A GUIDE TO MASTERING THE GRAFTMAX™ BUTTON ADJUSTABLE CORTICAL FIXATION DEVICE

An examination of surgical learnings during the first 6 months of clinical usage

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Several fixation systems have been designed for femoral side fixation in anterior cruciate ligament (ACL) reconstruction. Although most of them accomplish the required mechanical requirements, they also present some limitations that may place the procedure at risk in some situations:

- Short grafts
- Short tunnels
- Cortical fracture
- Uneven graft distribution between femoral and tibial tunnels
- Excessive removal of bone due to long fixed loops for cortical fixation
- Damage to the graft
- Potential enlargement of the tunnel as a result of the interference screw

The currently available femoral adjustable-loop fixation systems provide a solution to these flaws by providing:

- Only one size
- Complete graft fill of the femoral tunnel
- Ability to customize the graft distribution between femoral and tibial tunnels

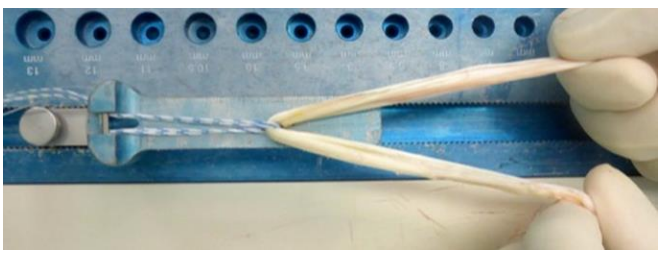
However, biomechanical testing has shown that under cyclic loading these adjustable-loop fixation systems might lengthen even under usual loads, before the biological fixation is accomplished.[1-3]

Biomechanical comparison of the GraftMax ™ Button to other adjustable-loop fixation systems shows that the GraftMax provides graft fixation equivalent to fixed loop devices.[4] The fact that GraftMax joins together the aforementioned advantages of an adjustable system and the mechanical reliability of a fixed system makes it an optimal femoral fixation system.

While the GraftMax Button shares the advantages of the adjustable-loop fixation systems, it also offers:

- *Comparable graft fixation to fixed-loop fixation systems*
- *User-friendly technique*
- *Short learning curve*

Figure 1



GraftMax Button Technique Tips and Tricks

Loading and Preparing the GraftMax Button

The soft tissue graft is folded onto the adjustable loop (Figure 1). A triple or quadruple soft-tissue graft can also be used (Figure 2a-d). The loop is lengthened to 15 cm (Figure 3). Lengthening the loop provides two benefits: enough suture tail length to easily retrieve the suture tails from the lateral aspect of the thigh, and prevents graft from entering the tibial tunnel when advancing the button, providing less resistance from graft in tunnel during button deployment.

A single mark is made on the graft. As a 25mm tunnel is drilled for the femoral side (see later), a mark at 22mm may better correspond to the amount of graft which will fill the socket after the button locks (Figure 4).

