Ultrasound and Clinical Evaluation of Soft-Tissue Versus Hardware Biceps Tenodesis: Is Hardware Tenodesis Worth the Cost?

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Abstract

This study assesses the failure rate of soft-tissue versus hardware fixation of biceps tenodesis by ultrasound to determine if the expense of a hardware tenodesis technique is warranted.

Seventy-two patients that underwent arthroscopic biceps tenodesis over a 3-year period were evaluated using postoperative ultrasonography and clinical examination. The tenodesis technique employed was either a soft-tissue technique with sutures or an interference screw technique using hardware based on surgeon preference.

Patient age was 57.9 years on average with ultrasound and clinical examination done at an average of 9.3 months postoperatively. Thirty-one patients had a hardware technique and 41 a soft-tissue technique. Overall, 67.7% of biceps tenodesis done with hardware were intact, compared with 75.6% for the soft-tissue technique by ultrasound (P = .46). Clinical evaluation indicated that 80.7% of hardware techniques and 78% of soft-tissue techniques were intact. Average material cost to the hospital for the hardware technique was $514.32, compared with $32.05 for the soft-tissue technique.

Biceps tenodesis success, as determined by clinical deformity and ultrasound, was not improved using hardware as compared to soft-tissue techniques. Soft-tissue techniques are equally efficacious and more cost effective than hardware techniques.

Biceps pathology, such as severe tendinosis, partial tearing, subluxation or superior labrum anterior and posterior (SLAP) lesions can cause shoulder pain. The nonoperative treatment options include activity modification, use of anti-inflammatory medications, physical therapy, and biceps sheath injections. Surgical options are debridement, SLAP repair, biceps tenotomy, and biceps tenodesis.

Several studies have demonstrated that biceps tenotomy is an acceptable treatment option for many patients with acceptable function results.[1-5] However, the cosmetic results are not always acceptable in certain societies and there is still some hesitation to perform tenodeses in younger individuals in order to potentially preserve peak strength and minimize fatigue.[3-5]

Based on the current clinical literature, it can be argued that tenotomy functions almost as well, if not as well, as tenodesis. Yet, tenodesis techniques continue to evolve into more complicated and expensive methods to achieve more rigid fixation. This complexity and expense may not be necessary based on the potentially marginal benefit of tenodesis. This study compares the integrity of rigid hardware-based tenodesis methods with soft-tissue tenodesis techniques. The hypothesis is that soft-tissue tenodeses fail less often or the same as hardware tenodeses thereby preserving the cosmetic appearance and function of the long head of the biceps at a fraction of the cost.

Materials and Methods

Seventy-two patients were retrospectively reviewed for more than 3 years. The study was designed prospectively, but it was felt that the type of tenodesis used should be dictated by the clinical scenario, and inclusion in the study was based on the documentation of an ultrasound 3 months or later postoperatively. All patients with a tenodesis had clinical documentation of the presence or absence of a deformity in their clinical charts. Outcomes were not used as the patients often had multiple other procedures including, most commonly, a rotator cuff repair, which would confound the results.

The choice of technique was based on the surgeon's preference, but in general, soft-tissue techniques were done if the rotator interval was intact. Hardware tenodeses included 28 patients with Biceptor PEEK tenodesis screw (Smith and Nephew Inc, Andover, Massachusetts) (**Figures 1A, 1B**), one with 1 metal anchor, and one with an AppianFx PEEK biceps tenodesis implant (KFx Medical, Carlsbad, California). Technique guides were followed for the use of the Biceptor and AppianFx implants and both implants were consistently placed in the supra pectoral region of the biceps groove. The sutures of the suture anchor were tied in cruciate fashion through the

