

Technical Note

Arthroscopic-Assisted Biceps Tenodesis for Ruptures of the Long Head of Biceps Brachii: The Cobra Procedure

David P. Richards, M.D., F.R.C.S.C., and Stephen S. Burkhart, M.D.

Abstract: A number of open procedures have been presented in the literature that described the repair of the ruptured long head of biceps brachii (LHBB). Although arthroscopic biceps tenodesis techniques have been used to address partial tears or subluxation of the biceps, no arthroscopic technique to assist in the treatment of complete retracted ruptures of the LHBB has been described. This article describes an arthroscopic-assisted biceps tenodesis, using interference screw fixation, in the treatment of acute or chronic LHBB ruptures. An arthroscopic-assisted biceps tenodesis with interference screw fixation provides an alternative to open LHBB tenodesis. The ability to tenodesise the retracted LHBB arthroscopically is a technologic advance that could reduce morbidity in comparison to open tenodesis, thus resulting in a better functional outcome. **Key Words:** Shoulder arthroscopy—Long head biceps brachii—Tendon repair—Biceps tenodesis.

The long head of biceps brachii (LHBB) tendon is a key stabilizer within the glenohumeral joint.^{1,2} Long head of biceps brachii pathology ranges from simple cases of tendonitis to more complex pathologies such as LHBB tendon instability (subluxation or dislocation) and tendon rupture (partial or complete). Pathologic entities such as instability and partial tears can be treated using open³⁻⁵ or arthroscopic techniques.⁶⁻¹⁰ However, the indications for repair of an acute or chronic rupture of the LHBB remain controversial. A number of studies have demonstrated that there is minimal dysfunction in individuals with LHBB ruptures.¹¹⁻¹⁵ Although the functional outcomes in these studies suggest that most individuals with chronic unrepaired ruptures have a normal or near-normal function of their biceps brachii, a sub-

group of young, active individuals tend to have less favorable outcomes. These individuals tend to have pain and cramping in their obviously deformed biceps when performing heavy activities associated with work or leisure. A number of open procedures have been described that address the rupture of the LHBB.^{4,5,11} Arthroscopic biceps tenodesis techniques⁶⁻¹⁰ have been described to address incomplete nonretracted biceps pathology. However, an arthroscopic technique to assist in the treatment of acute or chronic retracted ruptures of the LHBB has not been described. The purpose of this article is to describe an arthroscopic-assisted biceps tenodesis, using interference screw fixation, in the treatment of acute or chronic retracted LHBB ruptures. We have named this technique the Cobra procedure in reference to the striking cobra tattoo on the shoulder of the first patient on whom we performed this procedure (Fig 1).

From the San Antonio Orthopaedic Group, San Antonio, Texas, U.S.A.

Address correspondence and reprint requests to Stephen S. Burkhart, M.D., 540 Madison Oak Drive, Suite 620, San Antonio, TX 78258, U.S.A. E-mail: ssburkhart@msn.com

© 2004 by the Arthroscopy Association of North America

0749-8063/04/2006-4041\$30.00/0

doi:10.1016/j.arthro.2004.04.049

OPERATIVE TECHNIQUE

The patient is brought to the operating room and placed supine on the operating table and is then intubated under a general anesthetic. Once anesthetized, the patient is placed in the lateral decubitus position



FIGURE 1. Patient's arm with the cobra tattoo from which this technique derives its name.

and secured with a Vac Pac beanbag (Olympic Medical, Seattle, WA). A warming blanket is placed over the patient to prevent hypothermia. Next, a thorough physical examination of the shoulder is performed. The operative shoulder is then prepped and draped in the usual sterile fashion, and then placed in balanced suspension (5-10 lb) in a position of 20° to 30° of abduction and 20° of forward flexion (Star Sleeve Traction System; Arthrex, Naples, FL).

