Technical Note

Anatomic Double-Bundle Posterior Cruciate Ligament Reconstruction Using Double-Double Tunnel With Tibial Anterior and Posterior Fresh-Frozen Allograft

Arturo Makino, M.D., Luis Aponte Tinao, M.D., Miguel Angel Ayerza, M.D., Cecilia Pascual Garrido, M.D., Matias Costa Paz, M.D., and Domingo Luis Muscolo, M.D.

Abstract: Techniques for the reconstruction of knee ligaments must restore the injured knee to a satisfactory level of performance. For this, a precise anatomic reconstruction is necessary. Many arthroscopic techniques for reconstruction of the posterior cruciate ligament (PCL) have been reported to restore the normal anatomy of the intact PCL using a double-bundle reconstruction with a Y-shaped tendon graft (2 femoral tunnel and 1 tibial tunnel). However, this procedure is sometimes difficult because the graft must be tightened in different grades of flexion to obtain complete strength of both bundles. We thought that double-bundle PCL reconstruction using double-double tunnels (2 femoral and 2 tibial tunnels) would allow an anatomic reconstruction, restoring better knee biomechanics, and probably improving patient outcome. **Key Words:** Posterior cruciate ligament—Double-double bundle reconstruction—Knee—Allograft.

Over the past years, several new techniques for posterior cruciate ligament (PCL) reconstruction have emerged that are believed to more closely restore the normal anatomy of the intact PCL. Anatomically, the PCL has been described as consisting of 2 primary components, the anterolateral and posteromedial bundles.[1,2] With double-bundle reconstruction, both the anterolateral and posteromedial components of the PCL are addressed, restoring normal knee laxity.[3] Several biomechanical studies have suggested that this technique better restores normal knee biomechanics than a traditional single-bundle reconstruction of the anterolateral component,[4] thereby improving patient outcome. Double-bundle reconstruction usually uses a Y-shaped tendon graft, but this is sometimes a difficult procedure because both components must be tightened in different grades of flexion to obtain complete strength of both bundles. The purpose of this article is to describe a new technique for double- double bundle PCL reconstruction using 2 femoral tunnels and 2 tibial tunnels with fresh-frozen allograft tissue.

From the Institute of Orthopaedics "Carlos E. Ottolenghi," and the Orthopaedic Research Laboratory (CINEOT), Italian Hospital of Buenos Aires (A.M., L.A.T., M.A.A., C.P.G., M.C.P., D.L.M.), and Instituto de Ciencias Básicas y Medicina Experimental del Hospital Italiano de Buenos Aires (C.P.G.), Buenos Aires, Argentina.

Address correspondence and reprint requests to Cecilia Pascual Garrido, M.D., Servicio de Ortopedia y Traumatología, Hospital Italiano, Potosi 4215 (1181), Buenos Aires, Argentina. E-mail: cecilia.pascualgarrido@hospitalitaliano.org.ar

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SURGICAL TECHNIQUE

Patient Positioning

The patient is placed in the anterior supine position with the injured knee flexed to 90°, and a pneumatic

tourniquet is applied high on the upper thigh of the treated extremity. The treated extremity is then circumferentially prepared and draped distal to the proximal thigh using the standard sterile method. Finally, the tourniquet is inflated after scrubbing.

Arthroscopy Portals

Four arthroscopy portals are used in this technique. The first is a high anterolateral portal used for the arthroscope. An additional working portal lies lateral just above the joint line. The third portal lies medial to the patellar tendon just above the tibial plateau. A posteromedial portal is later created under direct arthroscopic vision.

Graft Harvesting and Preparation

Tibial anterior or posterior fresh-frozen human tendon allograft tissue is used as a separate simple band. Both tendons are sutured over a length of 3 cm at the end with a No. 5 Ethicon suture (Ethicon, Somerville, NJ) using a running baseball whipstitch technique. The exact diameter of the graft is measured using the sizing holes of a graft preparation block. This varies between 8 and 10 mm according to allograft.

Tunnel Preparation

The aim of the reconstruction is to reproduce the anterolateral and posteromedial bundles of the PCL. Two femoral tunnels (anterolateral and posteromedial) and 2 tibial tunnels are used. First, the native PCL is visualized at the femoral footprint using the high anterolateral arthroscopic portal previously described. Next, the femoral remnant of the ligament is removed using a shaver introduced through the low anterolateral and posteromedial portal, which allows better visualization of the footprint of the PCL insertion at the medial femoral condyle and tibial footprint.