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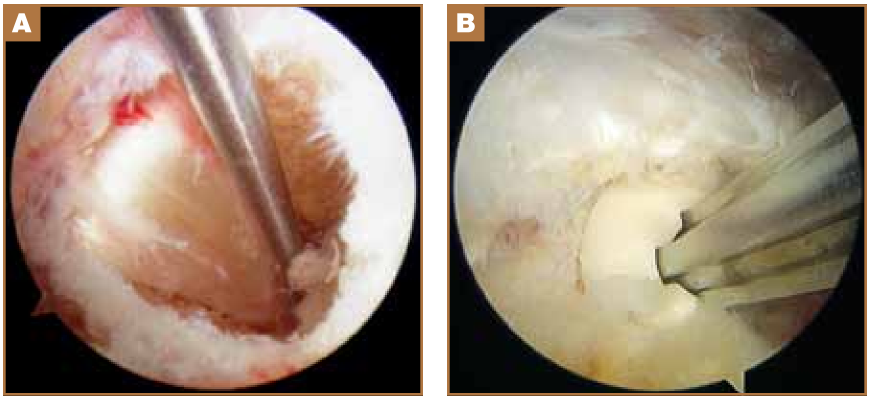

Figure 1. Biceptor interference screw. (A) Guide wire holding tendon in predrilled blind end tunnel. (B) Screw place over guidewire.

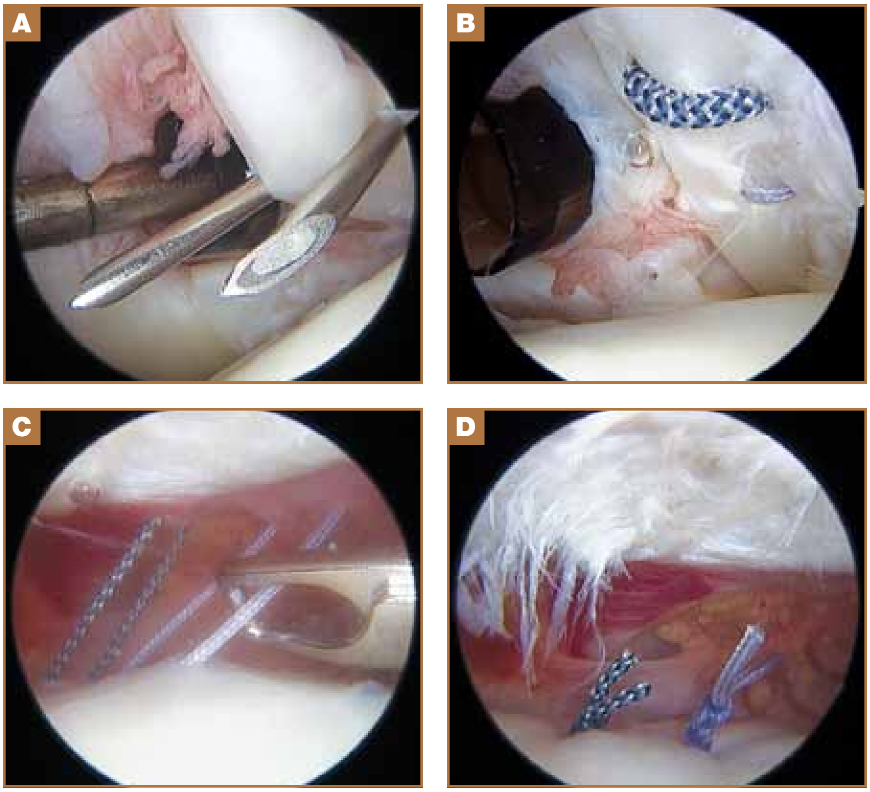

Figure 2. PITT technique. (A) Percutaneous capture of tendon with spinal needles. (B) Articular view after mattress sutures shuttled through. (C) Retrieval of sutures on the bursal side. (D) Completed tenodesis.

biceps tendon in the supra pectoral region of the biceps groove.

