Original Article

Low incidence of failure after proximal biceps tenodesis with unicortical suture button

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ABSTRACT

Purpose: Recent interest in suture button fixation has developed with regard to proximal biceps tenodesis fixation. Biomechanical studies have demonstrated viability of a unicortical suture button technique *in vitro*. Despite this, no clinical data has been reported to validate the biomechanical data. The purpose of this study is to report on complication and failure rates in the early postoperative period after bicep tenodesis with a unicortical suture button.

Methods: A retrospective review was performed of all biceps tenodesis performed at our institution over a 36-month period using a unicortical suture button for fixation. All included patients had a minimum 12 weeks follow up. Failures were defined as complete loss of fixation, change in biceps contour during the early postoperative period, acute pain at the tenodesis site, or acute loss of supination strength.

Results: 145 of 166 biceps tenodesis procedures performed by the 4 surgeons at our institution met inclusion criteria. 80.1% of the patients were active duty military at the time of surgery. The average age was 38.2 years. There were 7 total complications (4.8%), including one failure (0.7%) requiring revision. **Conclusion:** Failure and complication rates in the early postoperative period using a unicortical suture button for biceps tenodesis fixation are consistent with other reported techniques. This study adds clinical data to the existing biomechanical reports that this technique is strong enough to provide stable fixation of the biceps tendon to allow healing of the tendon to the humerus.

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1. Introduction

Tenodesis of the long head of the biceps tendon (LHBT) is a procedure that has been growing in popularity and frequency.¹ Techniques are widely variable. Approaches may be described as open, mini-open, or arthroscopic. Location of the tenodesis has been reported intra-articular, supra-pectoral, sub-pectoral, or soft tissue. Fixation techniques have included bone tunnels, tenodesis screws, anchor fixation, anchorless fixation, suture fixation, and cortical button fixation.

Open, subpectoral biceps tenodesis continues to be commonly performed, though arthroscopic techniques are growing in frequency.¹ No consensus exists on a superior tenodesis technique, and many biomechanical studies have been performed to establish the optimal fixation. Additionally, reports of humerus fractures

after LHBT due to the larger drill holes acting as stress risers have increased interest in techniques using smaller diameter holes.^{2–5} One such technique utilizes a cortical suture button. In the last three years, four biomechanical studies have looked at the use of cortical button fixation for LHBT. Sethi et al. found the button, placed on the posterior cortex of the humerus, to be inferior to screw fixation.⁶ The remaining three studies, with a unicortical button secured on the intramedullary surface of the anterior cortex, showed no statistical difference between button fixation and an intramedullary screw techniques.^{7–9}

Use of a unicortical suture button for fixation in LHBT procedures has been mentioned in reviews of biceps tenodesis.¹⁰ However, there is a paucity of literature clinically supporting the use of a unicortical button for LHBT. No studies have clinically validated the biomechanical data that a unicortical suture button is strong enough to maintain fixation of the biceps tendon until healing. The purpose of this study was to determine the early incidence of fixation failure and complication rates after LHBT using a unicortical suture button with a subpectoral approach.

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2. Methods

This was an IRB approved, retrospective review. All biceps tenodesis performed at the study institution by four orthopaedic surgeons were identified from January 2013 (when the technique was first employed) to January 2016. Clinical and operative notes were reviewed to confirm the procedure performed as well as technique utilized. Inclusion criteria included any patient 18 years old or older in which a unicortical suture button was utilized to perform an LHBT procedure. Any patient without 12 weeks follow up was excluded from results analysis.

Clinical notes and operative logs were also reviewed for complications. Fixation failure was defined as clinical findings suggestive of loss of fixation such as “popeye” deformity, change in muscular contour during the early postoperative period, acute clinical weakness in supination, or acute pain at the tenodesis site. Confirmation of clinical findings was performed with magnetic resonance imaging (MRI).

