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Ultrasound-Guided Percutaneous Long Head of Biceps Tenotomy: A Safe and Effective Treatment in Elderly

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SUMMARY

Introduction. Patients with painful shoulder and long head of the biceps (LHB) tendinopathy are candidates for shoulder arthroscopy or other major procedures. However, for patients with comorbidities or to old, a minimally invasive LHB tenotomy may be indicated. We describe the outcomes of ultrasound-assisted LHB tenotomy performed under local anesthesia.

Materials and methods. Between 2015 and 2020, 33 patients underwent echo-guided tenotomy surgery. Inclusion criteria were painful shoulder without pseudoparalysis, intact LHB, and inability or refusal to major surgery. Under ultrasound guidance, the LHB is located and fixed with a 18G needle at the proximal biceps groove. After local anesthesia, a mini-open tenotomy is performed. Both a Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) score and pain on the visual analog scale (VAS) were recorded at baseline and at follow-up. Satisfaction (1 to 5) and adverse events were recorded.

Results. Among the 33 eligible patients, 7 were lost at follow-up. The 26 (of which 17 women) patients enrolled had a median age of 76.5 years (IQR = 7). Mean follow-up was 39.5 months (range 8-63). Median QuickDASH changed from 67.1 to 21.6. Median VAS score before and after tenotomy was 8.5 and 3.5 respectively. Mean satisfaction score was 4.1. We recorded 7 Popeye deformities and 6 hematomas. Four patients presented with cramps and 6 reported a reduction of strength. Only 4/26 would not undergo the procedure again.

Conclusions. The ultrasound-assisted LHB tenotomy was confirmed as a reliable and safe.

KEY WORDS

Long head of biceps; minimally invasive technique; tendinopathy; tenotomy; ultrasound-guided.

INTRODUCTION

The function of the long head of the biceps (LHB) is still debated, described as both a shoulder stabilizer and a humeral depressor, with a role in shoulder proprioception (1-3). LHB tendinopathy is widely reported in cases of shoulder pain and dysfunction, where the main symptom is anterior and deep shoulder pain with causes ranging from inflammatory tendinitis to degenerative tendinosis (4-7). While isolated LHB tendinopathy incidence is low (about 5%), it is often associated with rotator cuff tears and

glenoid labrum tears due to their close anatomic relationship (8). The association of LHB tendinopathy with symptomatic rotator cuff lesions (RCTs) ranges from 36.1% to 88%, with an increased incidence linked to the size of the cuff lesion (9, 10).

The classical management of LHB lesions involves arthroscopic tenotomy or tenodesis, either as part of other shoulder procedures or as an isolated procedure. The biceps tendon can also be used as an augmentation in rotator cuff repair procedures (11). Arthroscopic LHB tendon tenotomy, popularized by some authors, has shown satisfactory results, including faster recovery and fewer residual symptoms compared to tenodesis (6, 12, 13). Older individuals, especially those with osteoporosis of the greater tuberosity, tendon degeneration, and reduced cellular activity, may benefit from tenotomy (14).

Our study aims to describe the results of a rapid, inexpensive LHB tenotomy technique performed under local anesthesia with ultrasound guidance, involving a small incision and no hospitalization. This technique is particularly suitable for elderly patients or those with severe comorbidities, providing an alternative to more invasive procedures.

MATERIALS AND METHODS

Ethical approval

The study was approved by Local Ethical Committee (cod. 09-21 EM – date of approval: September 22, 2021).

Study population

Inclusion criteria comprised individuals aged 75 or older with LHB tendinopathy confirmed by imaging after conservative treatment failure, and individuals aged 65-74 with LHB tendinopathy and rotator cuff tears, severe comorbidity, non-eligibility for high anesthesiological risk, or patient refusal for rotator cuff tear repair or reverse arthroplasty. Exclusion criteria included pseudo paralysis of the shoulder, severe arthrosis, acute infection, and allergy to local anesthetics. Ethical approval was obtained from the local ethics committee for this retrospective case series.

Follow-up

Patients with a follow-up of at least 6 months were considered. QuickDASH and VAS scores were recorded before surgery and at final follow-up. Additionally, a Likert scale assessed satisfaction, and adverse events were documented.

Surgical technique

All procedures were performed in an outpatient setting with the patient position in supine position. A shoulder ultrasound exam was performed to confirm the presence of the LHB tendon. The arm was positioned along the patient's side externally rotated to facilitate identification of the bicipital groove. Skin disinfection was done with a chlorhexidine solution. A sterile cover and a sterile gel were used for the linear multifrequency (4-15MHz) ultrasound (US) transducer (Esaote©, Genoa, Italy), and under ultrasound assistance, the LHB was located. The tendon was initially examined in the transverse plane at the level of the bicipital groove. The tendon was then examined in a longitudinal plane, rotating the transducer by 90°.