A standard posterior portal is created and the arthroscope is inserted into the glenohumeral joint. Pump pressure is maintained at 60 mm Hg throughout the case. At this point, a thorough diagnostic arthroscopic examination is performed. The insertion of the LHBB is assessed at the superior aspect of the glenoid. If a stump of biceps tendon remains attached to the labrum, it is debrided.

Next, the retracted tendon of the biceps is retrieved from the arm by means of a 3-cm incision placed over the musculotendinous junction at the proximal end of the deformed biceps muscle. The dissection is carried down through the subcutaneous tissue to the level of the biceps brachii. The tendon is identified and pulled out through the incision. The tendon length is assessed by laying it on the arm in the direction of its origin (Fig 2). The length must be sufficient for the tendon to reach a high anterolateral portal, just adjacent to the anterior corner of the acromion. This length ensures that the tendon can be fixed in the proximal humerus

in the area of the greater tuberosity and bicipital groove. The tendon is held taut and a whipstitch is woven into the tendon using a no. 2 FiberWire (Arthrex). This suturing is initiated approximately 5 mm from the end of the tendon. Also, the suture is passed in such a way that the suture ends will ultimately assist in pushing the tendon to the base of the bone socket by means of the cannulated BioTenodesis screwdriver tip (Arthrex). The bulbous end of the tendon is then debrided and contoured, leaving a tapered end. At this point, the tendon is sized using the BioTenodesis (Arthrex) sizing instrument.

Next, the proximal passage of the tendon is initiated. The lower end of the bicipital tunnel is digitally palpated through the incision in the arm. The surgeon then carefully passes the switching stick alongside his finger beneath the pectoralis major adjacent to its insertion, then into the bicipital groove and up through the anterior deltoid until the skin is tented. This is the site of the high anterolateral portal, and a small, 1.0-cm skin incision is made over the rod. At this point, both the proximal and distal ends of the switching stick are visible through the skin incisions. An arthroscopic sheath is inserted over the proximal end of the switching stick and a 7-mm clear fishbowl cannula (Arthrex) is inserted over the distal end of the switching stick (Figs 3 and 4). Both cannulas are manipulated so the clear cannula telescopes over the arthroscopic sheath, producing a continuous enclosed sheath for safe passage of a suture passer. This enclosed sheath prevents inadvertent medial penetration of the suture passer, thereby protecting the medially



FIGURE 2. The tendon length is assessed by laying it on the arm in the direction of its origin. The length should be sufficient for the tendon to reach a high anterolateral portal.



FIGURE 3. An arthroscopic sheath is inserted over the proximal end of the switching stick as it exits out the anterolateral portal (AL portal).



FIGURE 5. The long head of the biceps brachii is passed retrograde through its anatomic tract, beneath the pectoralis major, until the sutures pass out the high anterolateral portal.

located neurovascular structures. The switching stick is then removed and a long suture passer is inserted through the two cannulas. The clear cannula is then removed, leaving the suture passer exiting out through the skin incision. The suture is then grasped by the suture passer, and the prepared LHBB is passed retrograde through its anatomic tract, beneath the pectoralis major, until the sutures pass out the anterolateral portal (Fig 5).

The incision in the arm is then closed. The subcutaneous tissue is closed using 2-0 Vicryl (Ethicon, Somerville, NJ) and the skin is closed using 2-0 nylon (Ethicon; Ethicon) in a subcuticular fashion.

Next, the arthroscope is inserted through the posterior portal and into the subacromial space. An arthroscopic subacromial bursectomy is then performed, thus allowing visualization of the prepared LHBB tendon (Fig 6). Next, the bicipital roof is opened at the lateral aspect of the rotator interval, exposing the upper portion of the bicipital groove. This exposure is carried out by the means of a 4.0-mm shaver (Arthrex), and 90° electrocautery probe (OPES; Arthrex) (Fig 7). The bone in the area of the upper portion of the bicipital groove is then prepared using both the