2.1. Technique

A diagnostic arthroscopy is performed either in the beach chair or lateral position according to surgeon preference. The relevant pathology is identified and treated. Indications for biceps tenodesis at our institution include longitudinal tear of the biceps tendon, irreparable SLAP (superior labrum anterior – posterior) tear, unstable biceps or compromised biceps sling, or significant biceps tendinopathy that responded to a diagnostic injection at the bicipital groove. LHBT was also often performed in conjunction with rotator cuff repair, pan labral repair, or repair of the upper subscapularis tendon. The biceps tendon can be tagged just distal to its insertion on the superior labrum if desired using a scorpion (Arthrex Inc., Naples, FL), bird beak, or spinal needle, but then is released using arthroscopic scissors.

The arm is slightly flexed, abducted, and externally rotated. A small, 3 cm, longitudinal incision is made at the lower border of the pectoralis tendon in the anterior portion of the axillary fold (see Fig. 1a and b). Incision is made sharply through the dermis with a knife. Electrocautery is used for hemostasis. The subcutaneous tissue and overlying fascia are then released and blunt dissection is used to palpate the biceps tendon (see Fig. 2). A right angle can be used to retrieve the tendon, but often only digital palpation is needed. The lower border of the pectoralis tendon can be palpated, under which the bicipital groove can be felt. The long head of the tendon is often under a final layer of fascia that must be opened to access the tendon. The tendon is then retrieved out of the wound (see Fig. 3a).

Starting at the musculotendinous junction, a Fiberloop (Arthrex Inc., Naples, FL) is used to perform a modified whipstitch for about 2 cm proximally. The final pass of the needle goes just proximal to the previous stitch and exits on the deep surface of the tendon, as it will lie on the bone (see Fig. 3b). The loop is cut to remove the needle and the biceps button (Arthrex Inc., Naples, FL) is applied. The sutures are gently pulled to ensure they slide freely then a snap placed on the sutures.

To prepare the bone, a small pregnant Hohmann is carefully placed on the medial border of the humerus, a larger narrow Hohmann can be used on the lateral border exposing the lower border of the pectoralis tendon and bicipital groove between the two retractors. In larger, more muscular individuals, an Army-Navy is used superiorly for further exposure (see Fig. 3b). The arm may need to be rotated slightly to provide direct access to the distal portion of the bicipital groove. A knife or electrocautery is used to open the periosteum for a length of about 2 cm starting just proximal to the distal border of the pectoralis tendon. A rasp is then used to prepare the cortex (see Fig. 4a). A unicortical hole is drilled

Fig. 1. a) The arm is marked while at the side to orient natural skin folds. b) The incision is made over the biceps near the axillary fold, usually it does not need to be extended more than 3–4 cm.

in the anterior cortex of the humerus near the top of the exposed cortex, centered in the bicipital groove (see Fig. 4b).

After preparation, the button inserter is used to place the button in the intramedullary canal, and the two strands of the suture are pulled partially to ensure that the button has flipped prior to removing the inserter (see Fig. 5). After the inserter is removed, a free needle is used to pass one suture strand through the tendon

Fig. 2. Most of the dissection can be done bluntly with a finger after the initial fascia is opened with electrocautery or scissors.

from deep to superficial (see Fig. 6a and b). This can be done either before the tendon is fully seated or after. Any remaining excess tendon is removed. The sutures are tightened, fully seating the tendon, and tied over the tendon (see Fig. 7). The strands are then cut; the wound is irrigated and closed in standard fashion.

The patients are placed in a sling postoperatively. Postoperative x-rays are routinely obtained to ensure proper placement and seating of the button (see Fig. 8). Limitations are often determined by concomitant procedures. If performed in isolation, passive motion is allowed immediately post-operatively and gentle active motion is allowed beginning at 2 weeks. Strengthening begins at 8 weeks postoperatively, and by 12 weeks the patients are allowed to resume weight lifting and duties as tolerated.