Figure 2a-d

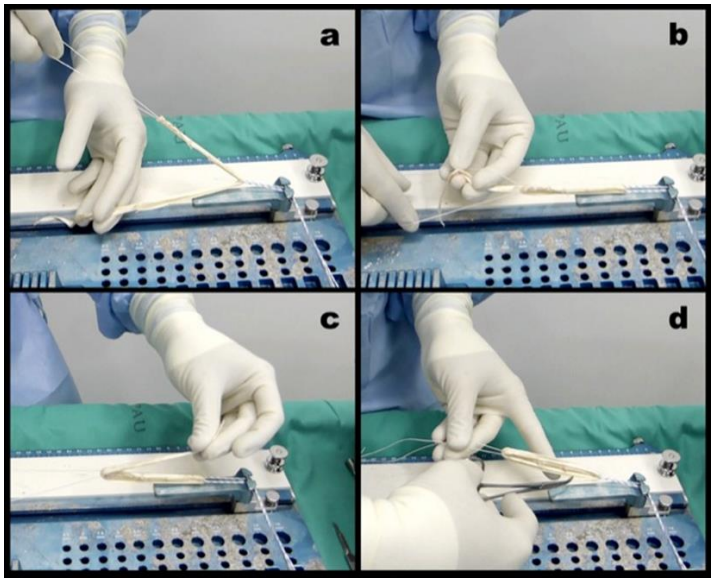


Figure 3

Figure 4

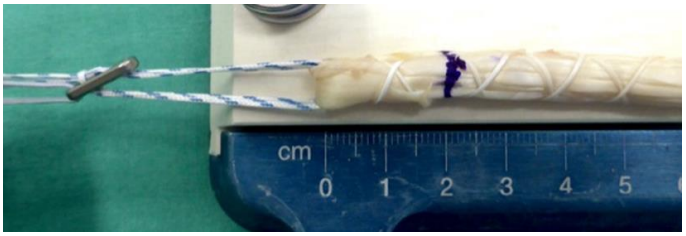


Figure 5

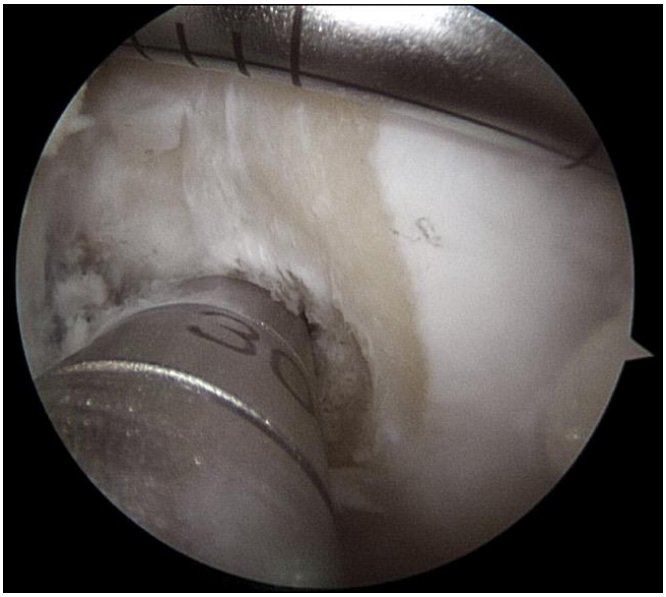


Figure 6

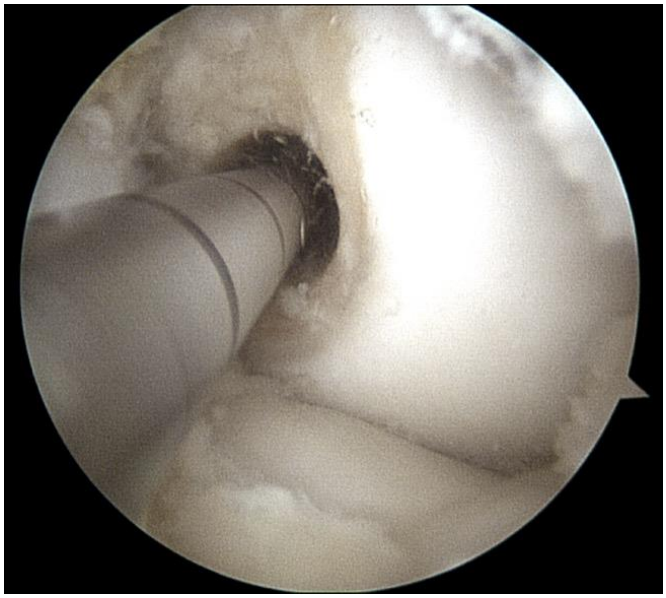


Figure 7a-c

Preparing the Femoral Tunnel

The desired position for the femoral tunnel is selected using the surgeon's preferred method. First, the reamer that matches the graft diameter is selected, and used to ream the femoral socket over the 2.4mm guide pin. A depth of 25mm is appropriate in most cases (Figure 5). Finally, a 5mm reamer is used to complete the femoral tunnel (Figure 6). A passing suture is left in place to later advance the suture tails of the GraftMax Button.

> **TIP**: When preparing the cortex with the 5mm channel reamer, care is taken to avoid excessive penetration into the femoral fascia. This will decrease the risk of advancing the GraftMax Button into soft tissue.

Advancing the Button

A passing suture is pulled from the lateral aspect of the thigh while keeping the button from entering the tibial tunnel. The solid blue sutures are the lead sutures and the white/blue striped suture tails are the adjustable loop sutures of the GraftMax Button.

