Level V Evidence With Video Illustrations

Bridging Self-Reinforcing Double-Row Rotator Cuff Repair: We Really Are Doing Better

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Abstract: Single-row versus double-row repair of rotator cuff tears is currently a controversial topic. In this Level V article, we articulate why we believe that second-generation double-row repair techniques, which use bridging sutures to link the 2 rows of suture anchors together in a self-reinforcing manner, are producing superior clinical and biomechanical results.

Sometimes the truth is elusive. Sometimes the obvious is obscured by irrelevant or by poorly understood facts. Such is the case, in our opinion, in the failure to recognize the clear-cut superiority of bridging double-row footprint repair of the rotator cuff over single-row and first-generation double-row repair techniques.

The goals of rotator cuff repair are independent of repair technique. We must be mindful that to achieve a successful anatomic outcome, the tendon must stay "long enough" and "good enough," and ultimately, we expect that our patients will have reductions in pain and improvements in strength and function. Recognizing that compromised biology is uniformly present in the setting of rotator cuff pathology, current thinking related to technical advances in repair constructs aims to prevent early failure to heal or late retear of the tendon from bone. First- and second-generation repair techniques (Table 1) continue to fail at an alarming rate (in excess of 30% in most series referenced in this review) primarily because of sutures pulling through tendons or tendons failing to heal at the tendon-bone junction, with a healing zone that is no more substantive than fibrovascular scar. These findings are exacerbated as tears become larger with increasing chronicity. Thus overcoming challenging biology is the primary advantage that improved mechanical constructs such as the bridging self-reinforcing double-row footprint reconstruction provide.

What separates the contemporary state-of-the-art double-row repair from earlier-generation techniques are specific characteristics of this double-row footprint construct that includes bridging sutures between the medial and lateral rows. This construct is frequently referred to as a transosseous-equivalent repair,[1,2] or as a suture-bridge configuration. The early-generation double-row repair construct consisted of medial mattress sutures and lateral simple sutures without linkage between the 2 rows.[3] Although initial biomechanical testing showed that this technique had superior profiles compared with single-row suture anchor techniques,[4,5] it still fell short of what is required in vivo to support the rotational effects and forces generated by an intact rotator cuff muscle–tendon unit,[6] where research indicates that these forces are distributed

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TABLE 1. *Evolution of Rotator Cuff Techniques*

First generation: Single-row repair
Second generation: Unlinked double-row repair
Third generation: Linked bridging self-reinforcing double-row repair (suture bridge)

across the entire rotator cuff insertional anatomy (the "footprint").

Conversely, biomechanical testing has consistently shown the superiority of a linked double-row construct compared with both unlinked double-row and single-row constructs. Traditional mechanical testing focused initially on strength of the repair construct at time 0 (ultimate load to failure).[4,5,7] However, conventional testing now emphasizes resistance to shear and reductions in gap formation through repetitive specimen cycling. Comparative time 0 biomechanical testing emphasizing internal and external rotation during high loading conditions indicates that the linked double-row construct is superior in this regard and that it possesses self-reinforcing properties similar to the Chinese finger trap.[8] The self-reinforcing features of the linked suture bridge indicate that in vivo destructive forces can be neutralized and even harnessed to make the construct stronger under load (Table 2).

So why do we find ourselves in the awkward position of having to rationalize the use of a repair construct that is biomechanically superior to other constructs and that has been shown in several studies to improve tendon-to-bone healing?[9-11] As we often say, "the proof is in the pudding." Recently published clinical studies have attempted to compare these techniques, leading to summary judgments that "single-row" techniques offer the same anatomic and clinical outcomes as "double-row" techniques.[12,13] A critical examination of this literature yields an invalid conclusion that cannot be generalized to the self-reinforcing double-row rotator cuff repair technique.

The study by Franceschi et al.[12] used a double-row repair technique with medial mattress sutures and lateral simple sutures, a construct devoid of suture linkage or bridging between the 2 rows. This first-generation double-row suture anchor repair technique, as previously discussed, embodies an inferior mechanical profile compared with the contemporary double-row linked bridging technique. The authors reported the use of a mean of 1.9 suture anchors for single-row repairs and 2.3 suture anchors for double-row repairs. In general, one would expect that the double-row repairs would have had twice the number of suture anchors as the single-row repairs. However, in this study the mean number of suture anchors was nearly identical, and it becomes difficult to differentiate these as truly differing repair techniques. Because this is a Level I study, the authors should be commended for conducting it in a randomized and controlled fashion. However, it suffers from a fatal flaw and essentially prevents one from deriving a valid conclusion based on the results. Although the authors concede that a limitation to their study is that no formal power analysis was performed, reporting on 26 patients in each group provides a study that is clearly grossly underpowered when healing is the primary outcome variable.[14] Thus it becomes impossible—even in the best of procedure comparisons (i.e., a true first-generation double-row technique compared with a single-row repair technique)—to conclude that differences do not exist between these 2 populations of patients. The study offers little to our knowledge or ability to compare a single-row with a double-row technique and does not speak in any way to the merit of the self-reinforcing linked bridging-suture technique.

