Anatomic Outside-In Anterior Cruciate Ligament Reconstruction Using a Suspension Device for Femoral Fixation

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Abstract: Cortical suspension is one of the most frequently used methods of femoral fixation in anterior cruciate ligament reconstruction. We present a simple technique for anterior cruciate ligament reconstruction using a suspension device for femoral fixation. The purposes of this technique are to ensure greater contact between the graft and the tunnel walls—a goal that is achieved by using the femoral fixation device with the shortest possible loop—to avoid the flip step and the need for hyperflexion, and in short, to minimize the risk of complications that can occur when using the anteromedial portal to drill the femoral tunnel. To this end, both the femoral and tibial tunnels are created in an outside-in manner and with the same guide. The graft is passed through in a craniocaudal direction, and the suspension device is fitted inside an expansion piece for a better adaptation to the femoral cortex.

Currently, one of the most frequently used methods for attaching the graft to the femur in anterior cruciate ligament (ACL) reconstruction using hamstring tendons as an autograft is cortical suspension, a system that, though proven to be effective, is not exempt from complications or technical difficulties.[1] These include the need to create the femoral tunnel through an anteromedial portal with the knee hyperflexed, thus reducing articular space and obstructing visibility during arthroscopy.

One possible complication during the passage of the device through the outer cortex of the femur is that the button may go past the fascia lata, which is then left trapped between the device itself and the femoral cortex.[2] The device can also become trapped inside the femoral tunnel.[3]

At the same time, the contact between the graft and the femoral tunnel should be of the maximum length possible.[4] In some cases, an excessively short tunnel requires the use of a fixation device with an extremely short loop, which in turn makes both flipping and passing through the femoral tunnel extremely difficult.

A further pitfall is the risk of accidentally perforating the outer cortex with the drill, resulting in bicortical reaming. Some manufacturers have designed implants of greater length, which are attached to the original implants to enable them to be used in tunnels of larger diameter.

One of the most commonly used tibial fixation systems involves the use of interference screws. Fixation resistance has been proved to be increased if both ends of the graft are sutured beforehand.[5]

The technique outlined in this report is designed to eliminate, or at the very least minimize, the risk of these complications arising, thus making reconstruction easier to carry out and achievable without specialized surgical instruments. It involves the use of the outside-in technique to create both the femoral and tibial tunnels, a procedure that can be performed with any of the ACL guides habitually used for the tibial tunnel, the only condition being that the guide must be adjustable to at least 80°.

Femoral fixation is achieved with the cortical suspension system, using the shortest possible loop (10 to 15 mm) to ensure maximal contact between the graft and the tunnel walls. This should be complemented by a further device of greater length, which will enable the support area to be increased, given that the lateral cortex of the femur is pierced. We use the G-Lok implant

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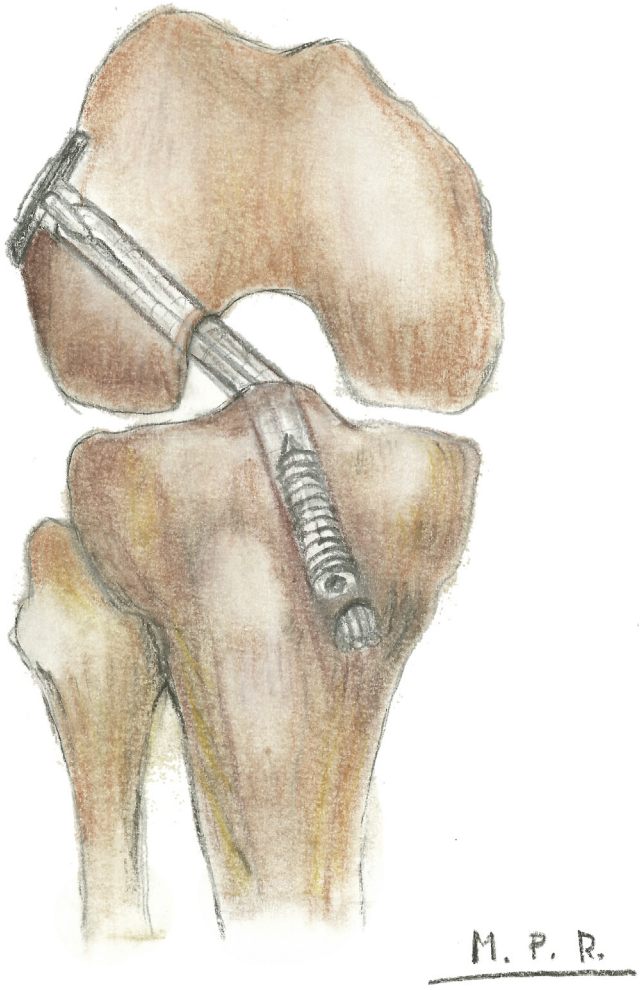

Fig 1. Diagram of technique (right knee). Femoral fixation is achieved with a suspension device engaged in its expansion piece; a minimal loop is used to allow longer contact between the tunnel walls and the graft. Tibial fixation is performed with an interference screw of the longest possible length.