At this point in the procedure, the scope is placed into the anteromedial portal to visualize the safe advancement of the button through the femoral tunnel. The button is advanced under direct visualization by pulling the blue lead sutures, and simultaneously keeping slack out of the white/blue adjustable suture tails. Once the button is introduced into the femoral tunnel (Figure 7a), the scope is gently placed at the intra-articular entry of the femoral tunnel (Figure 7b). The blue string is released once the button passes through the femoral cortex (Figure 7c). The device is designed to easily flip by simply placing tension on the graft. Alternatively, the button includes a toggle eyelet which allows the addition of a suture to facilitate deploying the button. However, this is seldom needed as flipping is easily obtained with the standard technique.

> **TIP**: Direct visualization of the button advancement through the femoral tunnel is important to prevent the button from entering the fascia. If the button enters the fascia, it can require a lateral incision 2cm in length to safely seat the button onto the cortex (Figure 8).

Figure 8

Advancing the Graft

Tensioning both white/blue striped sutures begins to shorten the adjustable loop and consequently, introduce the graft into the tunnel. To prevent excessive lifting of the button off the femoral cortex, the thumb of the opposite hand can be used to apply pressure to the lateral aspect of the thigh in line with the trajectory of the device while tensioning the adjustable loop sutures (Figure 9). If a tight press-fit of the graft within the tunnel is preferred, a suture handle is available to place significant tension on the suture tails, while avoiding any risk of injury to the gloves or hands (Figure 10a). Alternatively, a rolled compress or a Kocher clamp can be used (Figure 10b,c).

Tensioning of the adjustable suture tails stops once the entire femoral socket (i.e. 25mm) has been filled with the graft. The graft is tensioned to lock the button. The mark indicating 22mm of graft fill will disappear into the femoral tunnel initially. After tensioning the graft and locking the button the mark will reappear at the entry point of the femoral tunnel. This 2-3mm of movement of the graft confirms that the button has locked (Figure 11).

TIP: Tensioning of the adjustable suture tails followed by tensioning of the graft can be repeated two or three times to allow for additional loop shortening, and consequently greater graft fill of the socket.

TIP: In the case of a short graft, you can easily control the distribution of graft between the femoral and tibial tunnels. In this case, you can opt to leave a shorter amount of graft in the femoral socket in order to have more graft inside the tibial tunnel.

The ability to fill nearly the entire femoral socket with graft (Figure 12a), provides a versatile solution in the scenario of a short femoral tunnel. This provides a substantial advantage in comparison to fixed-loop fixation devices (Figure 12b).

Figure 9

Figure 10a-c

Figure 11

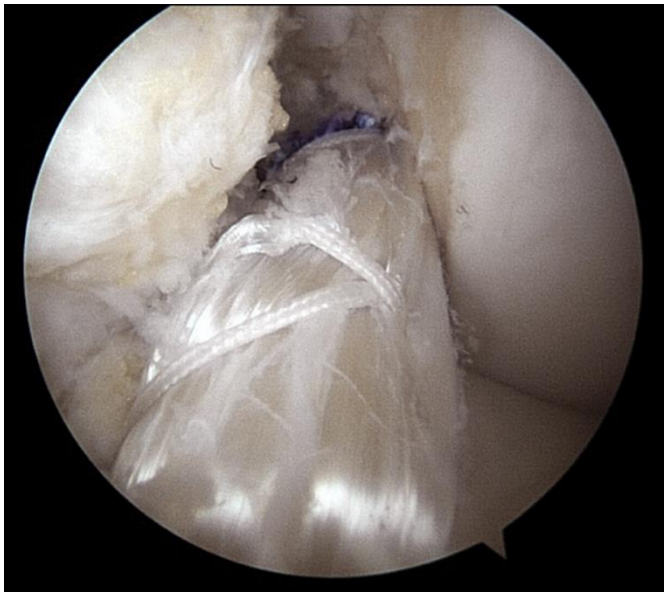
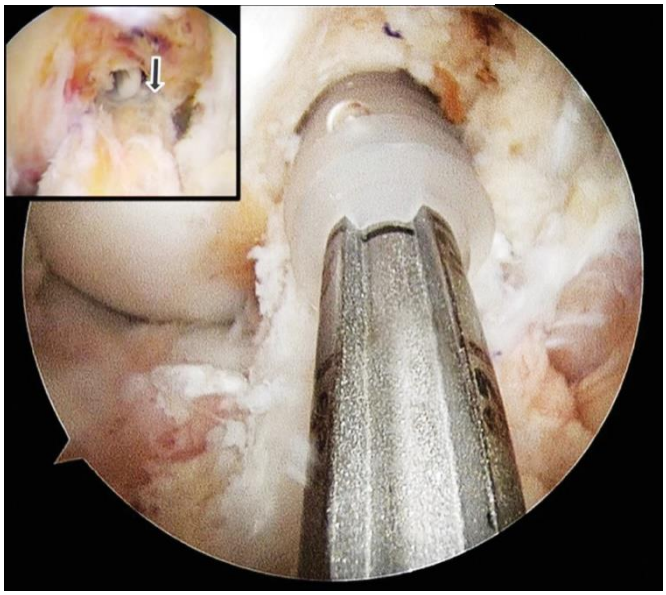