Soft-tissue tenodeses were done in 25 patients with the percutaneous intra-articular trans tendon technique (PITT) (**Figures 2A-2D**) or with an intra-articular mattress technique in 16 patients. The PITT technique used 2 spinal needles, two 0 polydiaxone sutures, and 2 No. 2 braided multifilament nonabsorbable sutures.[6] The spinal needles were used to pass two 0 polydiaxone sutures percutaneously through the biceps tendon. They were retrieved through the anterior portal and each was tied to the ends of 1 No. 2 braided multifilament nonabsorbable suture. The 0 polydiaxone suture was used to pull the 2 ends of 1 No. 2 braided multifilament nonabsorbable suture back through the joint and out the skin. This resulted in a mattress suture through the biceps and the rotator interval. This step was repeated. The elbow was flexed to 90° and minimal tension was placed to ramp the biceps into the joint to pass the sutures and avoid over tensioning. After the biceps was cut at its origin, the arthroscope was placed in the subacromial space and the suture ends were retrieved. They were then tied down in the subacromial space to complete the tenodesis.

The intra-articular mattress technique used a straight cuff stitch to pass 2 No. 2 braided multifilament nonabsorbable sutures. These sutures were sequentially passed from outside to inside through a cannula placed in the subacromial space and retrieved through an anterior portal. Once both ends of 1 suture were passed, it was tied down through the anterior portal. The second suture was passed and tied in similar fashion. The biceps was then cut at its origin. The elbow was flexed to 90° and minimal tension was placed to ramp the biceps into the joint to pass the sutures and avoid over tensioning.

Postoperative rehabilitation involved limitation of active elbow flexion for 4 weeks and no lifting of any weight with the arm for 12 weeks. It was also dictated by the concomitant pathology.

Postoperative ultrasonography was done 3 months postoperatively at no charge to the patient, if it was done to simply determine biceps integrity. In some patients, the ultrasound (US) was done for other reasons such as to examine the integrity of cuff repair. All US were done with a portable ultrasound machine with an 8-13 MHz linear probe (GE, Wauwatosa, Wisconsin). All US were done by an operating surgeon with more than 5 years of experience with musculoskeletal ultrasound. ANOVA and chi-squared tests were used to compare the groups.

Results

Data from 72 patients were collected and analyzed. Hardware tenodesis was used in 31 patients (43.1%). Interfer-

Table. **Comparison of Intact Tenodesis With Each Technique**

	Intact by Ultrasound	Intact by Clinical Exam	P Value
Soft-tissue techniques	75.6%*	78.1%*	.460
Hardware techniques	67.7%	80.7%	.788

*Percutaneous Intra-Articular Trans Tendon Technique (PITT) was 84% for both. Overall no difference between techniques.

ence screws were used in 28 patients, an anchor in 1 patient, and an interference fit biceps tenodesis implant in 1 patient. Soft-tissue tenodesis was used in 41 patients (56.9%). Twenty-five had the PITT technique and 16 had the intra-articular mattress technique.

There were 25 women (average age, 58.6 years; age range, 35 to 75) and 42 men (average age, 57.3; age range, 19 to 78). Age did not differ by sex (P = .588). Proportion of men and women did not differ significantly between hardware and soft-tissue techniques (P = .264), or PITT vs other techniques (P = .382), and was unrelated to proportion of patients with intact tenodesis by US (P = .773). However, men had significantly higher intact tenodeses by clinical exam (87.2%), compared with women (64.0%) (P = .021).

Follow-up time averaged 9.3 months (range, 2 to 48). Follow-up did not differ by sex (P = .665), hardware vs soft-tissue techniques (P = .482), or PITT vs other techniques (P = .481), and was unrelated to proportion of patients with intact tenodesis by US (P = .145) or by clinical exam (P = .198).

> The failure rate of the soft-tissue and hardware tenodeses is approximately 20% to 33%. Overall, there is no statistical difference in failure rates between techniques…specifically, the PITT technique had a higher success rate compared to the other soft-tissue techniques.

No differences were found between the hardware and soft-tissue techniques with respect to proportions of patients with intact tenodesis by US or clinical exam (**Table**). Surgery in the dominant arm had no effect (P = .251) whether evaluated by US or clinical exam. Within the soft-tissue techniques, the PITT technique had clinical exam intact rate (84.0%) similar to the hardware techniques (80.7%, P = .999) and somewhat higher than the other soft-tissue techniques (68.8%, P = .276), although these differences were not statistically significant. Similarly, the PITT technique had a higher US intact rate (84.0%), compared with both of the other soft-tissue techniques (62.5%, P = .150) and the hardware techniques (67.7%, P = .220), although these differences again failed to reach statistical significance.