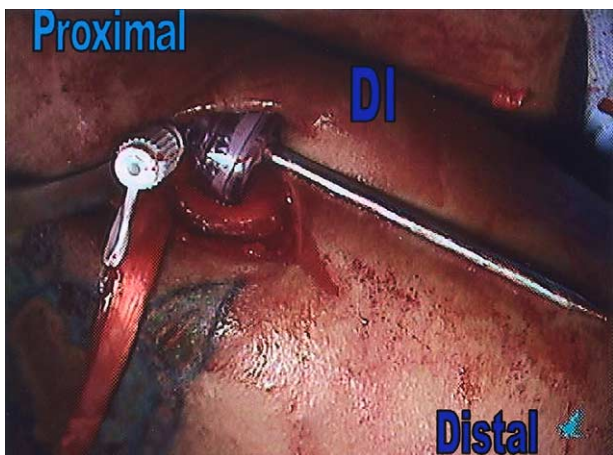


FIGURE 4. A 7-mm clear fishbowl cannula (Arthrex) is inserted over the distal end of the switching stick as it exits out of the incision over the biceps deformity.



FIGURE 6. An arthroscopic subacromial bursectomy is then performed, thus allowing visualization of the prepared long head of the biceps brachii tendon within the subacromial space.

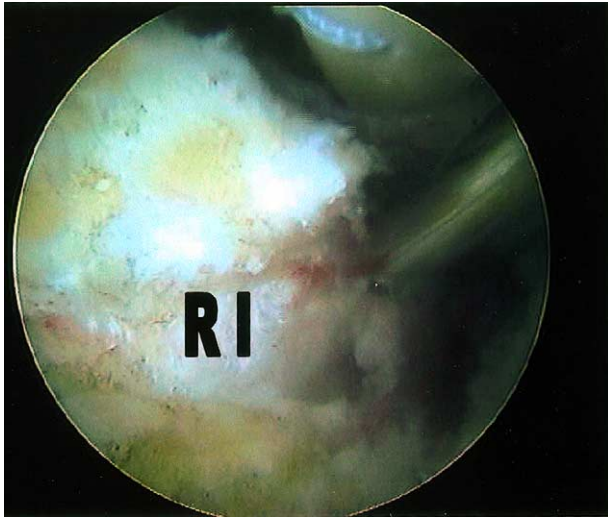


FIGURE 7. The bicipital groove adjacent to the rotator interval (RI) is exposed using a combination of a 4.0-mm shaver (Arthrex) and a 90° electrocautery probe (OPES; Arthrex).

shaver and the electrocautery until there is a bleeding surface.

The anterolateral portal is usually ideal for performing the biceps tenodesis. However, if the angle of approach to the proximal humerus is wrong, then another portal must be created to ensure an acceptable position of the bone socket. A 2.4-mm guide pin is passed through the portal and placed in the desired location of the bone socket (Fig 8). The guide pin is then inserted perpendicular to the surface of the bone.

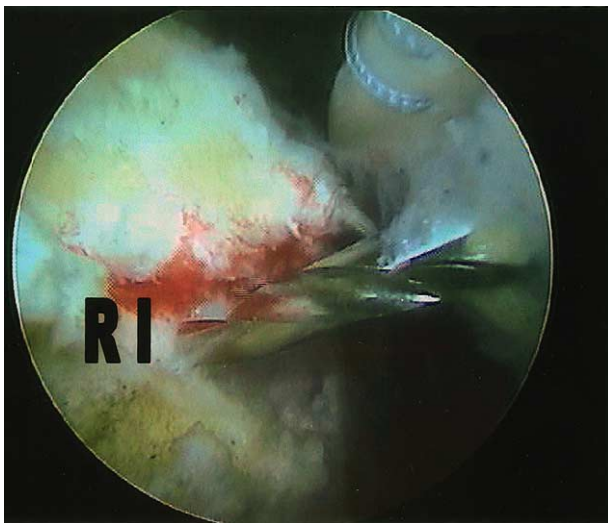


FIGURE 8. A 2.4-mm guide pin is placed in the upper portion of the bicipital groove, in the desired location for the bone socket.