Figure 12a-c

Figure 13



Tibial fixation

Tibial fixation is accomplished with the usual technique between 0º and 20º of knee flexion. A 1mm oversized screw is placed in the anterolateral aspect of the tibial tunnel to minimize the risk of graft impingement with the medial aspect of the lateral femoral condyle.

The GraftMax Button with a Bone-Tendon-Bone Graft

When using a bone-quadriceps tendon graft, a bone-patellar tendon-bone graft or other graft with a bone block, the GraftMax Button provides a user-friendly and reliable fixation system with advantages over the commonly used interference screw:

- 360º of bone-to-bone interface
- Avoid the risk of tendon injury caused by sharp screw threads
- The graft remains centered within the tunnel. Conversely, an interference screw compresses the graft to one side of the tunnel (Figure 13). Thus, GraftMax provides a more accurate method of anatomic graft placement for bone blocks.
- Easier ACL revision.
  - No hardware removal is needed
  - Less tunnel defect if an inert or a slow-rate-of-resorption screw has been used

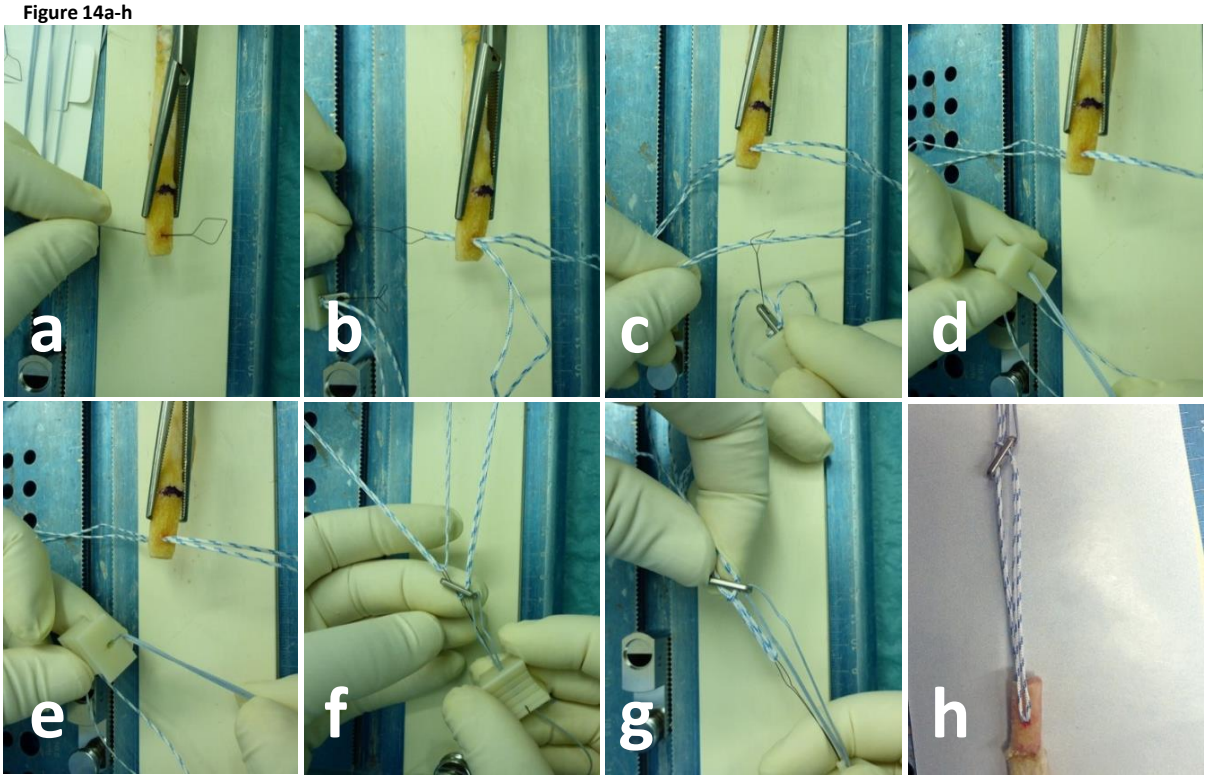
GraftMax BTB Tips and Tricks

Prepare the graft with the standard technique. The GraftMax BTB comes specially prepared to easily thread the white/blue adjustable loop sutures through the drilled bone plug.

First, use the provided nitinol loop to simply pass the striped adjustable loop sutures through the bone plug (Figure 14a,b). The same ends of the striped adjustable loop sutures are now threaded through the threader loop attached to the threader block (Figure 14c). Unlock the blue suture from the threader block (Figure 14d,e). Release the button from the threader block and pass it over the threader loop until the striped adjustable loop sutures pass through the button (Figure 14f,g). This allows for the creation of the adjustable loop suture with the bone block inplace (Figure 14H).

