Arthroscopically Confirmed Femoral Button Deployment

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Abstract: The anterior cruciate ligament TightRope RT (Arthrex, Naples, FL) is a graft suspension device for cruciate ligament reconstruction. It is an adjustable-length graft loop cortical fixation device designed to eliminate the requirement for loop length calculation and to facilitate complete graft fill of short femoral sockets that are common with anatomic anterior cruciate ligament placement. The adjustable loop length means “one size fits all,” thus removing the need for multiple implant sizes and allowing graft tensioning even after fixation. However, the device has been associated with the same complications that have been described with EndoButton (Smith & Nephew Endoscopy, Andover, MA) fixation. The button of the TightRope RT may remain in the femoral tunnel rather than flipping outside of the tunnel to rest on the lateral femoral cortex, or it may become jammed inside the femoral canal. Conversely, the button may be pulled too far off the femoral cortex into the overlying soft tissue and flip in the substance of the vastus lateralis. We describe a new and simple arthroscopic technique to directly visualize the deployment and seating of the TightRope button on the lateral cortex of the femur to avoid all the aforementioned complications.

The anterior cruciate ligament (ACL) TightRope (Arthrex, Naples, FL) is a second-generation adjustable-loop length suspensory fixation device. The adjustable graft loop has a 4-point, knotless locking mechanism relying on multiple points of friction to create a resistance to cyclic displacement and slippage under tension. The tensioning sutures (pull sutures) at the button end reduce the loop length and tension the graft strands in the same direction of graft advancement into the socket. This allows optimal graft-to-socket fill, reducing longitudinal (“bungee-effect”) graft motion within the bone tunnel and optimizing graft-to-bone healing.

Unlike the fixed-length loops, TightRope has a universal size that fits all tunnels without the need to overdrill the socket an extra 6 to 10 mm to facilitate button flipping. This utility simplifies the surgical technique and avoids the extra steps of measuring the tunnel length and matching it with the appropriate-length loop. However, the longer the TightRope loop is, the higher the risk of being pulled too far off the lateral femoral cortex into the soft tissue and flipping the button on muscles or fascia. Equally important, the absence of side sutures in the button may present difficulties in the flipping mechanism, leading to button anchoring with subsequent loss of graft tension. Intraoperative recognition of such complications will still allow easy redeployment of the TightRope button and optimum graft retensioning.

To avoid button deployment complications, we describe a new technique by which we have been directly visualizing the process of button passing and seating. The additional step, which involves maneuvering the arthroscope into the lateral gutter of the knee around the flare of the lateral femoral condyle, is performed through standard anterolateral portals without the need for any special equipment (Table 1, Video 1).

Surgical Technique

The semitendinosus graft is prepared and looped with the TightRope RT (Arthrex). The knee is left at 90° of flexion, and the arthroscope is introduced in the lateral gutter of the knee joint. With a standard needle, we visualize the best entrance point of the femoral tunnel completed with a small stab incision in the lateral aspect of the femur over the chosen area. This entrance point located in the lateral gutter is always anterior and...
proximal to the lateral collateral ligament femoral insertion. We prepare the femoral socket outside in from the anterolateral portal. The ACL femoral guide (drill guide handle, anteromedial hook, and drill sleeve for FlipCutter [Arthrex]) is introduced through the anteromedial portal and inserted at the femoral footprint of the ACL, and its other extremity is positioned in the lateral femoral incision. A 20-mm femoral socket is then created with a FlipCutter II (Arthrex) of a size determined from the diameter of the graft. A K-wire is left in place inside the femoral tunnel for visualization in the lateral gutter of the exit point of the femoral tunnel. Usually, shaving of the lateral gutter is recommended at this stage to debride the synovial tissue situated between the lateral cortex of the femur and the fascia lata (Fig 1). This step improves the visualization of the button-flipping process over the lateral cortex of the femur. The tibial tunnel is created in a standard fashion using the same diameter as the femoral tunnel. The tibial drill guide is positioned in the center of the anatomic ACL stump, and the tunnel is drilled progressively and carefully under arthroscopic control. Care is taken, when possible, to always remain inside the ACL stump to preserve the synovial sleeve.

With the knee being left at 90° of flexion, the graft is routed from the tibia to the femur. Introducing the arthroscope into the lateral gutter of the knee joint as described earlier allows us to see the exit point of the button on the lateral cortex of the femur and control the passage of the TightRope button through the pinhole. The device can be maneuvered with the assistance of a probe; the graft is pulled distally under vision until the button is correctly placed over the lateral femoral cortex. Any soft-tissue interposition between the button and the femur can be removed under arthroscopic control. The graft is secured with the TightRope tensioning device (Fig 2). Gentle countertraction on the tibial end of the graft is needed to prevent button displacement. The remaining process of the tibial fixation is completed without any modification.

Postoperatively, we routinely obtain a radiograph of the knee in all patients to ensure the correct positioning of the button. In the past 50 cases, 100% of the buttons were seated correctly on the lateral cortex of the femur.