FIGURE 9. The appropriately sized BioTenodesis cannulated reamer (Arthrex) is then passed over the guide wire and the socket is reamed to a depth of 25 mm.

The appropriately sized BioTenodesis cannulated reamer (Arthrex) is then passed over the guide pin and the socket is reamed to a depth of 2 mm (Fig 9) to accommodate slight countersinking of the BioTenodesis screw (Arthrex), which is 23 mm long.

This technique incorporates the use of a specifically designed BioTenodesis screw system (Arthrex) in which a cannulated biodegradable PLLA (poly-L-lactic acid) interference screw is used in association with a uniquely designed screwdriver. Three sizes of the 23-mm long BioTenodesis screws are available for fixation (7, 8, and 9 mm). The desired screw diameter is 1 mm smaller than the reamed hole if the bone quality is good or the same diameter as the bone socket if the bone is osteoporotic. The specifically designed cannulated screwdriver uses a reverse-threaded sleeve and a thumb piece on the shaft of the driver. This system allows the biceps tendon to be held securely under tension within the depths of the bone socket by the tip of the driver shaft as the biodegradable interference screw is inserted into place by the hex driver with the reverse-pitched thumb sleeve (Fig 10). The pitch of the threads on the sleeve is the same as the pitch of the threads on the BioTenodesis screw, ensuring that the tip of the inserter does not move from the bottom of the bone socket as the screw is advanced.

The ends of the suture that was used to whipstitch the tendon are passed through the suture loop at the end of the cannulated screwdriver. As the suture ends

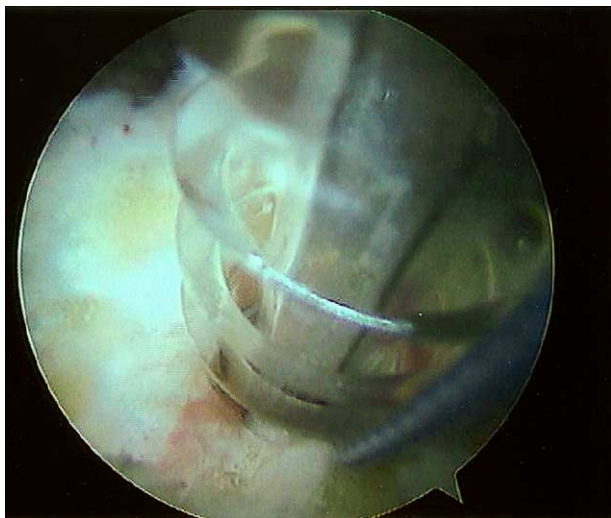


FIGURE 10. The biceps tendon is inserted into the bone socket and fixed with the biodegradable interference screw.

are pulled taut, the tendon is advanced to the end of the screwdriver. This allows the tendon end to be manipulated and controlled by the tip of the cannulated screwdriver. The biceps tendon, controlled by the tip of the screwdriver, is inserted into the shoulder through the anterolateral portal and into the bone socket. While maintaining the tip of the screwdriver and the biceps tendon at the bottom of the hole, the biodegradable screw is advanced distally into the bone socket. Turning the handle of the screwdriver while holding the reverse-threaded thumb piece causes advancement of the screw while maintaining the tip of the inserter in a stationary position. This technique allows the tendon to be held securely at the base of the bone socket as the interference screw is fixed in place. This ensures an adequate screw–tendon–bone interface within the bone socket. The screw–tendon–bone interface is then assessed by visualizing the construct through the transparent Bio-Tenodesis screw (Fig 11). The traction and loop sutures used in the tenodesis are used to repair the residual defect in the rotator interval (Fig 12).