Once the PCL is debrided, 1 K-wire is placed without a guide through the low anterolateral portal to the 1 or 11 o'clock position of the medial condyle according to the knee (1 o'clock for right knee, 11 o'clock for left knee). The entrance is 1 to 3 mm from the articular cartilage border reproducing the anterolateral band direction.

A second K-wire that will reproduce the posteromedial band is inserted through the same low anterolateral portal to the 2 or 10 o'clock direction of the medial condyle according to the knee (2 o'clock right knee, 10 o'clock left knee) Next, 2 closed-end femoral tunnels are drilled using the guide pin previously placed with an 8-mm reamer. A second femoral tunnel for the posteromedial bundle is created in the same manner with a 8-mm reamer. The 2 tunnels should spaced 2 mm apart to avoid tunnel bridge collapse (Fig 1).

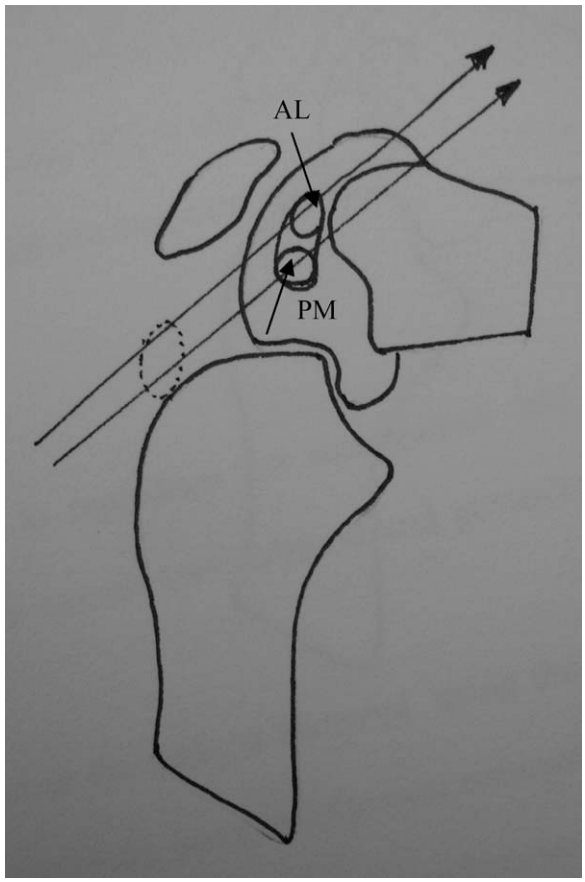

FIGURE 1. Lateral side of the medial femoral condyle with the correct femoral tunnels. Arrows show the anterolateral (AL) bundle and the posteromedial (PM) bundle.

Tibial Tunnel Preparation

Two tibial tunnels are prepared for the anatomic localization of the PCL. Under arthroscopic guidance from the anterolateral portal, the disrupted PCL stump is debrided to identify the femoral footprint of the PCL. The arthroscope is then inserted in the posterior compartment to determine the stump at the tibial insertion site. A mechanized shaver is introduced through the posteromedial portal to excise the tibial remnant and identify the footprint of the PCL. The hook of the tibial guide is introduced through the anteromedial portal into the knee joint and pushed far back over the anterolateral PCL footprint tibial insertion. Next a K-wire is placed in the skin through a