3. Results

The review identified 166 patients who underwent a biceps tenodesis with a unicortical suture button. Average age was 38.2 years (range 18–65 years). Eighty percent of the patients were active duty military at the time of surgery. All but 14 patients were male (85.5%). Average length of follow up was 27.9 weeks (range 2–164 weeks). Of these, 145 (87.3%) met inclusion criteria. Nine of these procedures were revision tenodeses; 8 were revised from a more proximal tenodesis, and one from a failed sub-pectoral tenodesis.

There were 7 total complications (4.8%) and 1 failure (0.7%) within the first 12 weeks postoperatively. The only major complication was the failure that required revision fixation. The other 6 complications were minor. One patient (0.7%) had mild asymmetry of the biceps contour noted by the surgeon postoperatively, but not appreciated by the patient, that did not progress or worsen. Additionally, there were 2 patients with chronic pain in the posterior shoulder (1.4%). One (0.7%) postoperative hematoma

Fig. 3. a) The cut tendon is retrieved out of the wound and is prepared at the distal musculotendinous junction in standard fashion. We commonly leave the excess tendon attached at this time for ease of later retrieval. b)–The stitching should be performed such that the sutures exit on the deep surface of the tendon after the final pass to ensure that the tendon will seat flat on the cortex (black arrow). The humerus is exposed using a medial and lateral retractor. A third, superior retractor can be used for added exposure.

occurred and was managed nonoperatively. One button was found not to be fully flipped and seated on the intramedullary portion of the anterior humeral cortex (0.7%), and one patient (0.7%) developed a superficial wound infection managed with oral antibiotics.

4. Discussion

This study provides early clinical validation for existing biomechanical data supporting the use of a suture button for fixation in LHBT procedures. A single patient lost fixation within twelve weeks of surgery. Though categorized as a failure of fixation, it should be noted that this patient had returned to weighted biceps curls in the gym two weeks postoperatively against surgeon instructions. The tenodesis was revised using the same fixation technique and went on to heal uneventfully. At the time of revision, it was noted that the mechanism for failure was suture pullout of the tendon, which has been noted as a common mode of failure in biomechanical testing.^{6–9}

There was one patient with mild asymmetry of the biceps contour (0.7%). This was not noted by the patient and required no intervention. This was most likely a result of decreased tension length restored at the time of the tenodesis, as the deformity did

Fig. 4. a) The periosteum is opened and a rasp used to prepare the bony surface (circled area), b) a unicortical drill pin is placed at the superior portion of this area.

not progress over time. Anatomic variability and tenodesis location along the humerus can alter normal landmarks for setting appropriate length tension.^{11,12} The patient with an incorrectly

Fig. 5. The loaded button with the sutures is then placed into the hole and flipped by pulling on each suture individually prior to removal of the inserter.

Fig. 6. a) A free needle is used to pass one limb of the suture through the tendon. This can be done after seating the tendon, but is more easily accomplished before the tenodesis is reduced to the bone. b) One suture passes beside the tendon and the other through the tendon (arrows). Excess tendon is cut at this time.

placed button, though it was not seated flush on the intramedullary surface of the anterior humeral cortex, healed uneventfully and maintained biceps tension and contour.

Biceps tenodesis was described in the early 20th century, with a review of the current literature, by Gilcreest, who did a substantial amount of work on the topic.¹³ Nearly a century later, the biceps tendon is still seen as a significant pain generator, and LHBT is increasingly being used as the treatment of choice for many pathologies.^{10,11,14–18} Sub-pectoral biceps tenodesis is a well-established location for tenodesis; given that residual groove pain is a concern for more proximal tenodesis, an argument has been made for the sub-pectoral location being the “optimal” location.^{15,17,19} Reports of humerus fracture through larger diameter cortical holes after biceps tenodesis have contributed to an

Fig. 7. The tendon is seated flush on the cortex. The white arrow shows the suture limb next to the tendon, while the black arrow points to the limb that was passed through the tendon. The sutures are then tied and cut.

