Technical Note

Long Head of the Biceps Tendon Pediculated Autograft Augmentation of Subscapularis Repair During Total Shoulder Arthroplasty

Tiago Martinho, M.D., Jeanni Zbinden, M.D., Alaa Elsenbsy, M.D., and Alexandre Lädermann, M.D.

Abstract: Access to the glenohumeral joint during a deltopectoral approach to total shoulder arthroplasty (TSA) often requires some form of subscapularis (SSc) tendon detachment, which may lead to iatrogenic damage and insufficiency of a previously healthy structure. Despite optimization of SSc management techniques, the overall repair failure rate remains high. Although various biological and structural augmentation methods have been advocated to enhance healing of rotator cuff repairs, few options have yet been explored for SSc repair after TSA. In this Technical Note, we describe a method involving the long head of the biceps tendon as a pediculated autograft to reinforce the SSc repair after anatomic or reverse TSA. After long head of the biceps tendon tenodesis, its proximal part is released from the supraglenoid tubercle while remaining in its groove to be subsequently placed at the rotator interval and sutured either to the SSc, the supraspinatus, or the entire anterosuperior rotator cuff on an individual basis. Repurposing the otherwise-discarded tendon brings several mechanical and biological advantages for SSc repair healing at low cost and without donor-site morbidity.

The deltopectoral approach is the gold standard for total shoulder arthroplasty (TSA). However, access to the glenohumeral joint often requires some form of subscapularis (SSc) tendon detachment, which may cause iatrogenic damage and lead to an insufficiency of a previously healthy structure.[1]

The SSc plays a central role in the overall function and survival of the implant after TSA.[2] However, the SSc repair failure rate can be as high as 25% and 60% after anatomic TSA (aTSA) and reverse TSA (rTSA), respectively.[3-5] Failure of SSc repair after aTSA is a recognized cause of pain, decreased range of motion, instability, and glenoid loosening and results occasionally in revision surgery or conversion to rTSA.[6-8] Two recent studies on rTSA[3,9] demonstrated significantly greater improvement in internal rotation hand-behind-back after healing of SSc repair. Despite the importance of the SSc and the current outcomes of its repair, there has been very little discussion about biological and structural augmentation methods after TSA. Nevertheless, as in rotator cuff repairs,[10] optimizing the biological environment may increase healing rates[11] for which the long head of the biceps tendon (LHBT) has proven itself useful.[12,13] The purpose of this Technical Note was to describe a method in which the intra-articular portion of the LHBT is repurposed as a pediculated autograft to augment the SSc repair after TSA.

Preoperative Decision-Making

Preoperative planning includes all of the surgeon's usual steps to plan an anatomic or reverse TSA. We routinely use this procedure to augment SSc repairs at increased risk of failure. The only prerequisite to this technique is the availability of the LHBT. Possible indications and contraindications are listed in Table 1.

From the Division of Orthopaedics and Trauma Surgery, La Tour Hospital, Meyrin, Switzerland (T.M., J.Z., A.L.); Faculty of Medicine, University of Geneva, Geneva, Switzerland (T.M., J.Z., A.L.); Department of Orthopedic and Trauma Surgery, Faculty of Medicine, South Valley University, Qena, Egypt (A.E.); and Division of Orthopaedics and Trauma Surgery, Department of Surgery, Geneva University Hospitals, Geneva, Switzerland (A.L.).

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Address correspondence to Tiago Martinho, M.D., Division of Orthopaedics and Trauma Surgery, La Tour Hospital, Av. J.-D. Maillard 3, CH-1217 Meyrin, Switzerland. E-mail: tiago.martinho@latour.ch

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Table 1. Possible Indications and Contraindications for LHBT Pediculated Autograft Augmentation of Subscapularis Repair After TSA

Indications	Contraindications
SSc repair only possible under tension	Spontaneous rupture of the LHBT
Poor tissue quality	History of LHBT tenotomy or tenodesis

LHBT, long head of the biceps tendon; SSc, subscapularis; TSA, total shoulder arthroplasty.

Surgical Technique

The pearls and pitfalls specific to this procedure are summarized in Table 2. Video 1 illustrates the described surgical technique.

Patient Positioning and Anesthesia

The patient is placed in the beach-chair position under general anesthesia and interscalene block.

