Single-Bundle Anterior Cruciate Ligament Reconstruction: Technique Overview and Comprehensive Review of Results

By Lieutenant Commander John-Paul H. Rue, MD, Paul B. Lewis, MD, MS, A. Dushi Parameswaran, MD, and Bernard R. Bach Jr., MD

Introduction

The purpose of this scientific exhibit is to review the single-bundle anterior cruciate ligament reconstruction theory and technique, focusing on technical pearls used to avoid the most commonly encountered errors, and to provide a comprehensive review of outcomes after single-bundle anterior cruciate ligament reconstruction.

Single-Bundle Theory

A vertically oriented femoral tunnel is one of the most common causes of failure after anterior cruciate ligament reconstruction[1-3]. In this situation, patients may demonstrate a normal result on the Lachman examination but have instability as demonstrated by a pivot shift phenomenon on clinical examination. As opposed to the two-incision anterior cruciate ligament reconstruction, in which the femoral and tibial tunnels are drilled independently of each other, the femoral tunnel position in a single-incision, transtibial technique is dependent on the position and orientation of the tibial tunnel.

Problem: Instability Due to Vertical Graft

When the transtibial, single-incision technique is used for reconstruction of the anterior cruciate ligament, it is possible for surgeons to inadvertently create a vertically oriented graft (Fig. 1). Such a vertical graft may not adequately restore either the translational or rotational kinematic properties of an intact knee. Clinical failure in these patients commonly presents as subjective instability, with a positive pivot shift, despite a negative result on the Lachman test.

Anatomy: Anteromedial Bundle Provides Anterior Stability and Posterolateral Bundle Provides Rotational Stability

To further investigate this problem, the contributions of the anteromedial and posterolateral bundles of the native anterior cruciate ligament have been studied. The anteromedial bundle has been shown to be located more toward the eleven o'clock position in a right knee and primarily provides a restraint to anteriorly directed forces, while the posterolateral bundle is located more laterally near the nine o'clock position and provides restraint to both anterior as well as rotational forces[4,5] (Fig. 2).

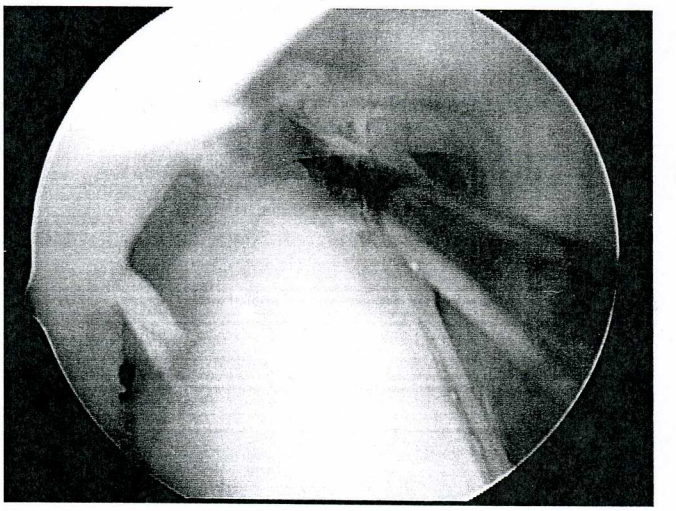

Fig. 1

Arthroscopic image of a vertically oriented anterior cruciate ligament graft in a right knee. This patient complained of instability, and the physical examination demonstrated a negative Lachman test with a positive pivot shift. Note that the arthroscopic probe is placed at the twelve o'clock position.

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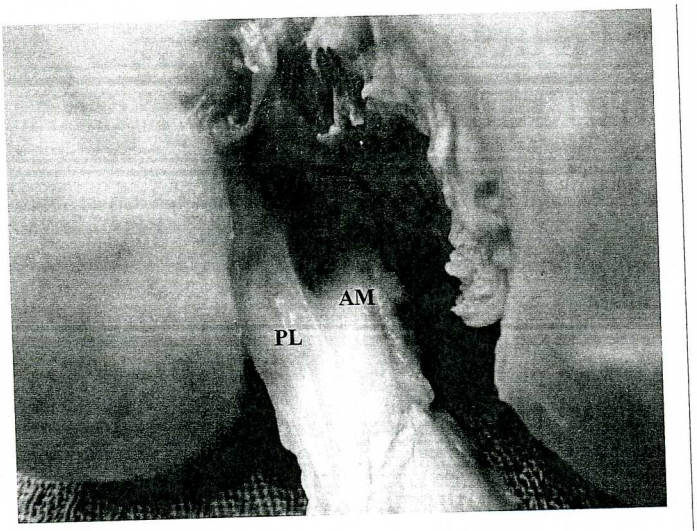

Fig. 2

Cadaver dissection showing the anteromedial (AM) and posterolateral (PL) bundles of the anterior cruciate ligament.