The average hardware tenodesis cost was $514.32 and the average soft-tissue tenodesis cost: $32.05

Discussion

This study suggests that the failure rate of the soft-tissue and hardware tenodeses is approximately 20% to 33%. Overall, there is no statistical difference in failure rates between techniques, although there may have been differences between the soft-tissue techniques that were unable to be clearly detected given our limited sample size. Specifically, the PITT technique had a higher success rate compared to the other soft-tissue techniques. The PITT technique also had a higher success rate compared to the hardware techniques as evaluated by US but a similar success rate when evaluated clinically. There is a discrepancy between the clinical appearance and the US result possibly due to patient body habitus and the tension placed on the biceps when tenodesed. Additionally, the screw tenodesis is done more distally which leaves a shorter segment of tendon to identify by US. It is difficult to explain the higher failure rate in females, but it may be due to lower quality tissue to tenodese, a less robust intact tendon that is difficult to visualize by ultrasound, and less tone in the tenodesed tendon that makes it appear to have failed clinically.

Several studies assessed the strength of biceps tenodesis. Patzer and colleagues[7,8] found that screw tenodesis is biomechanically superior to suture anchor tenodesis. These were cadaveric studies. Most studies support the fact that interference screw tenodesis is superior to anchor tenodesis. However, some studies have found that suture anchor tenodesis is biomechanically superior.[9]

One biomechanical study was done comparing the PITT technique to a suture anchor. That was a cadaveric study that compared the ultimate load and stiffness in the PITT technique with 2 sutures and a suture anchor technique using 2 bioabsorbable anchors. Both methods were noted to fail at the suture-tissue interface with the load to failure of the suture anchor technique exceeding that of the PITT technique but not with any statistically significant difference (175.4 vs 142.7 N with p>.05). No cyclic testing was done and interference screw fixation was not included.

One clinical study was also done comparing suture anchor tenodesis and the PITT technique[10]. This study compared 30 patients who underwent anchor tenodesis with 27 patients who had the PITT technique. The patients were evaluated with a Constant score, long head of the biceps (LHB) score, and by structural integrity by magnetic resonance imaging (MRI). They found higher LHB scores and structural integrity scores by MRI in the anchor tenodesis group. The weakness of that study is similar to the weakness of our study. The sample size was relatively small and the differences between groups were relatively small (LHB score, 91.8 vs 80.9; MRI score, 2.2 vs 2.7). Also, the LHB score is not validated.

Our study has several limitations. It is retrospective and not randomized. However, we have larger numbers than prior studies and we assess the outcome with socially relevant parameters: cosmesis and cost. Several studies have already shown that tenotomy results in relatively little loss of function.[2] Many societies accept the clinical deformity after tenotomy, but it is still difficult for some societies to accept that. We find that the main complaint in our practice is focused on appearance. For this reason, we use clinical appearance and US assessment to determine the integrity of the tenodesis.

We have noted several other variables that need to be considered when reviewing our results. One is operative time. This will vary depending on the experience of the surgeon. The surgeons in this study were adept at both techniques and it is estimated that operative times were similar. It is difficult to assess this because other procedures were done concomitantly. Also, the decision was generally made to perform the soft-tissue tenodesis if a healthy segment of biceps could be pulled into the joint and the rotator interval was intact. This did not give the soft-tissue technique an advantage because the hardware tenodesis was not done if the extra-articular biceps tissue was noted to be of poor quality as well. Based on the data of our study, it is unlikely that a clinically relevant difference existing between the integrity of soft-tissue and hardware tenodesis. When our results are considered with the significant cost differential, it seems reasonable to recommend the use of soft-tissue tenodesis when feasible with an intact rotator interval and healthy distal biceps tissue.

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