Technical Note

Subcortical Backup Fixation in ACL Reconstruction
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Abstract: Anterior cruciate ligament (ACL) injuries result in knee instability in a majority of patients. Repair and reconstruction techniques have continually evolved over the past several decades. ACL reconstruction outcomes are directly impacted by physical therapy with early range of motion, weightbearing, and progressive strengthening. Therefore, the fixation must be sufficient to withstand the tensile and shear stresses across the graft construct during the biological healing phase. Occasionally, the primary fixation device is not strong enough to withstand these stresses. In turn, supplementary fixation devices, which are important especially in cases of revision ACL reconstruction, are imperfect. They occasionally become symptomatic, requiring hardware removal. Posts and washers require bicortical fixation, with moderate-sized holes in the tibia. Biocomposite screws rely on friction in the bone–screw interface, making them susceptible to failure. Tensioning can be problematic with the use of a post-and-washer construct. Subcortical fixation, which has not previously been described as a backup fixation method, provides several advantages. It requires a smaller, unicortical hole and provides fixation with a much lower profile than post-and-washer and interference-screw constructs. This is the first description of subcortical backup fixation in ACL reconstruction.

The optimal method of graft fixation in anterior cruciate ligament (ACL) reconstruction remains a controversial topic in orthopaedics. With the evolution of aggressive rehabilitation protocols and increasing pressure for athletes to return to sport in shorter time intervals, adequate graft fixation is a growing concern for surgeons. In particular, tibial-sided fixation has generated scientific interest, as it has been reported to be the weakest point in ACL reconstructions. Single-and dual-fixation methods are available; however, concerns pertaining to bone density, thread geometry, and insertional torque in primary fixation methods have led many surgeons to consider supplemental techniques. A recent systematic review of 21 studies demonstrated stronger initial fixation strength and less side-to-side laxity in hybrid tibial-sided graft fixation methods compared with single modes of fixation, owing to the load-sharing nature of the construct.

A wide variety of backup fixation options are available. Two commonly used methods include the post and washer and the biocomposite screw. Although

Table 1. Quick reference

| Supplies                  |
|---------------------------|
| One #2 FiberLoop or FiberWire (optional) |
| One #2 TigerLoop or TigerWire |
| One Arthrex 3.2-mm drill pin |
| One Arthrex BicepsButton   |

| Preparation             |
|-------------------------|
| Thread 1 limb of each suture through 1 side of the button and back through the opposite side. Thread the other limb through the button in the same manner, starting on the opposite side. See Figs. 1–4. |

| Drilling              |
|-----------------------|
| Using the 3.2-mm drill pin, drill a 3.2-mm unicortical hole 2 to 3 cm below the inferior aperture of the tibial tunnel. Ensure that the hole is drilled centered on the medial face of the tibia (between the tubercle and posteroomedial cortex) directed toward the fibula. See Fig. 6. |

| Insertion             |
|-----------------------|
| Maintain tension on the sutures and insert the button through the cortex. Pull on the free suture limbs to seat the button against the tibia. See Figs. 7 and 8. |

| Tensioning and knot tying |
|---------------------------|
| Tension each suture limb pair. Once they are tensioned, tie a knot with opposing suture limbs. One knot using the 4 limbs is recommended. See Fig. 9. |
Bicortical fixation in the former construct is appealing, hardware prominence is a concern in some patients. In turn, biocomposite screws provide a low-profile construct, but pull-out concerns arise from the reliance on a unicortical bone–screw interface. A biomechanical study comparing 3 methods of tibial-sided backup fixation demonstrated no statistical difference in ultimate load-to-failure of a 4.5-mm post and washer compared with a 4.75-mm biocomposite screw (1148 vs. 1007 N; \( P = .100 \)).4

The use of suspensory fixation is commonly used as the primary fixation technique among reconstructive procedures in orthopaedic sports medicine. Fixed and adjustable-loop constructs rely on a cortical button, seated on the periosteum, for fixation during ACL reconstruction.5 Similarly, cortical button fixation has been described for tenodesis of the long head of the biceps tendon to the humerus (albeit placement is within the intramedullary canal). In a matched-cadaver study, no differences in load-to-failure were identified between button and interference screw fixation (218.8 vs. 212 N; \( P = .625 \)).6 Suture–tendon interface failure has been reported as the most commonly observed mode of failure with the button technique.7

To date, no study has evaluated the utility of subcortical fixation as a backup fixation method in ACL reconstruction. The purpose of this study was to demonstrate use of the unicortical button for subcortical backup fixation. Future studies will demonstrate the biomechanics of this backup fixation method.

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**Fig 1.** The cortical button can be attached during graft preparation with the BicepsButton and inserter. This figure shows an allograft with 4 trailing #2 sutures, a FiberWire, and a TigerWire.

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**Fig 2.** Each limb is threaded through 1 side of the button and back through the opposite side. The other limb is threaded through the button in the same manner, starting on the opposite side. Two different limbs can be passed at 1 time.