(Stryker Endoscopy, San Jose, CA) with its expansion piece (G-Lok XL) (Fig 1).

Technique

The patient is given a regional or general anesthetic and positioned supine. An ischemia cuff is used, and the limb in question is supported by a leg holder with the knee at 90° of flexion. We generally use a central transtendinous portal for cruciate ligament reconstruction (Fig 2). The ACL damage is identified, and any associated injuries are treated with the aid of a single anteromedial portal, although an additional anterolateral portal may be used if required.

A 3-cm oblique skin incision is made anteromedially to the anterior tibial tuberosity to harvest the semitendinosus and gracilis tendons and to create the tibial tunnels. The tendons are harvested with a standard tendon stripper. Both tendons are prepared on an auxiliary table and joined by means of a bioabsorbable suture, which will serve as a traction thread. The ends of the graft are sutured to form a closed loop. Placed in position beforehand is a femoral fixation device with a 10- to 15-mm loop. Attached to this is a further device of greater length to facilitate cortical fixation once the whole of the tunnel has been created with a diameter identical to that of the graft (Fig 3). Meanwhile, the medial wall of the lateral femoral condyle is prepared with a radiofrequency probe and a resector (Stryker Endoscopy).

Both the femoral and tibial tunnels are created with the aid of an ACL tibial guide (we use the device manufactured by Stryker Endoscopy). This must be adjustable to at least 80° to ensure the correct positioning of the femoral tunnel (Fig 4).

Starting with the femoral tunnel, the arthroscope is inserted through the anteromedial portal and the guide set at the widest possible angle (we usually place the femoral tunnel at 80°) (Fig 5) through the central transtendinous portal. If it is possible to identify the bony anatomic landmarks, namely the bifurcate and intercondylar ridges, said reference points are used to determine and mark the center of the ACL footprint; if not, the center of the tunnel is established approximately halfway along a line drawn parallel to the posterior margin of the lateral femoral condyle, from deep to shallow, at a distance from said margin equal to the radius of the femoral tunnel plus 2.5 mm (e.g., 7 mm for a tunnel 9 mm in diameter) (Fig 6).[6-8] A 1.5-cm incision is made in the lateral femoral epicondyle, and a guide needle is introduced with the aid of the ACL reconstruction guide, entering the joint at the predetermined site.

The tibial tunnel is created by returning the arthroscope to the central portal and introducing the same guide through its anteromedial counterpart, at an angle of 55° (Fig 7). First, a needle is inserted using the guide and positioned at the center of the footprint of the native ACL. Both tunnels are then completed with the aid of a drill bit of identical diameter to that of the graft.

The graft is introduced from cranial to caudal (Fig 8). The traction thread is inserted into the joint through the tibial tunnel until the graft has passed through both tunnels.

The graft is fixed to the femur with the composite device to which it has previously been attached. It is fixed to the tibia by a bioabsorbable interference screw that is 1 mm larger in diameter than the tunnel and of the maximum length that the latter will allow (Fig 9, Video 1).

Discussion

ACL reconstruction with cortical suspension devices is a technique that was first outlined in 1995.[9] Since then,