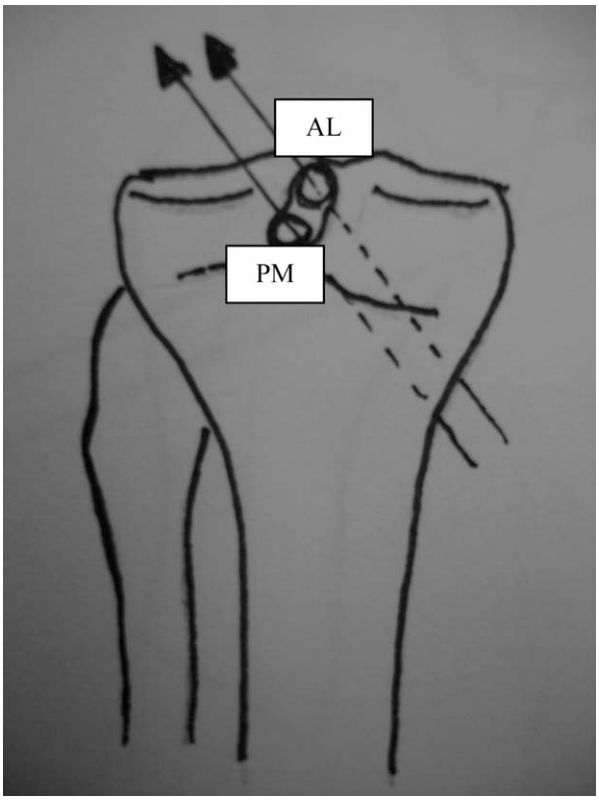

Figure 2. Drawing showing the tibial surface from posterior, where the tibial tunnels must go out.

small vertical incision being cautious not to damage the pes anserinus insertion; it enters in the anterior medial aspect of the proximal tibia approximately 1 cm below the tibial tubercle at a point midway between the posterior medial border of the tibia and the tibial crest anteriorly (Figs 2 and 3A). The K-wire exits at the anterolateral PCL footprint. The end point of K-wire must be visualized arthroscopically through the posteromedial portal. The tip of the K-wire should be protected with a curette to avoid vascular lesions; this is sometimes done under fluoroscopy (Fig 3B). Before the 8 to 10 mm tibial tunnel is drilled, we must assess the correct position of the K-wire; for this we suggest using as a point reference the distal insertion of the posterior capsule (suggesting this to be the inferior point where the tunnel can exit). Sometimes the popliteal muscle can be seen as the posterior capsule loses its attachment. The second tibial tunnel (corresponding to the anterolateral bundle) is created in the same way but is inserted parallel to the first one and 3 to 4 mm above to prevent collapse of the bone septum between both tibial tunnels. To assess this, we use the hook of the tibial guide viewed under the arthroscopic posteromedial portal.

Graft Passage and Fixation

First the femoral sides of the grafts are fixed using a reabsorbable interference screw. Fixation on the tibial side is obtained with a reabsorbable interference fit screw and a titanium staple, and both grafts are tensioned individually in different grades of flexion knee according to PCL portion.

The anterolateral portion of the graft is fixed with the knee in 70° to 90° of flexion and externally rotated and an anterior drawer force is placed on the knee to

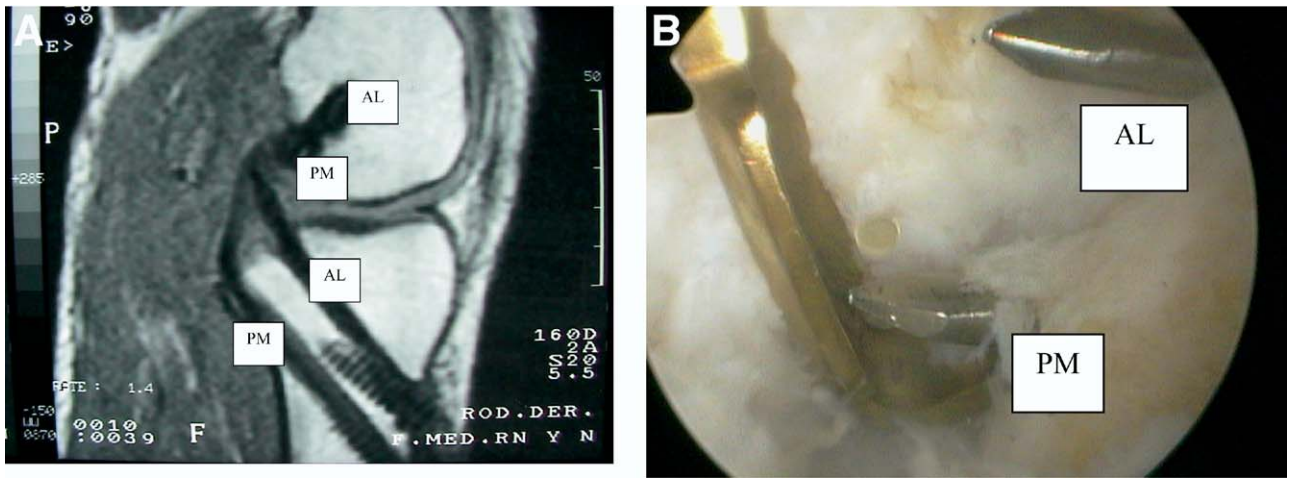

Figure 3. (A) Magnetic resonance image of the double-double tunnel reconstruction. (B) Arthroscopic view through posteromedial portal, in the tibial footprint of the PCL. See tibial guide inserted to avoid vascular lesion.