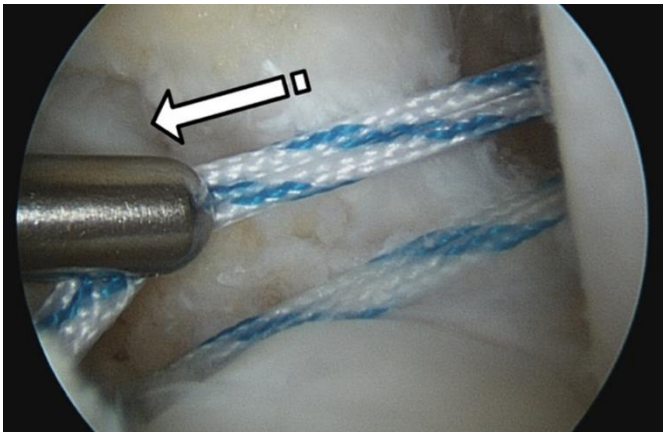
The technique for button prep, placement and graft fixation does not differ from that explained for soft-tissue grafts.

Figure 14a-h



TIP: In some cases, the bone plug may get lodged in the tibial tunnel. Utilize a grasper through the AM portal to lengthen the striped adjustable loop suture and retrieve the bone plug from the tibial tunnel (Figure 15). Without the need to remove the button, the bone plug can be re-shaped or the tunnel can be expanded with a dilator. This method can also be used for soft tissue grafts, although required less frequently.

Figure 15



TIP: If the striped adjustable loop is no longer visible intra-articularly, the adjustable loop may be lengthened with the use of an un-locking suture. This extra suture may be added to the button which allows the locking loop to be un-locked and the adjustable loop to be lengthened.

References

1. Barrow AE, Pilia M, Guda T, Kadrmas WR, Burns TC. Femoral suspension devices for anterior cruciate ligament reconstruction. Do adjustable loops lengthen? *Am J Sport Med* 2014;42:343-349.
2. Johnson JS, Smith SD, LaPrade CM, Turnbull TL, LaPrade RF, Wijdicks CA. A biomechanical comparison of femoral cortical suspension devices for soft tissue anterior cruciate ligament reconstruction under high loads. *Am J Sport Med* 2015;43:154-160.
3. Petre BM, Smith SD, Jansson KS, de Meijer PP, Hackett TR, LaPrade RF, Wijdicks CA. Femoral cortical suspension devices for soft tissue anterior cruciate ligament reconstruction. A comparative biomechanical study. *Am J Sport Med* 2012;41:416-422.
4. Data on file – TR14-464, 12/12/14.