ACL reconstruction, the differences between the two surgical procedures have been minimal for other outcome objective and subjective variables measured [9, 30].

Almost all of the comparison studies of single-bundle versus double-bundle ACL techniques used hamstring grafts for both types of procedures. Only a few studies exist that compare a single-bundle ACL reconstruction with a patellar tendon autograft to a double-bundle ACL reconstruction [10, 28], and this is the true comparison that needs to be made.

Ishibashi et al. [10] performed an intraoperative evaluation of anteroposterior laxity and rotational stability at various degrees of knee flexion and found no difference between anatomic double-bundle ACL reconstruction and single-tunnel ACL reconstruction with patellar tendon autograft. Tsuda et al. [28] compared a "lateralized" single-bundle ACL reconstruction with a PTG with double-bundle ACL reconstruction with hamstring grafts. The location of the "lateralized" placement of the femoral tunnel was in the 10 or 2 o'clock position. The results showed no differences in KT1000 arthrometer measurements, pivot-shift tests, or Lachman tests between groups. Furthermore, there was no difference between groups for IKDC objective grade at final follow-up.

## 11.4 Summary

I do not believe that the double-bundle ACL reconstruction technique is needed to provide superior stability in the knee because excellent anteroposterior and rotational stability can be achieved with a single-bundle ACL reconstruction with a patellar tendon autograft. The trend away from using the PTG was due to donor site problems that surgeons were having difficulty solving. An extremely effective rehabilitation program for ACL reconstruction with PTG is available that provides for excellent range of motion, strength, and function after surgery, but it does require a commitment by the surgeon to educate their patients and rehabilitation staff in order to be effective. Whatever ACL technique or graft source is used for surgery, rehabilitation to achieve normal knee range of motion needs to be emphasized in order to achieve the ultimate goal of patient satisfaction and lower incidence of OA in the long term.

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