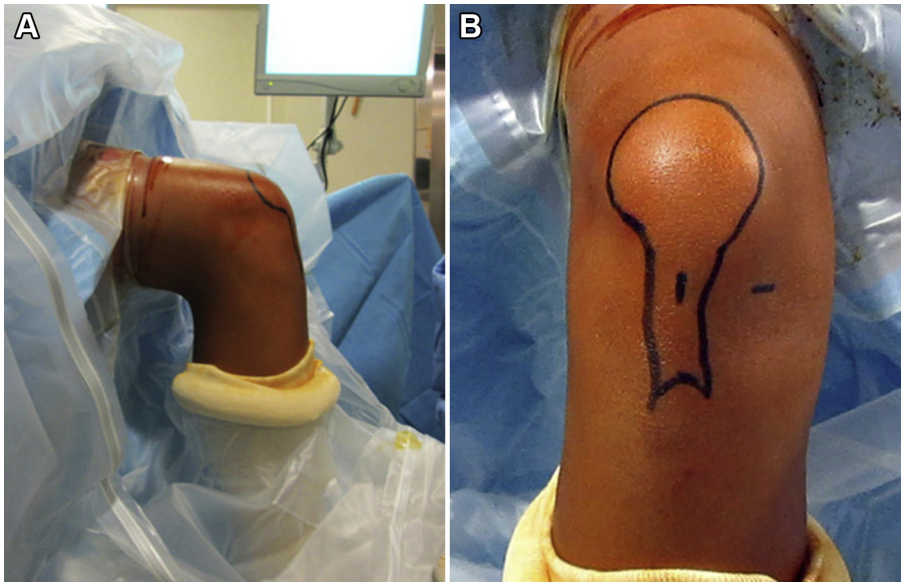

Fig 2. (A) The patient's limb is placed in a leg holder with the knee flexed to 90° (lateral view of right knee). (B) The central and anteromedial portals are used (right knee).

it has frequently been used in operations of this type. The technique presented in this report is an ACL reconstruction procedure similar to others using said system of femoral fixation.

The most distinctive feature of our method is that the outside-in technique is used to create the femoral tunnel, an approach that we believe offers several advantages (Table 1). Surgery can be carried out with the knee in the same position throughout, avoiding the need for the hyperflexion required when the inside-out technique is used through the anteromedial portal.[1,10] As pointed out in the study by Seo et al.,[11] the outside-in technique is a valuable one because it provides adequate rotational stability.

We enter centrally through the transpatellar portal: this provides us with an optimal view of the intercondylar notch and eliminates the need for an additional inferomedial portal. Locating the center of the anatomic insertion of the ACL on the femur can usually be achieved with the aid of known landmarks (the lateral intercondylar and lateral bifurcate ridges), although these are not always visible.[12] In such cases, the center of the tunnel is set approximately at the midpoint of a line drawn parallel to the posterior margin of the lateral femoral condyle at a distance equal to the radius of the femoral tunnel plus 2.5 mm from said margin.[6-8] In this technique, the femoral tunnel is created via the outside-in method alone. Because this involves making an aperture on the lateral femoral cortex, a retrograde drill need not be used. However, this also gives rise to the only limitation that we have found with this technique, namely the need to carry out femoral fixation with the aid of an additional

Fig 3. Prepared graft. The free ends are stitched together. The graft loop is placed onto the femoral fixation device (red arrow), which in turn is attached to a second device to increase its length (yellow arrow).

Fig 4. Guide used to create both tunnels. The only condition is that the guide must be adjustable to at least 80°.

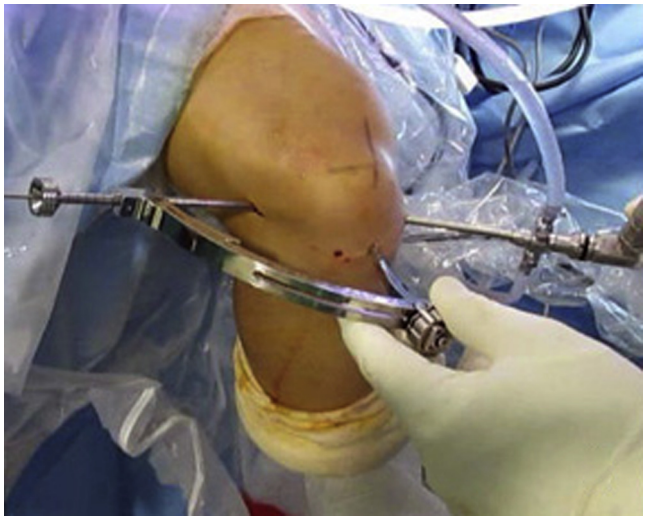

Fig 5. Positioning of guide for femoral tunnel (right knee). The guide is inserted into the joint through the central portal and must be adjustable to at least 80°. The arthroscope is inserted through the anteromedial portal.

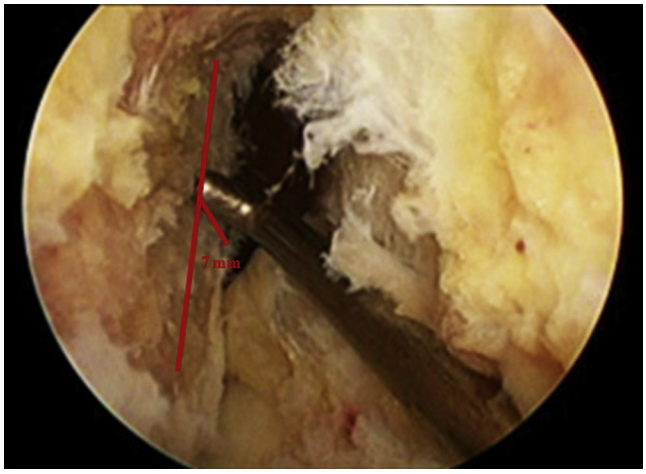

Fig 6. The location of the center of the femoral tunnel (view from transtendinous portal, showing medial aspect of lateral condyle) is set at the midpoint of a line drawn parallel to the posterior margin of the lateral femoral condyle at a distance of 2.5 mm plus the tunnel radius from said margin.