Surgical Approach

The procedure begins with a deltopectoral approach. We first identify the deltopectoral interval proximally at the level of Mohrenheim fossa, a triangular region inferior to the clavicle free of neurovascular structures, which we open bluntly with 2 retractors, taking care to move the cephalic vein laterally with the deltoid. The clavipectoral fascia is incised laterally to the conjoint tendon. The LHBT is located without opening the bicipital groove, and tenodesis is performed to the upper border of the pectoralis major with two No. 2 absorbable sutures. Next, the rotator interval is opened along its entire length from the upper border of the SSc to the glenoid. The LHBT is cut as closely as possible to the supraglenoid tubercle to ensure maximum length and left aside until conclusion of the arthroplasty (Fig 1). At this point, additional No. 2 absorbable sutures may be placed as needed along the intact bicipital groove to reinforce the structure. The boundaries of the SSc are exposed. The anterior circumflex vessels are identified and ligated. The SSc is marked with a stay suture and taken down to access the glenohumeral joint. In this case, our preferred technique is a tenotomy. However, the augmentation procedure may be applied regardless of the SSc takedown method.

Table 2. Surgical Pearls and Pitfalls for LHBT Pediculated Autograft Augmentation of SSc Repair After TSA

Pearls	Pitfalls
Perform LHBT tenodesis to the upper border of the pectoralis major tendon with two No. 2 absorbable sutures.	Take care not to open the bicipital groove to avoid destabilizing the LHBT.
Open the rotator interval along its entire length from the upper border of the SSc.	Cut the LHBT close to the supraglenoid tubercle to ensure the longest possible length for augmentation of SSc repair.
Add 1 or 2 additional No. 2 absorbable sutures at the bicipital groove to reinforce the structure.	
LHBT augmentation of SSc repair can be performed regardless of the technique of takedown and repair of the SSc tendon	
At the end of the procedure, place the LHBT at the rotator interval and suture it to the upper border of the SSc with No. 2 nonabsorbable sutures.	
Alternatively, the LHBT can be used for augmentation of the SSn or the whole anterosuperior cuff.	

LHBT, long head of the biceps tendon; SSc, subscapularis; SSn, supraspinatus; TSA, total shoulder arthroplasty.

Prosthetic Implantation

The surgery continues with the implantation of a TSA according to the manufacturer's recommendations and the surgeon's habits.

SSc Repair

We repair the SSc tendon with side-to-side No. 2 nonabsorbable sutures (PowerSuture; Medacta, Castel San Pietro, Switzerland) and 2 racking hitch knots using two No. 5 closed loop nonabsorbable sutures (PowerSuture; Medacta) with the lateral suture limbs secured with 2 half hitches (Fig 2). This technique has been previously detailed by Denard et al.[14]

SSc Augmentation

The final step of the procedure is the reinforcement of the SSc repair with the LHBT. The LHBT is recovered, placed at the rotator interval, and sutured to the SSc with No. 0 nonabsorbable sutures (FiberWire; Arthrex, Naples, FL) (Fig 3). Several other augmentation options are otherwise possible (Fig 4). Although this technique was first developed for augmentation of SSc repair after TSA, its versatility resulting from the position of the graft at the rotator interval offers the options of reinforcing either the supraspinatus or the whole anterosuperior rotator cuff instead of the SSc. The choice depends on the size of the LHBT and the area of the rotator cuff most in need.

Postoperative Rehabilitation

Patients wear a sling for 4 weeks after surgery. During this period, they only perform active hand, wrist, and

