Suture V Technique: A Method for Supplementing Soft-Tissue Interference Fixation of Anterior Cruciate Ligament Grafts

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The Suture V technique, a modification of traditional bioabsorbable interference screw fixation methods, is used for attaching a soft-tissue anterior cruciate ligament graft in the tibia. This technique adds trivial length to the tibial skin incision and the overall time of the surgical case, and may provide valuable reinforcement to the tibial tunnel fixation.

The ideal method for attaching a soft-tissue anterior cruciate ligament (ACL) graft in the tibial tunnel should meet the following criteria. Foremost, the fixation should be strong enough to withstand the expected forces on the graft until healing takes place. Removal of the hardware, likewise, should not be difficult and the fixation should not cause symptoms or interfere with radiography postoperatively. It also is helpful if the graft is secured as close to the joint line as possible. And lastly, the technique should be easy.

The Suture V technique meets all of these standards. This method consists of standard interference fixation using a bioabsorbable screw placed near the joint line, supplemented by tying the graft sutures under a bone bridge at the entrance of the tunnel distally. This fixation is termed the "Suture V" technique, as the sutures from the graft form an inverted capital "V" on the anterior tibia.

TECHNIQUE

Two strong sutures are woven through the distal part of the soft-tissue ligament graft. After it is secured in the femoral tunnel and the absence of impingement in the notch is confirmed, the graft is fixed in the tibial tunnel under the appropriate tension with a bioabsorbable interference screw. This screw is advanced in the tibial tunnel, until it rests near the articular surface. Range of motion and graft tension are checked.

Once the interference fixation and graft placement is deemed satisfactory, a CurvTek drill (Arthrotek, Warsaw, Ind) is used to create a suture tunnel with a short bone bridge 2 cm beyond the exit of the graft (Figure 1). A special free needle, which matches the curvature of the drilled tunnel, is then

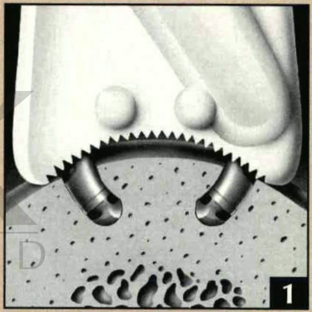

Figure 1: Schematic of the CurvTek drill (Arthotek, Warsaw, Ind) creating a subcortical bone tunnel. The drill has flexible bits that advance out of the cartridge as the tunnel is made. (Drawing courtesy of Arthrotek, Warsaw, Ind.)

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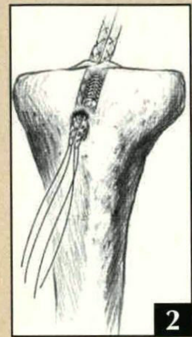

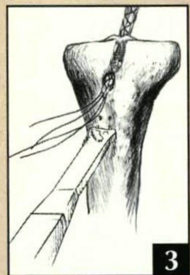

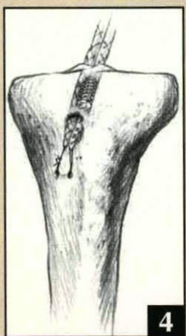

Figure 2: The-soft tissue graft is secured within the tibial tunnel, using an absorbable interference screw placed near the joint line. The sutures woven through the graft are used to generate tension when securing the interference screw. These are then retained for supplemental fixation under the bone bridge. **Figure 3:** A small horizontal suture tunnel is created using a CurvTek drill (Arthrotek, Warsaw, Ind). This suture tunnel is placed just distal to the entrance to the main tibial tunnel. **Figure 4:** The sutures woven through the graft are passed through the horizontal suture tunnel and are tied over the tibial cortex.

Take Home "Pearl"...

Two strong sutures are woven through the distal part of the soft-tissue ligament graft. The graft is fixed in the tibia under the appropriate tension with a bioabsorable screw. A suture tunnel with a short bone bridge is created and a free needle passes the suture through this tunnel under the bridge. The sutures are tied under the bone bridge, forming an inverted capital "V" on the anterior tibia.

used to pass one arm of each graft suture through the tunnel under the bridge. With the graft held under tension by the interference screw, these sutures are tied in situ over the bone bridge (Figures 2-4). The 2-cm distance from the graft tunnel is arbitrary, but it must be sufficiently far from the tunnel such that no laxity is present on the sutures when tied under this bridge.

DISCUSSION

Bioabsorbable interference screw fixation provides secure attachment of a soft-tissue graft within the bone and does not produce symptoms or impediments to imaging postoperatively. It is therefore an effective and popular technique for securing the graft during ACL reconstruction. However, the method has some limitations. The Suture V technique is devised to compensate for these limitations, without producing problems of its own.