Anatomy: Lateralized Femoral Tunnel Reconstructs Portions of Both Anteromedial and Posterolateral Bundle Origins

In a cadaver model, a lateralized, transtibial, drilled 10-mm femoral tunnel placed at approximately the 10:30 position (halfway between the ten and the eleven o'clock position) has been shown to overlap approximately 50% of the anteromedial bundle and 51% of the posterolateral bundle[6] (Figs. 3, 4, and 5).

Biomechanical Data: Lateralized Femoral Tunnel Position Restores Rotational Stability

In biomechanical studies, an oblique femoral tunnel positioned laterally on the intercondylar wall has been shown to restore rotational stability, as well as anterior and posterior stability[7-9].

Practical Application: A Lateralized Femoral Tunnel Can Be Achieved with Use of a Transtibial Technique

A recent cadaver study has suggested that transtibial techniques that place a femoral tunnel within the anatomic footprint of the anterior cruciate ligament origin result in a shortened tibial tunnel and might compromise tibial fixation[10]. In more than 1800 anterior cruciate ligament reconstructions by the senior surgeon (B.R.B. Jr.), this has not been found to be a problem. In contrast, we reviewed the postoperative radiographs of fifty consecutive knees that had a primary single-bundle anterior cruciate ligament reconstruction with use of a transtibial anterior cruciate ligament technique and found that we were reliably able to place the femoral tunnel at approximately the 10:30 position through a tibial tunnel angled approximately 60° in the coronal plane[11] (Fig. 6).

Summary of Single-Bundle Theory

With use of a transtibial technique, a lateralized femoral tunnel placed at the 10:30 position (right knee) places the anterior cruciate ligament graft at the midpoint between the anteromedial and posterolateral bundles of the native anterior cruciate ligament, effectively creating a hybrid anterior cruciate ligament reconstruction (Figs. 7-A and 7-B).

Overview of the Single-Bundle Anterior Cruciate Ligament Reconstruction Technique

As is common to most described anterior cruciate ligament reconstruction techniques, a graft is placed through a tibial and a femoral bone tunnel to substitute for the native anterior cruciate ligament. There are three critical points to performing a single-bundle anterior cruciate ligament reconstruction with use of a transtibial drilled lateralized femoral

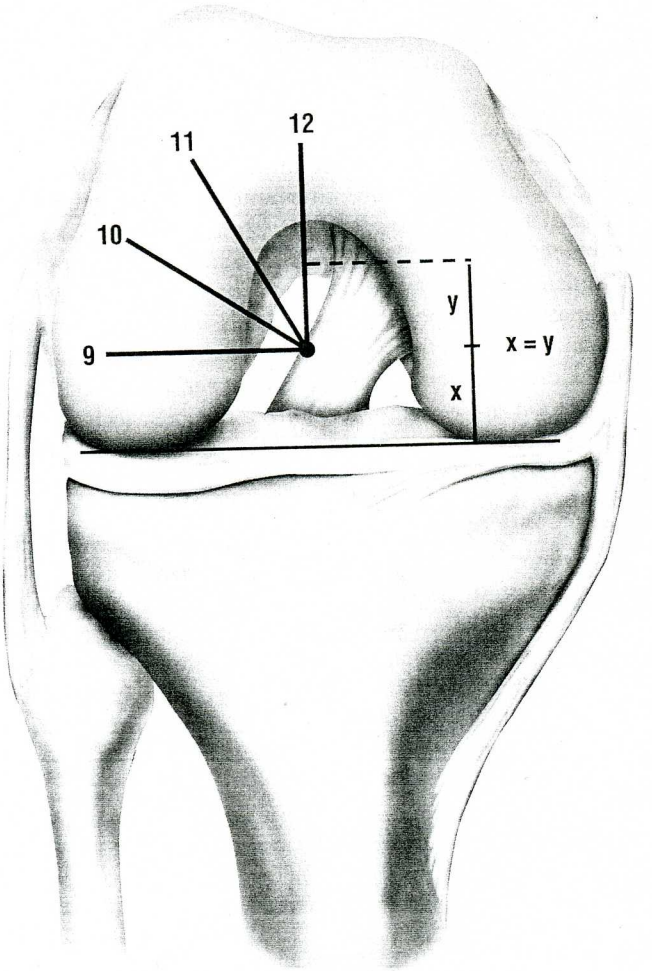

Fig. 3

Schematic drawing of a clock face superimposed on a coronal image of a right knee. The clock face reference is a useful tool for coronal plane orientation. (Reprinted, with permission, from: Rue JH, Busam ML, Bach BR Jr. Hybrid single-bundle anterior cruciate ligament reconstruction technique using a transtibial drilled femoral tunnel. Tech Knee Surg. 2008;7:107-14.)