As for the study by Burks et al.,[13] the repair technique was not a bridging double-row construct or a true double-row technique as it was initially described, but rather, it was a "triangle" repair with 1 medial anchor and 2 lateral anchors. Mazzocca et al.[15] have previously tested this "triangle" configuration and found its strength to be equivalent to single-row repairs. So, it is no surprise that this older-generation non-bridging double-row repair construct was not superior to the single-row technique. Once again, these authors should be commended for conducting a Level I randomized controlled trial. However, similar to the study by Franceschi et al.,[12] the authors presented a grossly underpowered study,[14] whereby valid comparisons of these techniques cannot be made. In essence, the authors predicted a 20% retear rate yet only showed a 10% retear rate in both groups and thus committed a type II error, whereby 20 patients analyzed in each group cannot render a valid comparison of 2 surgical techniques. To summarize, although both of these studies are often quoted as providing substantive evidence that there are no differences between

TABLE 2. *Advantages of Linked Suture-Bridge Construct Over Earlier-Generation Constructs*

Higher load to failure
Self-reinforcing characteristics (stronger under load)
Better resistance to shear and rotational forces
Higher clinical healing rates

single-row and double-row techniques, they both suffer from an inability to make valid comparisons because they are grossly underpowered, in addition to using older-generation non-bridging repair constructs for their double-row repairs. Making the argument that differences do not exist between these repair techniques is no different than the historical argument that arthroscopic suture anchor repairs for instability should not be done because the earlier arthroscopic transglenoid instability repairs had very high failure rates.

Furthermore, multiple studies have shown that tendon-to-bone healing occurs in significantly greater numbers of patients who have had double-row cuff repairs than in those with single-row repairs.[9-11] In the systematic review of the existing literature performed by Duquin et al.,[11] which included more than 1,100 rotator cuff repairs, the authors demonstrated a statistically significant reduction in anatomic retear rates for true double-row repairs compared with single-row repairs for all tears greater than 1 cm in length. Although this study supports what some authors might believe to be a self-evident finding, considering the biomechanical comparisons of these techniques, this review does not separate or discuss the results of the self-reinforcing bridging-suture technique.

Recently, at the November 2009 Closed Meeting of the American Shoulder and Elbow Surgeons in New York, NY, Gartsman et al.[16] presented a Level I prospective randomized comparison using ultrasound evaluation of single-row repairs of isolated supraspinatus tendon tears compared with the suture-bridge transosseous repair technique, a self-reinforcing bridging-suture technique. The authors performed a power analysis and determined that for 80% power, assuming a 12% difference between groups with $P = .05$, 50 patients in each group would suffice. They used a suture-bridge technique with 2 suture anchors medially and 2 suture anchors laterally and showed that the single-row retear rate was 20% versus 6% for the transosseous-equivalent suture-bridge technique, a significant difference that confirmed the superiority of the suture-bridge technique. The limitations of this study include that it is not yet published and no functional outcomes were reported.

A consistent problem with existing literature is that aggregate scores (University of California, Los Angeles; American Shoulder and Elbow Surgeons; Constant) and outcomes do not separate out strength as a primary outcome variable. Arguably, comparisons of strength after different repair techniques might yield additional findings not yet considered by the current literature. We believe that the magnitude of improvement in external rotation and forward elevation strength after self-reinforcing suture-bridging double-row repair has been greater than that seen previously with single-row techniques. Most recently, Cole et al. have shown a statistically significant improvement in forward elevation strength as used to, in part, calculate the Constant score when comparisons were made between double-row and single-row repair techniques (unpublished data, January 2010).

Let us take this line of reasoning a bit further. We have long known that arthroscopic debridement and decompression for the treatment of rotator cuff tears lead to significant pain relief and improvement in postoperative University of California, Los Angeles scores even in the face of little or no gain in strength. But is that level of functional improvement the benchmark that we want for evaluating our rotator cuff tears? Surely not!

In our opinion, the great advantage of cuff repair over cuff debridement is the ability to improve strength, yet strength is not properly (or at all) weighted in our current scoring systems. In light of this, we are currently evaluating the relative importance of strength return to patients in the outcome after rotator cuff repair and are developing a new outcome tool that adequately addresses strength by quantifying postoperative gains in strength. This is the only way that we can assess the clinical improvement that is directly attributable to tendon healing with improved transmission of muscle forces to the joint.

So what is the self-reinforcing bridging rotator cuff repair technique? Arguably, it can be achieved in multiple ways. We use variations of bridging constructs tailored to the patient's tear pattern and tissue quality. Two totally knotless techniques are frequently used, one that uses a suture tape (FiberTape; Arthrex, Naples, FL) with 4 screw-in anchors (SwiveLock, Arthrex) and the other that uses a chain-link suture and screw-in anchors (FiberChain-SwiveLock system, Arthrex). Similarly, by tying knots medially and effectively neutralizing the forces that are transmitted laterally, a knotless device (PushLock Anchor, Arthrex) can effectively create the self-reinforcing suture-bridge technique with total rotator cuff tendon apposition. Furthermore, a "double-pulley" double-mattress suture tied with suture limbs from the 2 medial anchors can seal the medial footprint from the potentially deleterious effects of joint fluid[17,18] (Videos 1-3, available at www.arthroscopyjournal.org).

Unfortunately, the recent studies by Burks et al.[13] and Franceschi et al.[12] are being used by some clinicians to justify the use of less expensive and easier procedures that are inferior to self-reinforcing bridging-suture double-row techniques. The path of least resistance in orthopaedics is not always the best way. We should not apologize for using the strongest construct while others try to minimize its importance. On the contrary, we should celebrate its superiority and recognize its importance as a significant advancement in the treatment of rotator cuff tears.

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