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**Fig 3.** (A) Diagram illustrating proper passage of the first suture through the button. The second suture is passed in the same manner as the first. Note that both sutures can also be passed simultaneously. (B) Subcortical placement of the button with 4 suture strands. Note the 3.2-mm drill hole for passage of the button.
Surgical Technique

Indications
Subcortical backup fixation using the unicortical button (BicepsButton; Arthrex, Naples, FL) can be used in primary and revision ACL reconstructions with quadriceps autograft, bone-to-bone autograft, hamstring autograft, and allograft. It can be used in most standard ACL reconstruction techniques. For all-inside ACL reconstruction, it can be used for sutures that are not tied around the Attachable Button System (ABS; Arthrex). During graft preparation, 2 to 4 trailing sutures should be placed on the tibial (trailing) side of the graft. Our technique is shown in the Video 1. A summary of our technique is given in Table 1.

Fig 4. Once the sutures are passed, the inserter can be unthreaded from the button to facilitate pretensioning and graft passage.

Fig 5. Quadriceps autograft prepved with a cortical button for backup fixation.

Fig 6. The button is threaded back onto the inserter after graft passage and primary fixation.

Supplies
The following supplies are recommended: one #2 FiberLoop or FiberWire (Arthrex), one #2 TigerLoop or TigerWire (Arthrex), one 3.2-mm drill pin (Arthrex), and 1 BicepsButton (Arthrex). Alternatively, the drill pin and BicepsButton can be found in the BicepsButton kit (Arthrex) (Fig. 1).

Preparation
During graft preparation, use 2 different colored sutures (FiberLoop/FiberWire and TigerLoop/TigerWire) and place Krackow stitches in the tibial (trailing) side of the graft, creating 4 trailing suture limbs. If using FiberLoop, ensure that the bulky suture is cut from the...
suture tails to facilitate passage through the button. For added efficiency, we recommend placing the button during graft preparation. Thread 1 limb of each suture through 1 side of the BicepsButton and back through the opposite side. Thread the other limb through the button in the same manner, starting on the opposite side (Figs. 2 and 3). Unscrew the BicepsButton inserter and tension the graft (Fig. 4). The BicepsButton can remain in place during graft passage, tensioning, and fixation (Fig. 5).

**Drilling**

After the graft has been passed and tensioned and primary fixation has been performed, thread the BicepsButton inserter onto the button (Fig. 6). Using a 3.2-mm drill pin, drill a 3.2-mm unicortical hole 2 to 3 cm below the inferior aperture of the tibial tunnel (Fig. 7). Ensure that the hole is drilled Centered on the medial face of the tibia (between the tubercle and posteromedial cortex) to ensure that the button will flip.

**Insertion**

Maintain tension on the sutures and insert the button through the cortex (Fig. 9). If the button does not easily pass through the cortex, avoid twisting it, as the tip may...
break off of the inserter. Instead, lightly tap the inserter. Unthread the inserter but leave the inserter within the hole. Pull on the free suture limbs to seat the button against the tibia. Remove the inserter from the hole and pull the sutures to ensure that the button is positioned properly.

**Tensioning and Knot Tying**

Tension each suture limb pair by hand. Once they are tensioned, tie a knot with opposing suture limbs (Fig. 10). One knot using the 4 limbs is recommended. Postoperative x-rays are shown in Fig. 11.

**Discussion**

We describe ACL subcortical backup fixation with a unicortical button. As the surgical technique is identical to that used in tenodesis procedures of the long head of the biceps tendon, it may be readily reproducible for surgeons who are familiar with that use. Advantages and disadvantages are summarized in Table 2. Advantages over using a 4.75-mm biocomposite anchor include the smaller size of the unicortical hole (3.2 vs. 4.0 mm), which theoretically creates a smaller stress riser within the tibia; no reliance on the bone—screw interface for fixation; and decreased cost of the implant. Whereas the biocomposite anchor (SwiveLock) predictably fails at the bone—screw interface, the button technique has been shown to fail most commonly at the suture—tendon interface.7

Compared with a post-and-washer construct, which is partially subcutaneous, the subcortical button alleviates the concern for hardware prominence. Additionally, this method may be used in other surgeries that require tibial-sided fixation, such as meniscal root repair.

A disadvantage of the unicortical button is the comparative difficulty of hardware removal when

| Category                  | Advantages                                      | Disadvantages                                                                 |
|---------------------------|-------------------------------------------------|-------------------------------------------------------------------------------|
| Size of hole              | 3.2 mm                                          | Smaller than 4.0-mm hole for SwiveLock and 4.5-mm hole for 6.5-mm bicortical post; larger than 2.5-mm hole for 4.5-mm bicortical post |
| Type of fixation          | Unicortical button                              | No reliance on friction in the bone—screw interface versus SwiveLock         |
| Strength of fixation      | Undergoing biomechanical testing                | Minimal displacement and excellent strength in proximal subpectoral biceps tenodesis; unknown biomechanical strength in anterior cruciate ligament (ACL) backup fixation |
| Number of suture strands  | Four #2 FiberWire strands (2 pairs)             | Supports ≤4 strands of #2 FiberWire recommended in most ACL reconstruction techniques; bicortical post and SwiveLock support >4 strands (if needed) |
| Hardware prominence       | Minimal, size of knot                           | Smaller hardware prominence compared with bicortical post and washer; more prominent than SwiveLock because of overlying knot |
needed, such as in the case of postoperative infection, given the intramedullary placement of the device. A theoretical concern is migration of the knot stack, which directly overlies the tunnel, and may serve as a point of failure. Pearls and pitfalls are summarized in Table 3.

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