The most important feature of any graft fixation is that it should be strong enough to withstand the expected forces on the graft until healing occurs.[1] This is the sine qua non of any valid fixation method. Studies have shown that the pull-out strength of soft-tissue interference fixation, although believed to be adequate to the clinical demands,[2] is nevertheless lower than the strength of similar fixation with bone plugs.[3,4] This concern may be even more germane to bioabsorbable screws because the biological digestion of the screw may be associated with enough loss of volume to cause graft slippage. It was noted in studies that the screw is absorbed before the space is replaced with bone.[5] Supplementation of the fixation, even as "insurance," may therefore be desirable.

Many surgeons believe graft fixation should be as close to the joint line as possible, so-called "aperture fixation." This location is favored for two theoretical reasons. The first is to minimize motion of the graft at the entrance to the tunnel.[6] If the graft is secured distally, it may oscillate near the joint line, and this motion may inhibit biological incorporation. Motion also could potentially widen the tunnel and abrade the graft itself.

The second reason aperture fixation

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is desirable is that it effectively shortens the graft. A short graft, in turn, is desirable because for a given stiffness, a short graft elongates less when stressed. Stiffness refers to a percentage elongation. Thus, a 30-cm tendon, which elongates 10% for a given load, will stretch 3 mm, whereas 60 cm of the identical material will stretch 6 mm. Of course, it is the net excursion and not the percentage elongation that may compromise the clinical outcome. The length of graft subject to stretching spans from the femoral attachment to the tibial attachment. If this tibial attachment is at the joint line rather than the distal cortex, the length of the graft exposed to elongation may be cut by as much as 50%. Accordingly, the graft is effectively stiffened by aperture fixation—by exposing a shorter segment to deforming forces.

Aperture fixation also limits the effect of suture laxity[7] within the graft itself as a source of ultimate graft laxity.

Aperture fixation has its costs. Without the reinforcement offered by the Suture V technique, aperture fixation may be a weaker construct over time than one achieved with more distal placement of the screw. That is because aperture placement, by definition, uses interference fixation within trabecular bone, rather than within the maximally dense cortical bone. For that reason, a secondary restraint may be preferred.

Given the inherent limitation of aperture fixation, it is reasonable to supplement it with external hardware. This is an established method in orthopedics, and tying the graft sutures over a post or under a staple is easy, as the location of such hardware is subcutaneous and exposed effortlessly. The facile exposure of the tibial crest is a liability as well: easily placed hardware also is easily palpable hardware and may be a source of irritation. Irritation can be minimized by countersinking the hardware, but that may weaken the anterior cortex and bicortical fixation (ie, drilling through the posterior tibial cortex) may be needed. Such drilling places the neurovascular bundle at risk.

Bellemans et al[8] proposed supplementing the screw fixation with a soft-tissue staple on the anterior cortex. (Technically speaking, they proposed the opposite, namely, supplementing staple fixation with an interference screw: in their method the graft tension is first established with the staple, and only thereafter is the interference screw inserted.) This staple approach brings with it the problems associated with hardware implantation, but also requires that at least 3 cm of graft material go to waste—the amount of graft that must protrude distally to be captured under the staple. In hamstring grafts, this wasted length may be critical, as it represents a net 6 cm of tendon, given that the graft is folded on itself.

LIMITATIONS

Disadvantages of the Suture V technique must be considered. A slightly longer incision is needed. The total added length typically is trivial, no more than compared to post-fixation. The CurvTek drill bit and free needle are an added cost. These costs can be eliminated (perhaps at the expense of less precision) by drilling standard holes in the cortex and creating the tunnel with towel clip. Additional time is needed to perform the suture attachment but this is not a great amount—comparable or less than the time required to drill and insert a post and tie the sutures over it. The Suture V technique avoids using this post and the potential bursitis it may cause; however, the possibility of soft-tissue irritation from the suture knot itself remains. However, with this technique the two pairs of sutures can be tied separately—and their knots seated apart—thus minimizing the overall height.

CONCLUSION

Traditional means of soft-tissue interference screw fixation for ACL reconstruction is a reliable process. Nevertheless, some potential problems can be identified. It would be unfortunate to compromise the results of an otherwise excellent reconstruction with graft slippage in the tibial tunnel, fixation failure due to screw reabsorption, or hardware induced bursitis. The Suture V technique may help avoid these complications. The advantages imputed to the Suture V technique are to date only theoretical. However, because the biological costs to the patient and technical costs to the surgeon are trivial, it deserves empirical use when the surgeon identifies the need.

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