DISCUSSION

Although LHBB ruptures commonly occur in the situation of advanced degenerative tendinopathy, they can also occur, albeit less commonly, as a result of tensile overload in a younger age group. This commonly occurs in laborers performing an activity requiring strong resisted elbow flexion. Numerous stud-

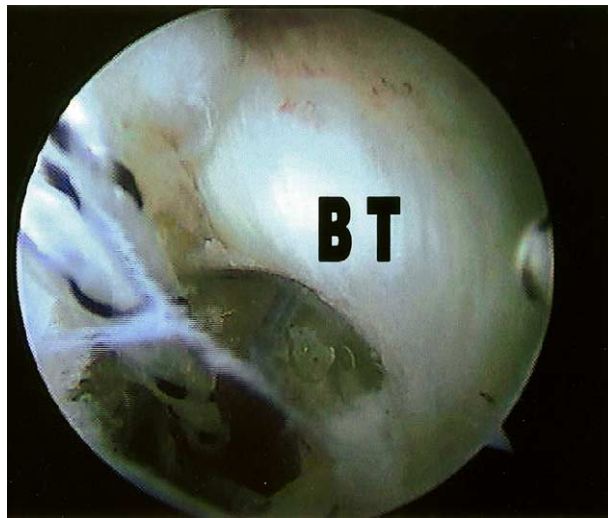


FIGURE 11. The screw–tendon–bone interface is assessed by visualizing the construct through the transparent Bio-Tenodesis screw. (BT, biceps tendon).

ies¹¹⁻¹⁵ have assessed the function of the upper extremity after a rupture of the LHBB. Azar and Pickering¹¹ found that in their series of patients (>50 years old) who underwent biceps tenodesis, there was no difference between preoperative and postoperative elbow flexion power and only minimal increase in postoperative supination power. Warren¹⁵ had similar results in that there was a 10% loss of supination power based on Cybex isokinetic testing. Mariani et



FIGURE 12. The traction and loop sutures used in the tenodesis can be cut or incorporated into the repair of the residual defect in the rotator interval (RI).

al.¹² assessed the outcome of 27 LHBB ruptures and found that the surgical group had no loss of elbow flexion strength or supination strength. The nonoperative group had a loss of 21% of supination strength and 8% of elbow flexion strength. However, this series had a disproportionate number of nonsurgical patients. In another study, Sturzenegger et al.¹⁴ found that their nonoperative group lost 16% of elbow flexion strength and 11% of supination power, whereas their operative group lost 8% of elbow flexion strength and 7% of supination power. Both the nonoperative and operative groups were compared with a control group, which consisted of 20 healthy individuals. Soto-Hall and Stroot¹³ demonstrated in their study that in patients with a recent LHBB rupture, there was an approximate 20% loss of elbow flexion strength compared with the opposite side. However, this weakness was not seen in other patients who presented later with the same injury.

The literature indicates that rupture of LHBB tends to produce only mild strength deficits. However, in the case of a young laborer, these decreases in elbow flexion power and supination strength could be significantly disabling. It has been our experience that those active individuals who require significant arm strength to perform their jobs will commonly complain of muscle fatigue and cramping with activity in the arm with the ruptured LHBB. A number of techniques have been described to repair the retracted ruptured LHBB, but all of these techniques are open surgical procedures.^{3-5,11} Froimson and Oh⁴ describe an open technique that uses the insertion of the LHBB tendon into a keyhole in the proximal humerus. A modification of this technique has also been described in which the LHBB tendon is brought back out through the proximal humerus in a secondary, more proximal hole and sewn back onto itself.¹¹ Alternatively, the LHBB tendon can be placed anatomically in the bicipital groove and tenodesed into place on the proximal humerus.⁵ Arthroscopic techniques have been described for biceps tenodesis for cases in which the tendon has not yet ruptured.⁶⁻¹⁰ However, once the tendon has ruptured and retracted distally, the conventional wisdom has been that arthroscopic repair techniques could not be applied.