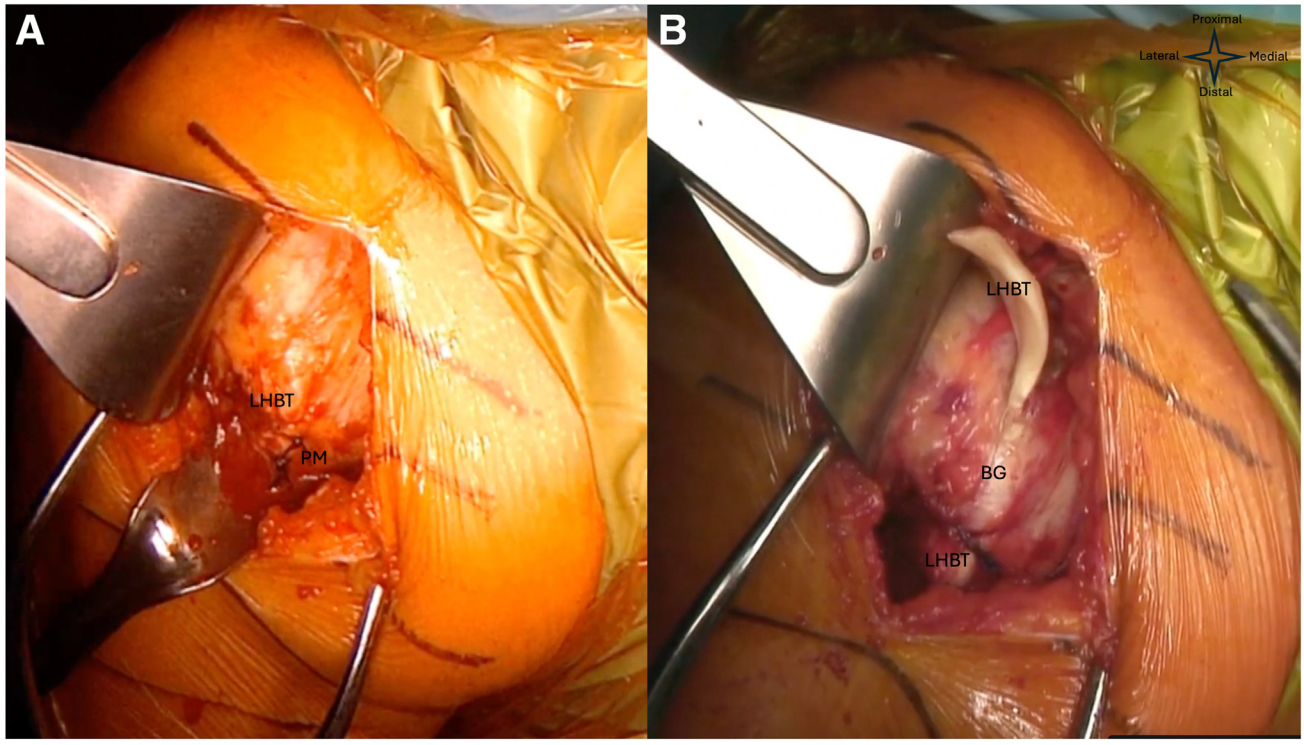

Fig 1. Deep dissection during a deltopectoral approach of the right shoulder of a patient in the beach-chair position illustrating the technique of LHBT tenodesis to the upper border of the PM by two No. 2 absorbable sutures (A), and opening of the rotator interval and release of the LHBT from the supraglenoid tubercle without opening the BG (B). (BG, bicipital groove; LHBT, long head of the biceps tendon; PM, pectoralis major.)

elbow exercises, as well as active scapular retraction exercises. At 4 weeks postoperatively, the sling is discontinued, and shoulder range of motion is initiated. Progressive strengthening, if necessary, is proposed only after full recovery of active range of motion, no earlier than 3 months postoperatively.[15]

Discussion

We have presented a technique for augmentation of SSc repair using the LHBT after aTSA or rTSA. This inexpensive method is built on a freely available, true biological material that is most often discarded during the procedure. Its major advantage lies in the use of a pediculated autograft, which has the ability, on the one hand, to improve healing and scar formation and, on the other hand, to neutralize the forces applied to the rotator cuff. The only prerequisite to this technique is the availability of the LHBT. The advantages and disadvantages of this technique are detailed in Table 3.

There are several techniques for SSc management during TSA, each with its own set of advantages and disadvantages.[16,17] A plethora of studies[18-21] have examined the optimal method of SSc takedown and repair. Despite improvement of the technique, the failure rate remains high and there is therefore room for further development. Biological environment optimization in SSc repairs after TSA has been underexplored thus far; LHBT may present a promising solution due to its successful role in enhancing healing of rotator cuff repairs.[11]

Hawthorne et al.[22] compared in a cadaveric study the biomechanical strength of a standard SSc peel repair to 2 methods of SSc peel repair augmented with LHBT after aTSA. The augmentation technique consisted of horizontal and V-shaped free grafts applied to the anterior aspect of the upper part and the upper and lower part of the SSc, respectively. The results of this investigation revealed that the augmentation of an SSc peel repair with LHBT conferred greater load to failure and construct stiffness compared to a standard SSc peel repair. Between the 2 augmentation methods, the V-shaped graft was stronger than the horizontal one. Cohn et al.[23] described a technique for rerouting the LHBT after aTSA in order to act as a rip-stop construct to help protect the repair from suture pullout. The LHBT is released from the supraglenoid tubercle while remaining in continuity distally, passed through the SSc tendon vertically in a pulvertaft weave fashion, and secured to itself. Although these techniques provide a robust augmentation, they may present an added risk to the well-established phenomenon of anterior

