

Editorial Commentary: Anterior Cruciate Ligament Graft Reinforcement: A New Era Supported by Science



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Abstract: The use of suture tape for soft tissue reinforcement during anterior cruciate ligament surgery is amassing science from translational models to bench biomechanical studies and now clinical outcomes. Suture tape reinforcement is not a synthetic ligament replacement. The primary goal of adding suture tape is for anterior cruciate ligament graft protection during the healing and remodeling phase, especially in young, active patients, to minimize the risk of graft retears. Accepting new techniques requires critical review of available science, as well as an inherent belief that there always is a better way. New technology supported by foundational scientific evidence and focused medical education is essential for successful clinical outcomes.

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We are in a new era of reinforcing repairs and reconstructions with suture tape. Suture tape is not classified as a synthetic ligament; its primary purpose is to stabilize ligament tissue during healing and remodeling, and perhaps even minimize the risk of re-tear. As an orthopaedic community, we have seen this evolution firsthand. For some of us, we have historical knowledge that warrants a heightened sense of skepticism, as I discussed in a recent podcast.¹

I read with great interest the article published in this issue, "Suture Augmented Versus Standard Anterior Cruciate Ligament Reconstruction: A Matched Comparative Analysis" by Bodendorfer, Michaelson, Tout Shou, Apseloff, Spratt, Nolton, and Argintar.² In their retrospective study, they show that anterior cruciate ligament (ACL) reconstruction using hamstring auto- or allograft with additional suture tape augmentation has several benefits compared with ACL reconstruction without suture augmentation: specifically,

improved Western Ontario and McMaster Universities Osteoarthritis Index and International Knee Documentation Committee score changes, less pain, and earlier return to preinjury activity level. I was very impressed by their study design, wherein they matched their groups, blindly reviewed the subjective outcomes score, and also blinded the physical therapists to the treatment groups. I commend the authors for this methodology.

In both groups, the authors reported 2 of 30 ACL reinjuries requiring revision (6.7%). It is important to note that they excluded study patients under the age of 18 years, which is well known to be the high-risk population in regard to ACL reinjury.³ In other words, it is still unknown whether their impressive return to activity data and low retear rate will translate to a younger age population undergoing ACL reconstruction.

The authors also describe their technique of placing the suture tape (FiberTape; Arthrex, Naples, FL) through the loop of an adjustable loop device (Tight-Rope; Arthrex). Furthermore, they fix the suture tape at 30° of knee flexion. This brings up the important topic of the technique for ACL reconstruction with suture tape reinforcement that I hope to further clarify in this editorial commentary.

There is one small, yet very significant, difference between the technique of Bodendorfer et al. (augmentation)² and a technique that my colleagues and I have

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described previously in *Arthroscopy* (reinforcement).⁴ Their technique places the suture tape through the adjustable loop of the femoral fixation device with the graft, whereas the technique we have described places the suture tape through the titanium button and allows the tape to run alongside the graft (Fig 1).

Having the suture tape run through the titanium button provides for some additional advantages, such as independent loading of the tape and graft, higher failure load of the entire construct resulting from loading on a metal button versus suture loops, and ability to secure the button directly to the lateral femoral cortex after flipping because of suture tape countertension. The primary reason for the discrepancy in the technique from Bodendorfer et al.² compared with Bachmaier et al.⁴ is the timing of this evolving technique.

It is clear that this study provides a key piece of the scientific pyramid that we aim to build surrounding the concept of suture tape reinforcement for ACL reconstruction. The authors have provided clinical evidence of earlier return to activity along with a higher percentage of return to preinjury activity level and better patient-reported outcomes. These data could suggest that suture tape plays an important role on protecting ACL graft tissue and thereby facilitating biologic graft revascularization and remodeling.