Fig 7. Positioning of guide for tibial tunnel. The arthroscope is inserted through the central portal and the guide, set at 55°, through its anteromedial counterpart.

Fig 8. The graft is pulled in a craniocaudal direction through the femoral tunnel, exiting through its tibial counterpart (a reversal of the conventional technique).

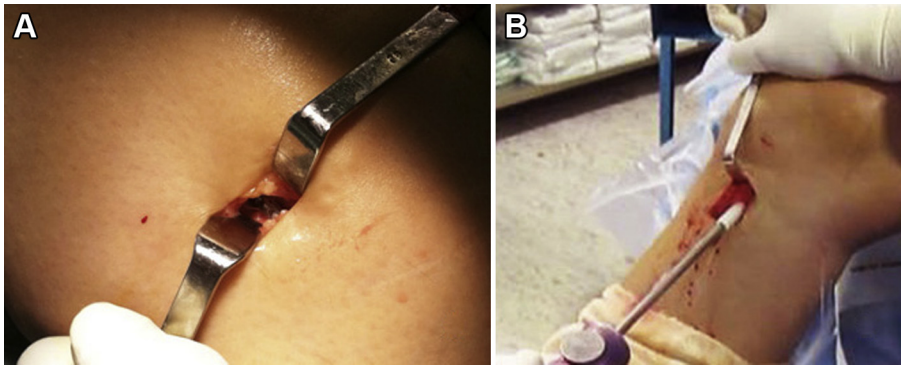

Fig 9. (A) Femoral fixation. Good contact with the graft can be checked under direct vision. (B) Tibial fixation with interference screw.

Table 1. Advantages, Disadvantages, Tips, Pearls, and Pitfalls

Advantages
Surgery can be performed with the patient in the same position throughout.
Hyperflexion is not required.
Both the femoral and tibial tunnels are created by the outside-in technique and using the same guide (the one habitually used to perforate the tibial tunnel). The only condition that must be fulfilled is that the guide be large enough and offer a sufficient angle of adjustment to create the tunnel.
An extremely short loop may be used, eliminating the need for the flip step. This also ensures maximal contact between the graft and the tunnel walls.
The passage of the graft from cranial to caudal avoids the potential risk of snagging the fixation device on soft tissue, as well as affording the surgeon a clear view of the proceedings, thus facilitating the task of adjusting the graft to the femoral cortex with absolute precision.
Disadvantages
The fixation device must be combined with another device of additional length.
Tips and pearls
Though not essential, we recommend that the central portal be used to ensure a clear view of the intercondylar notch without the need for accessory portals.
When the ACL landmarks are not visible, the posterior articular margin of the lateral femoral condyle should be used as a reference. The probe may be used as a guide when measuring height.
Once the femoral tunnel has been created, the shallow edge should be "planed" to reduce graft friction.
The tibial guide should be set to 55° to ensure that the tibial tunnel is of sufficient length.
Once the graft is in place, one should check that the device is properly supported by the femoral cortex.
Pitfalls
During its passage through the tunnels, the graft may become snagged. To avoid this, utmost care should be taken when suturing its extremities to ensure that the ends of the stitches are not frayed, distended, or irregular in any way. In addition, one should check that the graft can be passed with ease through the diameter calibrator.

device of greater length, which may make the cost of the operation slightly higher, although a cost-effectiveness study has not been conducted.

The graft is passed through in reverse manner in comparison with most other techniques, that is, from cranial to caudal, thus avoiding the risk of snagging the fixation device on soft tissue in the femoral supracondylar region[2] and enabling the device to be adjusted with maximum precision to the lateral cortex of the femur, which is directly visible. Furthermore, the device requires only a very short loop because the flip step is not needed. This ensures greater contact between the graft and the tunnel walls.

Finally, tibial fixation is accomplished with an interference screw 1 mm greater in diameter than the tunnel, and both ends of the graft are sutured beforehand, a measure proven to increase fixation resistance.[5] We believe that the technique described is both easy to perform and highly feasible, reducing the risk of complications and technical problems that other systems entail.

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