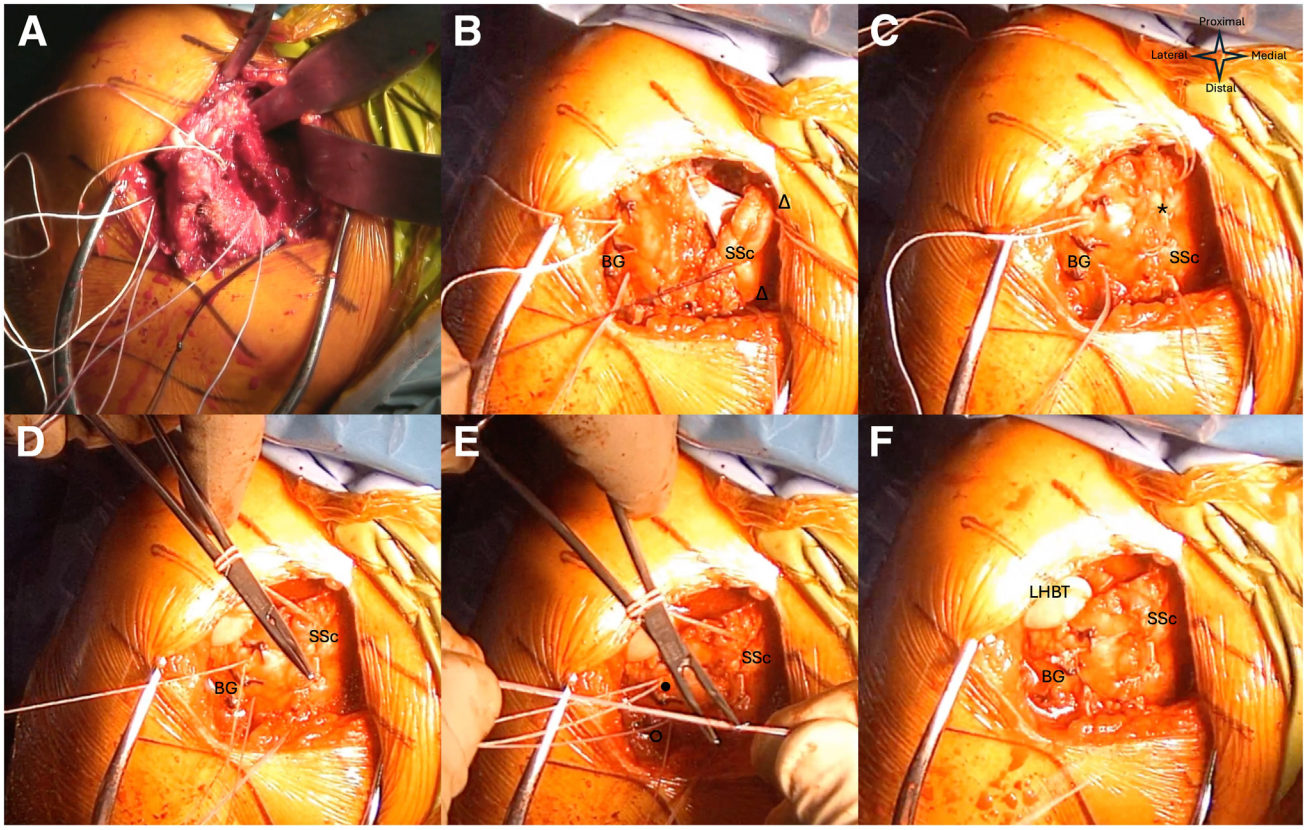

Fig 2. Demonstration of the SSc tendon repair technique in the right shoulder of a patient in the beach-chair position. (A) First, two No. 5 closed-loop nonabsorbable sutures (PowerSuture; Medacta, Castel San Pietro, Switzerland) are passed by the loop end through the metaphysis starting laterally to the bicipital groove. (B) Next, each loop end is run through the SSc tendon from the inside out (Δ). (C) The SSc tenotomy is repaired (*) with side-to-side No. 2 nonabsorbable sutures (PowerSuture; Medacta). (D) Each loop end is folded on itself to create a half-racking hitch held by a clamp. (E) One strand of the superior suture (●) and one strand of the inferior suture (○) are shuttled through the superior loop. The process is repeated for the inferior half-racking hitch using the 2 remaining strands. (F) Finally, sutures are tightened to obtain a crisscrossed suture-bridging configuration secured in 2 half hitches. (BG, bicipital groove; LHBT, long head of the biceps tendon; SSc, subscapularis.)

impingement after TSA[24] as a result of graft bulkiness in the subcoracoid space. The position of the graft at the rotator interval resolves this issue. In addition, it offers the option of augmenting either the supraspinatus or the entire anterosuperior rotator cuff instead of the SSc, decided on a case-by-case basis.