The benefit of suture tape comes from the lessons learned in rotator cuff surgery, where a bridged repair is able to stabilize the reapproximated tissue during the early rehabilitation phase.^{5,6} The concept of internal bracing (Arthrex) was first introduced to a traditional standard-of-care procedure for lateral ankle instability, the anterior talofibular ligament Broström repair, with a long-term follow-up study reporting that 42% of patients were unable to return to their preinjury sport level.⁷ It was quite remarkable that such a simple concept, adding suture tape to act as an internal brace to this procedure, disrupted the orthopaedic community with clinical evidence of its efficacy.⁸ Early on, there was a great deal of skepticism that such a complex problem could be solved by such a simple solution. This concept required a significant investment in biomechanical science,⁹ in addition to clinical outcomes, to address these concerns, and also to identify the mechanism by which the internal brace functioned in relation to the repaired tissue.

I have performed >250 ACL reconstructions with suture tape reinforcement in the last 2.5 years, passing the InternalBrace (Arthrex) independently through the femoral side cortical button; this came after much scrutiny over the available biomechanical and preclinical science. During the early adoption of this

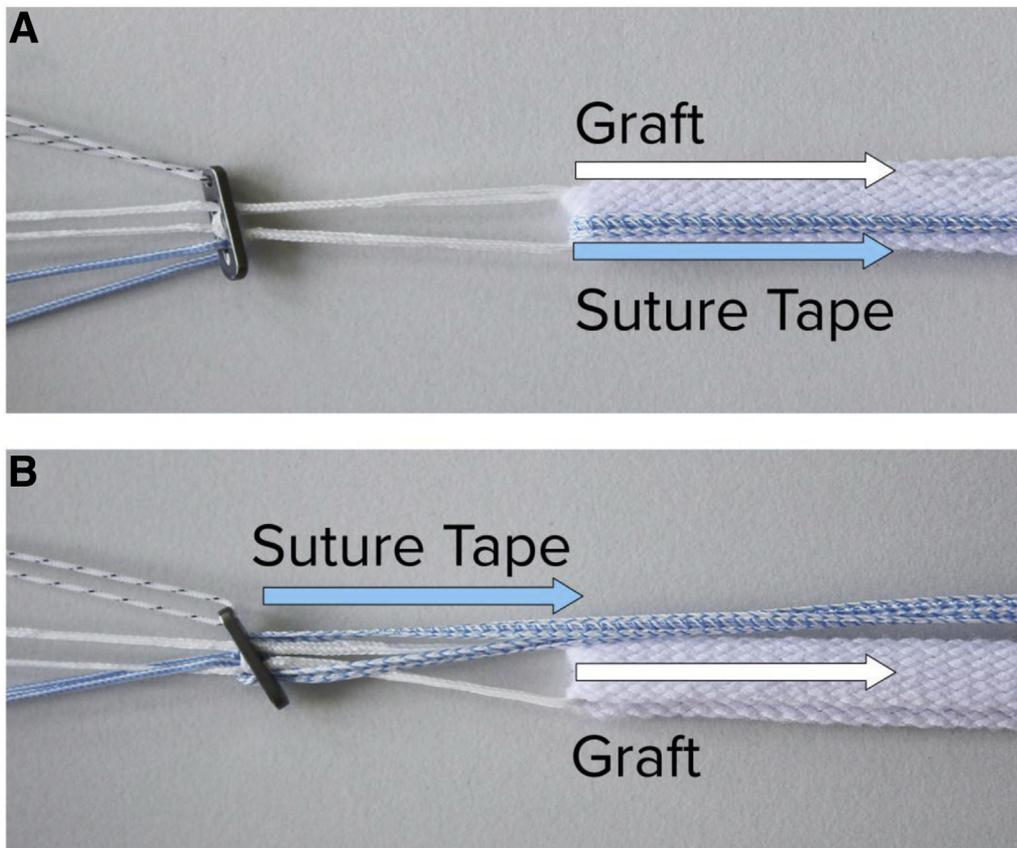


Fig 1. From Bachmaier et al.,⁴ showing the technique difference between the suture tape passing through the loop of the cortical fixation device (augmentation; A) and through the metal button (reinforcement; B).