Fig. 8. Postoperative x-ray showing the suture button seated on the humeral cortex.

increased interest in alternative fixation techniques that allow for smaller cortical holes.^{2–5}

Bosley et al. described use of the suture button for fixation of the tendon in 2009.²⁰ Snir et al. also described a technique using a suture button, but they utilized a larger hole in the anterior humeral cortex in which the tendon could slide and then a smaller hole in the posterior cortex through which the button was placed for fixation.²¹ Additionally, a technique video was created, demonstrating use of the unicortical button.²² The latter of these utilizes a 3.2 mm drill, as compared to a 6–8 mm hole often used for an interference screw.¹⁰ No clinical data was reported in either article describing the technique or the video.

Several biomechanical studies have looked at techniques with suture button to determine viability as a stable method of fixation. Arora et al. compared unicortical button, bicortical button, bicortical button with screw backup, and a single interference screw in sub-pectoral tenodesis. They found that interference screw had the highest load to failure and least displacement, but was not significantly better than a unicortical button.⁹ A second study compared a unicortical button to an 8 mm interference screw and also found no statistical difference between the two techniques with regard to load to failure, displacement, and

stiffness.⁸ Deangelis et al. also compared these two techniques and found decreased displacement with the cortical button group compared to the interference screw and no difference in load to failure or stiffness.⁷ One study found cortical button fixation to be biomechanically inferior to interference screw fixation.⁶ However, this study utilized a bicortical button fixation with the suture button through the anterior cortex and positioned on the posterior cortex as opposed to the anterior cortex as in the other three studies mentioned. A single series has been reported utilizing this technique, with no failures and good results.²³

While unicortical suture button fixation has been shown to be sufficiently strong in laboratory testing, no study, to our knowledge, has attempted to answer the question of whether fixation held *in vivo*. Clinically, what is the risk of failure of fixation? Is there a risk of biceps deformity due to displacement? This study included 145 patients; the majority of them were young, active duty military. The failure rate was 0.7%. This is comparable to other reported failure rates for LHBT.²⁴

Other complications included pain in other parts of the shoulder, superficial wound infection, and a postoperative hematoma. These are known risks with biceps tenodesis.²⁴ The musculocutaneous nerve, radial nerve, axillary nerve and artery, and deep brachial artery are known to be “at risk” structures with subpectoral biceps tenodesis.^{24–27} The axillary nerve is primarily at risk with bicortical drilling, penetrating the posterior cortex.²⁶ The tenodesis site itself, on the anterior cortex, does not put as many structures at risk as placement of the medial retractor during the approach for a sub-pectoral LHBT.^{26,27} There were no patients with neurologic complications in this cohort.

Limitations of this study include the retrospective nature of the design and inherent biases therein. Follow-up was short, but all patients were followed to at least twelve weeks, which allows adequate time to provide sufficient tendon to bone healing such that failure would be likely caused by new trauma and not with loss of fixation.²⁸ Furthermore, there are no validated functional outcome scores in this study. However, this study was designed to answer a specific question, what is the risk of early failure with this technique? This question has been answered with use of a suture button for the distal biceps repair, but has not yet been established for proximal tenodesis with a cortical button.²⁹ Further study is being conducted to determine functional outcome and patient satisfaction with this technique. Future studies should also include randomized studies comparing surgical techniques as well as longer term follow up to determine risk of humerus fracture with the smaller diameter cortical hole.

5. Conclusion

Subpectoral biceps tenodesis is a well-established technique for treatment of many pathologies in the shoulder. Biomechanical evidence exists for use of a unicortical suture button for fixation of the tendon to the humerus. This study provides clinical support for the biomechanical data, concluding that the cortical button will safely and reliably secure the biceps tendon to the humerus allowing for healing.

Contributions

All authors contributed to data collection, data assimilation, and manuscript, preparation.

IRB information

This study was approved by the IRB at Dwight D. Eisenhower Army Medical Center: Project number 1604019-1.

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