**Master Lecture:** PCL Reconstruction – Two Tunnels are better than one.

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**Introduction**

Why would you consider doing a double bundle reconstruction?

The surgical results of PCL reconstruction are often inconsistent. This may be due to several factors:

- The complex double bundle anatomy of the PCL.
- The constant force of gravity on the PCL graft even at rest.

The single bundle reconstruction does not reproduce the anatomy of the PCL.

**Anatomy**

The femoral attachment site is wide, fan shaped, or tear drop, in appearance. This femoral attachment site spans almost 28 mm in a crescent shape.

**Kinematics**

A. Two bundle kinematics of the PCL
1. Anterior bundle tight in flexion
2. Posterior bundle tight in extension
3. Recruitment of fibers from both bundles in mid range flexion.
4. No bundle is even close to isometric when studied independently
5. The unique “Y” shaped geometry of this ligament produces these unique properties

Harner has shown that in the lab there is better reproduction of the normal kinematics with the tunnels drilled in the positions shown above.
In this lab study, the 2 femoral tunnels were created in the position as seen above using a Achilles tendon graft for the anterolateral and a double looped semitendinosus for the posteromedial bundle. The kinematics for the intact PCL, the PCL deficient and the PCL reconstructed knee were measured. The reconstructed knee was similar to the intact knee at all angles that were measured.

The data confirmed the hypothesis that a double-bundle PCL reconstruction more effectively reproduces intact knee kinematics and in situ forces in the PCL across the full range of flexion than a single-bundle reconstruction. In response to a 134-N posterior tibial load, posterior tibial translation of the knee with a single-bundle PCL reconstruction was significantly greater than that in the intact knee, by up to 3.5 mm, whereas the double-bundle PCL reconstruction successfully restored posterior tibial translation from full extension to 120° of knee flexion. These data are consistent with those of previous researchers who also found that the double-bundle reconstruction more closely restores posterior tibial translation of the intact knee (Ref. 19; D. Mannor et al., unpublished data, 1999).
Race and Amis

Fig 10  Fig 11 The dissected footprint on the femoral condyle by Race and Amis. Based on the PCL footprint, the 2 femoral tunnels were drilled.

Fig 12 The completed femoral tunnels by Race and Amis

Fig 13 The grafts in the femoral tunnels.

Race and Amis [8] have also studied the 2 bundle reconstruction. They found that the 2 bundle prevented posterior translation over the entire range of knee motion. The 2
bundles were greatest in the flexed knee. Noyes comments that the 2 tunnels were too distal, but it looks like the grafts were actually more proximal, or deep as Noyes describes.

It is interesting to note that slight variations in the degree of knee flexion as well as the slope of the notch can effect the position of the second tunnel.

Morgan
Morgan [9] described the anatomic landmarks as seen by the arthroscopist with the knee flexed at 90°.

Fig 9 The measurements were made with a caliper at the time of total knee replacement. The reference site is the surface of the articular cartilage. This placed the posteromedial bundle slightly more distal than Harner.
Fig 11 The 2 bundles as marked and measured by Morgan

The position of the 2 femoral tunnels as drilled by Morgan in a cadaver lab.
The finished two bundle reconstruction using semitendinosus.

In summary several researchers have shown that the reproduction of the normal PCL anatomy with 2 bundles is an improved approach to PCL reconstruction.

What are the indications for a double bundle reconstruction?

The indications for reconstruction in the acute situation are a complete tear of the PCL, usually in association with other ligamentous structures. The indication in the chronic scenario is the combined ligamentous laxity. The patient is often not symptomatic, even with combined ligament injuries, but it is felt that these do poorly over the long term, and consideration should be given to reconstruction.

The trans-tibial tunnel is the traditional, and the most common reconstruction. The graft choice is usually Achilles tendon, but autogenous quads tendon is very similar in appearance and function. The bone block was initially left in the femur and the graft passed from proximal to distal. Markoff has shown that if the bone block is left at the very proximal part of the tibial tunnel, it reduces the forces on the graft at the ‘killer turn’. [6] Clinical results by Chen, and Fanelli support the continued use of the trans-tibial tunnel approach. [7-9]
The current consensus is that for the acute reconstruction a single bundle reconstruction is adequate. This is based on Harner’s review of his case series which showed good results in the acute situation, but less than satisfactory in the chronic cases. [10] The double bundle reconstruction in chronic cases is recommended.

The posterior inlay technique as originally described by Getscheler and Jacob in Europe, and Berg in North America was to avoid the ‘killer tunnel angle’ at the posterior edge of the tibia. [11] Bergfeld has shown in the lab there is attenuation and thinning of a trans-tibial graft as it passes around the back of the tibia. [12] The posterior inlay graft does not have this problem, and should be able to survive the posterior force of gravity as well as the forces applied during cyclic loading of the graft. However Ahn has shown good results with both reconstruction and augmentation of the PCL remnant using the trans-tibial tunnel technique. In follow-up arthroscopy and MRI there was no attenuation of the graft around the back of the tibia.

Another reason to use the posterior inlay technique is to avoid injury to the neurovascular structures that occasionally happens when drilling the tibial tunnel. [13]

What about the clinical results of double bundle reconstruction?

Bergfeld has shown the superior kinematics in the double versus the single bundle posterior inlay technique. [15]

The results of the double bundle posterior inlay technique have been reported by Richards, Noyes, and Stannard. [17-19] The technique of double bundle posterior inlay has been described by Noyes. [20]

Zhoa has published good results using double bundle reconstruction using 8 strands of hamstring graft and four tunnels. [21]
Summary. The conventional wisdom is that a single bundle reconstruction is adequate for the acute reconstruction, but in the chronic combined situation a double bundle tunnel is preferred.

Bibliography