Table 1. Critical Questions and Available Science Surrounding Internal Bracing for Anterior Cruciate Ligament (ACL) Graft Constructs

1. Are there biomechanical benefits to adding suture tape to an ACL graft construct?
 - Up to 50% decrease in dynamic elongation for 8-mm grafts and even 26% improvement for standard 9-mm grafts⁴
2. Are there biological benefits to augmenting an ACL graft construct with suture tape?
 - Construct allowed for normal 4-zone graft-to-bone integration and functional graft remodeling while avoiding historical problems noted with use of synthetic grafts¹⁰
3. Are there any negative effects with adding suture tape within the knee joint?
 - Intra-articular use of intact or frayed suture tape is safe. No severe inflammatory or immune responses, bony erosions, or premature osteoarthritis development were noted during the 6-month study period, even in a “worst-case” transected tape scenario.¹¹
4. Is there a potential to stress-shield the ACL graft with the addition of a suture tape?
 - The synergistic load-sharing configuration bypasses any stress-shielding effects and allows for continuous loading of the ACL graft.⁴
 - The suture tape is fixed at full extension to ensure that the graft is the primary stabilizer throughout the entire range of motion.⁴
 - Importantly, as a result of the normal behavior of the ACL loosening by 3 mm at 90° flexion, the suture tape is always lax in flexion to further avoid any stress shielding.⁴
5. Is there clinical proof that adding suture tape to an ACL graft is efficacious?
 - Improved patient-reported outcome measures based on recent publication²; specifically, less pain, and improved return to preinjury activity levels without overconstraint
6. Is there a biomechanical advantage to placing the suture tape through the button as opposed to the suspensory fixation device loop?
 - Biomechanical evidence shows that the suture tape through the button (reinforcement) provides independent loading of graft and tape, while transferring loads to the cortex, as opposed to the loop where the graft resides.⁴
 - Furthermore, adding suture tape through the adjustable loop button allows for independent tensioning of the suture tape and the graft (seat belt effect).⁴
 - This concept allows for independent retensioning of the ACL graft as the primary stabilizer for the final step of the operative procedure.
7. Does the order of fixation with suture tape and the graft make a difference?
 - I recommend fixation of the suture tape first in full extension followed by the graft next in full extension. Fixing the tape first ensures that the graft always sees load last, further enhanced by use of retensioning possible with adjustable loop suspensory graft fixation.
8. Does the anatomic location of the suture tape in relation to the ACL graft matter?
 - I currently recommend independent and posterior to the graft as the ideal location based on isometry data,¹² although future studies specific to this technique are needed to support this theory.
9. Is there an ACL graft or patient cohort that benefits more from this reinforcement?
 - This is an open question currently being studied, although grafts that have been shown to have a higher failure rate such as allografts in young patients could see the greatest benefit of suture tape reinforcement during the early healing and remodeling stages.
 - Suture tape reinforcement is adaptable for all grafts, so it can be used for hamstring, quadriceps tendon, and patellar tendon bone-tendon-bone autografts, as well as allografts.
10. Does the addition of independent suture tape reinforcement of ACL grafts reduce retear rates?
 - This open question will require defined eligibility criteria, consistent surgical techniques, and a large patient cohort to prove this theory.^o

technique, there were key questions that required answers and, as is clear in the Table 1, additional questions have arisen since.

A patient spends a considerable amount of time, physically and emotionally, preparing for ACL surgery, going through arduous postoperative rehabilitation, and returning to their preinjury activities. A graft retear is devastating on multiple fronts; additionally, clinical outcomes report that their results with revision reconstruction would be worse.¹³ Advanced techniques supported by scientific rigor are what our patients deserve, and this is the only way forward. Time will tell if we are at the brink of a new standard for ACL reconstruction, but the available science is promising.

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