Denard et al.[25] described a surgical technique for SSc augmentation with an LHBT compressed autograft after aTSA. The proximal part of the LHBT was harvested after tenodesis to the pectoralis major and compressed before being applied to the anterior aspect of the SSc repair. This innovative procedure is costly, however, and requires additional material and graft preparation time. Moreover, processing a tubular- into a flat-shaped structure leads ineluctably to a decrease in its mechanical and biological properties, such as ultimate tensile strength and modulus as well as reduction in the residual viable tenocyte count.[26] On the same basis, Barnes et al.[27] suggested an SSc repair augmentation method during aTSA with a bioinductive implant. However, this technique requires 5 to 6 bone anchors in addition to the patch and is therefore expensive. Compared with the aforementioned procedures, our inexpensive technique with a freely available pedicu-lated LHBT autograft retains its structure and its vascularization by its muscular attachment, thereby retaining the mechanical and biological properties closer to the native tendon and favoring healing of the SSc repair.

The described surgical technique offers an additional solution to improving the healing potential of SSc repairs after aTSA as well as rTSA. We believe this procedure can be easily performed and presents very few potential drawbacks. However, further studies are needed to assess its properties and clinical performance.

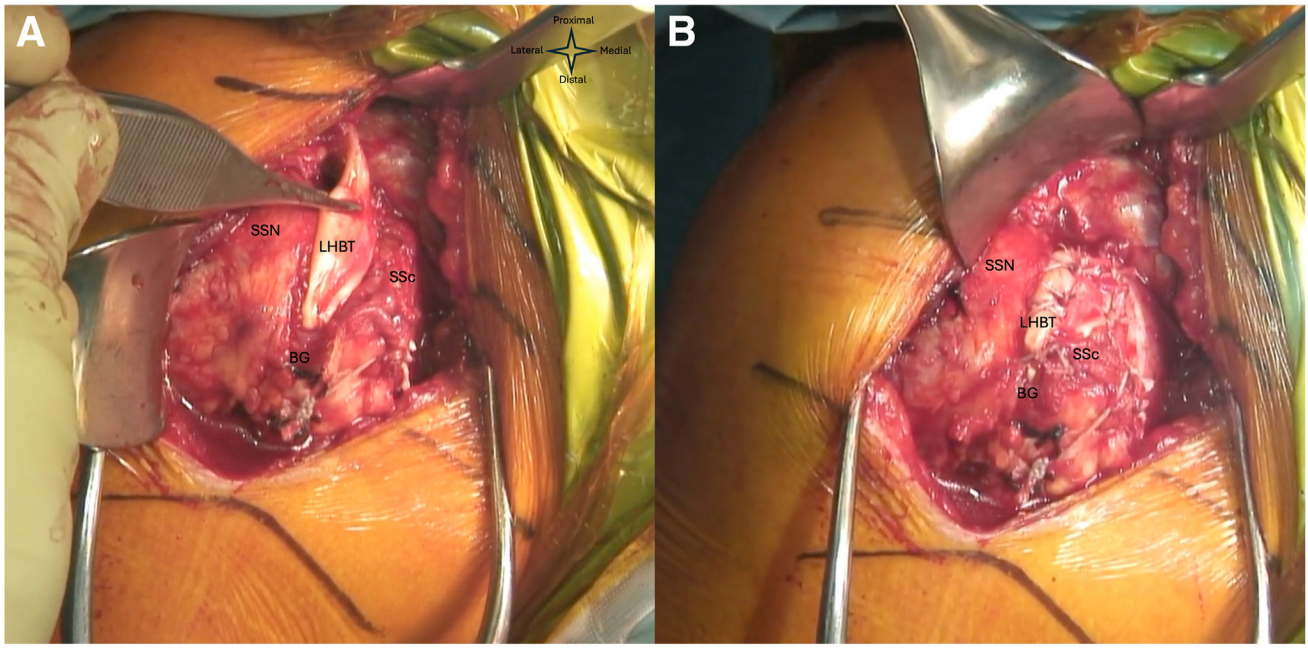

Fig. 3. Presentation of the SSc repair augmentation technique with the LHBT in the right shoulder of a patient in the beach chair position. (A) The LHBT lies at the rotator interval while remaining pediculated distally and stabilized in the unexposed BG. (B) The LHBT is sutured with No. 2 nonabsorbable sutures (PowerSuture; Medacta, Castel San Pietro, Switzerland) to the SSc and the SSn, thereby reinforcing the entire anterosuperior rotator cuff. (BG, bicipital groove; LHBT, long head of the biceps tendon; SSc, subscapularis; SSn, supraspinatus.)