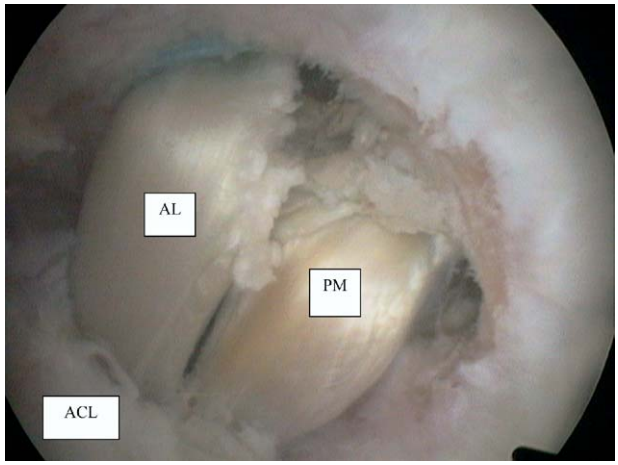

FIGURE 4. Arthroscopic view of the PCL reconstruction with the proposed double-double technique.

reproduce normal step-off. Then the posteromedial portion of the graft is fixed with the knee in 10° to 5° of extension and a slight anterior drawer tibial force is applied. The grafts are checked arthroscopically and examined to ensure that the posterior drawer has normalized (Fig 4).

Postoperative Rehabilitation

Postoperative rehabilitation following PCL reconstruction is designed to restore range of motion without stressing the graft. Exercises that reproduce posterior tibial translation are avoided. Limited weight bearing using crutches is allowed with a knee brace locked in extension with a posterior bag just behind the popliteal area for 4 to 6 weeks 24 hours day. Weight bearing of 25% body weight is allowed during 1 to 4 weeks postoperatively, increasing to 50% at 5 to 6 weeks, with full body weight thereafter.

DISCUSSION

Reconstruction of the PCL is a demanding procedure. Anatomic reconstruction is essential to have a good outcome[5]; for this, both bundles of the PCL must be restored. Biomechanically, the thinner posteromedial bundle is tight in extension and the stronger anterolateral bundle is taut in flexion.[6] The technique of double-bundle reconstruction has been widely used with the Y-shaped type where the anterolateral bundle is tensioned and fixed in extension and the posteromedial is anchored in flexion. This has the advantage of restoring most approximately the anatomy of the PCL; it has bone fixation on 3 ends, thus allowing rigid fixation and bone-to-bone healing.[7] But this technique is sometimes difficult, especially when passing the graft through the tunnels because of the bone plugs.

The main objective in ligament reconstruction is the restoration of joint stability with normal knee laxity and kinematics The double-double technique we propose has the advantage that each bundle maintains its own strength because they are fixed individually, reproducing the normal kinematics of the knee. The fixation on 4 ends allows better osteointegration because no interface tissue is developed between the tendon and the bone, enabling a rigid fixation.

Using allograft has advantages in this procedure. The allograft is longer, which is important for the reconstruction of the posteromedial bundle. Also, the contact area is increased, allowing better osteointegration to the bone tunnel.

Some argue that allografts do not have the same biology as autograft, but many investigators have shown that fresh-frozen allograft provides the possibility of a revascularization process similar to that of autogenous graft.[8] We believe that the advantages include less morbidity as well as decreased operative time.

In summary, we are describing a double-double PCL reconstruction technique that can be used for primary or revision PCL reconstructions and for multiligament injuries as well. We believe that this technique better simulates the normal anatomy of the knee in full range of motion, is highly reproducible, and has low morbidity. We used this technique for PCL reconstruction and obtained satisfactory clinical results. Nevertheless, a large series of patients with long-term follow-up is required to fully assess the effectiveness of this procedure. To our knowledge, this technique has never been described in the literature.

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