Our technique, the Cobra procedure, is an arthroscopic-assisted technique that uses a mini (3 cm) incision in conjunction with our previously described technique of arthroscopic biceps tenodesis.^{9,10} To our knowledge, this is the first report of an arthroscopic

tenodesis of a ruptured and retracted LHBB. This technique provides an arthroscopic alternative to the open techniques that have been taught over the years. The ability to address this pathology arthroscopically could minimize postoperative shoulder stiffness, therefore providing the patient with less significant morbidity and a quicker return to full activity.

The limitations to this technique are twofold. First, the LHBB tendon must have adequate length to allow passage up to the subacromial space. For that reason, we recommend surgery on acute ruptures within the first 3 weeks if possible. If the length is not sufficient, another means of biceps tenodesis at a more distal location must be used. Second, in some instances, the tendon is irretrievable as a result of scarring of the tendon within its tract as it exits out to the shoulder joint into the bicipital groove. When faced with these problems, this arthroscopic approach will not be possible.

CONCLUSION

An arthroscopic-assisted biceps tenodesis, the Cobra procedure, provides an alternative to open LHBB tendon repairs. The ability to tenodesise the LHBB arthroscopically is a technologic advance that could assist in alleviating the morbidity associated with open shoulder surgery, thus allowing for a better functional outcome.

REFERENCES

1. Pagnani MJ, Deng XH, Warren RF, Torzilli PA, O'Brien SJ. Role of the long head of the biceps brachii in glenohumeral stability: A biomechanical study in cadavera. *J Shoulder Elbow Surg* 1996;5:255-262.
2. Rodosky MW, Harner CD, Fu FH. The role of the long head of the biceps muscle and superior glenoid labrum in anterior stability of the shoulder. *Am J Sports Med* 1994;22:121-130.
3. DePalma AF, Callery GE. Bicipital tenosynovitis. *Clin Orthop* 1954;3:69-85.
4. Froimson AI, Oh I. Keyhole tenodesis of biceps origin at the shoulder. *Clin Orthop* 1974;112:245-249.
5. Hitchcock HH, Bechtol CO. Painful shoulder observation on the role of the tendon of the long head of the biceps brachii in its causation. *J Bone Joint Surg Am* 1948;30:263-273.
6. Gartsman GM, Hammerman SM. Arthroscopic biceps tenodesis: operative technique. *Arthroscopy* 2000;16:550-552.
7. Boileau P. Arthroscopic biceps tenodesis using an interference screw with trans-osseous drilling. Presented at the Annual Closed Meeting of the American Shoulder and Elbow Surgeons, Austin, TX, October 17, 2000.
8. Klepps S, Hazrati Y, Flatow E. Arthroscopic biceps tenodesis. *Arthroscopy* 2002;18:1043-1045.
9. Lo IKY, Burkhart SS. Arthroscopic biceps tenodesis: Indica-

- tions and technique. *Operative Techniques in Sports Medicine* 2002;10:105-112.
10. Richards DP, Burkhart SS, Lo IKY. Arthroscopic biceps tenodesis with interference screw fixation: The lateral decubitus position. *Operative Techniques in Sports Medicine* 2003;11:15-23.
 11. Azar FM, Pickering RM. Traumatic disorders. In: Canale ST, ed. *Campbell's Operative Orthopaedics*, ed 9. St. Louis: Mosby-Year Book, Inc., 1998:1405-1449.
 12. Mariani EM, Cofield RH, Askew LJ, Li GP, Chao EY. Rupture of the tendon of the long head of biceps brachii. Surgical versus nonsurgical treatment. *Clin Orthop* 1988;228:233-239.
 13. Soto-Hall R, Stroot JH. Treatment of ruptures of the long head of biceps brachii. *Am J Orthop* 1960;2:192-196.
 14. Sturzenegger M, Beguin D, Grunig B, Jakob RP. Muscular strength after rupture of the long head of the biceps. *Arch Orthop Trauma Surg* 1986;105:18-23.
 15. Warren RF. Lesions of the long head of the biceps tendon. *Inst Course Lect*, vol 34. Rosemont, IL: American Academy of Orthopaedic Surgeons, 1985:204-209.