**Discussion**

The TightRope RT is a fixation device for ACL reconstruction that has some technical properties that simplify the procedure. On the other hand, though still

| Surgical Steps | Pearls | Pitfalls |
|----------------|--------|----------|
| Knee positioning during outside-in femoral tunnel placement | Leave the knee at 90° of flexion. Use a standard needle to check proper visualization in the lateral gutter. Transillumination will help to quickly position the arthroscope in an adequate position to visualize the needle. | Identifying the tunnel entrance and performing the stab incision with the knee in extension will impair visualization of the entrance point during all further surgical steps performed at 90° of knee flexion (femoral guide placement, femoral tunnel socket creation, button flipping onto lateral cortex). |
| Femoral socket creation by use of FlipCutter | After choosing the guide direction and drilling the pilot path for the femoral tunnel, ensure proper impaction of the FlipCutter’s sleeve in the bone tunnel entrance with the arthroscope in the lateral gutter. | Insufficient FlipCutter sleeve impaction could result in sleeve loosening and further difficulties in regaining access to the FlipCutter pinhole on the lateral femoral cortex. |
| Preparation of button seating area (femoral tunnel outlet) | Introduce a 2.4-mm pin through the FlipCutter sleeve inside the bone in the femoral tunnel. Remove the sleeve and shave the synovial tissue around the pin to further improve outlet visualization. | Inadequate shaving will result in poor button visualization and seating. |
| Flipping of button onto lateral cortex under arthroscopic visualization | With the arthroscope placed in the lateral gutter, identify the button suture thread emerging at the lateral femoral cortex; then, pull gently on the suture thread until the button emerges from the FlipCutter pinhole. Use an arthroscopic probe through the stab incision as a soft-tissue retractor to create enough room to flip the button and to help the flipping process. Pull on the graft on the tibial side to firmly seat the button onto the cortex. | Abrupt suture pulling with poor arthroscopic control could result in button emergence at the stab incision. |
| Graft advancement in femoral tunnel and gradual tensioning | Use gentle countertraction on the tibial end of the graft to prevent button displacement during graft final tensioning. Check proper button positioning on the femoral cortex after final fixation. | Graft passage and tensioning without countertraction on the tibial side can result in button mobilization and migration into the FlipCutter pinhole. |
not reported in the literature, there are some potential complications that have been observed with this device. EndoButton (Smith & Nephew Endoscopy, Andover, MA) malpositioning over the soft tissue around the knee\textsuperscript{2-4} subjects the button to cyclical loads during knee flexion-extension, which in turn leads to either soft-tissue irritation or migration of the button\textsuperscript{3,5,6}. Both complications might require second-look surgery for implant removal, which is undesirable. Mae et al.\textsuperscript{4} have reported a rate of soft-tissue interposition between the EndoButton and the lateral cortex of the femur of up to 25.2% on postoperative radiographs obtained after ACL

**Fig 1.** Use of FlipCutter to create femoral socket and arthroscopic visualization of femoral tunnel outlet in lateral gutter in a right knee. (A) The arthroscope is passed into the lateral gutter, and the femoral tunnel entry point is identified with a needle. (B) The femoral socket is created with a FlipCutter. (C) A wire is left in place inside the femoral tunnel to identify the entry point. As shown in the inset, the synovial tissue is shaved from the femoral tunnel outlet.

**Fig 2.** Process of flipping TightRope button on lateral cortex of femur under arthroscopic visualization in a right knee. While the arthroscope is in the lateral gutter, the blue suture is tensioned to pull the graft into the joint. (A) The button is visualized while exiting the tunnel. (B, C) A probe is used to help seat the button.
reconstruction. In their series they also found a positive correlation between this complication and a higher rate of button migration. Theoretically, a button suspended over the soft tissue instead of the lateral cortex of the femur could also be detrimental to clinical outcomes. Weakening of the femoral fixation before graft integration might be the final result, leading to neoligament loosening and failure of the reconstruction.

Therefore our arthroscopically confirmed femoral button deployment ensures that the TightRope button is seated properly on the lateral cortex of the femur. It not only avoids a button positioned over the extensor mechanism of the knee but also avoids jamming the device inside the femoral tunnel or positioning of the button too close to the posterior cortex, which can cause posterior migration.\textsuperscript{7,8} Careful cleaning of the soft tissue over the lateral cortex of the femur and direct control over the tilting process of the button before final tensioning are essential. The reason for these last steps is that the TightRope RT permits further tensioning of the graft even after fixation. This prevents another potential source of migration of the button as a result of a “seesaw” phenomenon. Cyclical movements of the suture attached to the button are required during the technique, which might also lead to migration of this suspensory device. Rechecking the final position of the button, as described in our present technique, avoids such a complication after the graft is raised into the femoral socket.

On the other hand, positioning the button in the lateral gutter restricts tunnel entrance placement in this specific anatomic area. A guide pin angle of 60° to a line perpendicular to the femoral anatomic axis, combined with a pin entrance angle of 20° to the transepicondylar axis, has been recommended to obtain intra-articular femoral tunnel outlet morphology that approximates the human ACL femoral footprint length, width, area, and angular orientation.\textsuperscript{9} We did not evaluate whether the previous recommendations are compatible with a femoral tunnel entrance located in the lateral gutter. Lastly, this technique positioned the button in an intra-articular area. In our experience there have been no specific complications such as irritation or other adverse effects caused by the intra-articular placement of the implant in any of our first 50 cases with a minimum of 3 months’ follow-up.

Thus, in our opinion, our technique is a safe technique with a relatively short learning curve providing the surgeon excellent intraoperative feedback on the femoral fixation in ACL reconstruction. Previous publications on button deployment could not provide us with the same degree of confidence in correct button positioning.\textsuperscript{10}

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