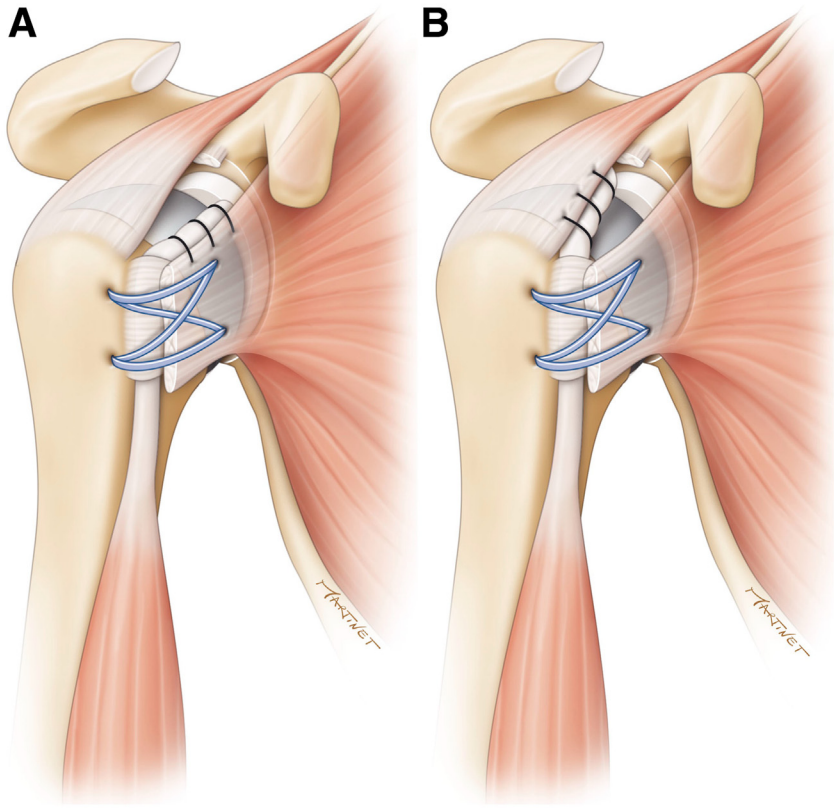

Fig 4. Final construct options for rotator cuff augmentation with a pediculated LHBT autograft. The versatility of this technique resulting from the position of the graft at the rotator interval offers the options of reinforcing either the SSc (A) or SSn (B) on a case-by-case basis depending on the size of the long head of the biceps tendon and the area most in need. (LHBT, long head of the biceps tendon; SSc, subscapularis; SSn, supraspinatus.)

Table 3. Advantages and Disadvantages of the LHBT Pediculated Autograft Augmentation of SSc Repair After TSA

Advantages	Disadvantages
Free available autograft	Unable to perform if LHBT is unavailable
Vascularized graft	No clinical data
No donor-site morbidity	May be a pain generator
No loss of surgical time	
Easy to perform	
No risk of anterior impingement	
Anterosuperior rotator cuff augmentation possible	

LHBT, long head of the biceps tendon; SSC, subscapularis; TSA, total shoulder arthroplasty.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: A.L. reports consulting or advisory, paid expert testimony, speaking and lecture fees, and travel reimbursement from Arthrex and Stryker; consulting or advisory, equity or stocks, funding grants, paid expert testimony, speaking and lecture fees, and travel reimbursement from Medacta International SA; and consulting or advisory and paid expert testimony from Enovis Corporation; (co-)founder of FORE, Med4Cast, and BeeMed; stock options in Follow Health; board member of the French Arthroscopic Society. All other authors (T.M., J.Z., A.E.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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