After injection of 10 ml 2% lidocaine, the LHB tendon was fixed with an 18G needle to the proximal bicipital groove (**figure 1**). A small skin incision of 1.5-2 cm was made, and a deeper dissection was performed, following the needle embedded in the tendon as a guide (**figure 2**).

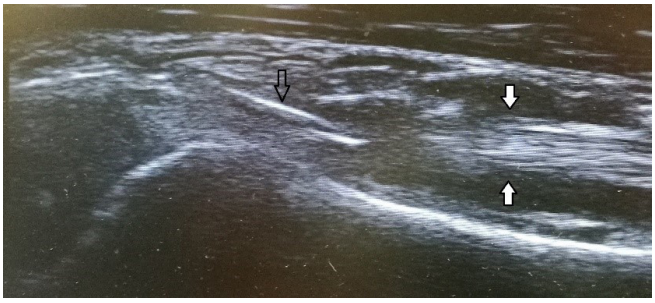

Figure 1. Right shoulder of 71-years-old female: longitudinal view of anterior part of proximal humerus.

Image shows the needle (black arrow) fixing the intact LHB tendon (white arrows) at the level of the bicipital groove.

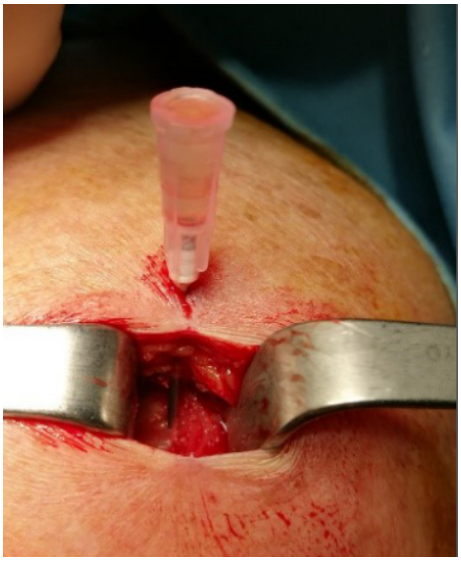

Figure 2. Identification of the LHB tendon through the small incision with the help of the 18G needle.

Tenotomy of the LHB tendon was obtained directly by a #11 scalpel from medial to lateral. Hemostasis was performed after tenotomy, and the skin incision was sutured. The presence of an empty bicipital groove was checked with the US transducer (**figure 3**).
All patients were discharged with pain medication. Local ice packs were recommended for the first 2-3 days, and rapid arm mobilization was encouraged.

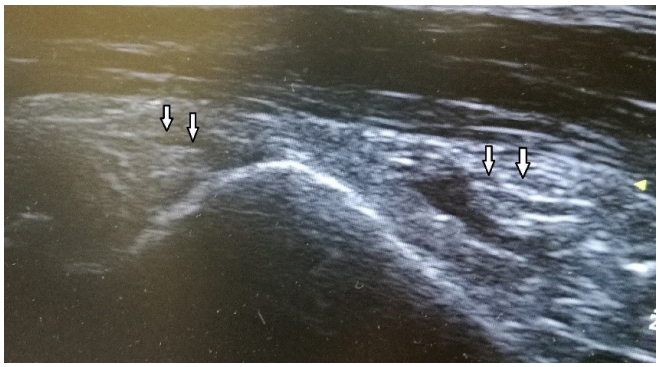

Figure 3. Longitudinal view of anterior part of proximal humerus after procedure.
Image shows empty bicipital groove and the two separate tendon stumps (white arrows).

Statistical analysis

Descriptive statistics were used for categorical (absolute frequency, relative frequency) and continuous (median and interquartile range, IQR) variables. Wilcoxon signed-rank tests compared pre-operative and follow-up scores, with Spearman's rank correlation assessing associations. STATA software, version 15.1 (STATACorp, College Station, TX, USA), was used for all analyses.

RESULTS

Between January 2015 and December 2020, 33 patients underwent minimally invasive ultrasound-assisted percutaneous LHB tenotomy surgery at our institution. Unfortunately, four patients were passed before follow-up, two could not answer our questionnaire independently, and one did not wish to participate in the study. Therefore, we could evaluate 26 patients at a minimum 6-month follow-up and enroll for the study according to our inclusion criteria. All patients fulfilled the inclusion criteria. The male/female sex ratio was 9:17 and the median age of patients was 76.5 years (IQR = 16; range 68-84). In 53,8% of cases (n = 14), it was involved the dominant side. Resume of demographic data are reported in **table I**.

Table I. Demographic data of study population.

Variables		
Age (mean)	76.5 (range 68-84)	
	n	%
Gender		
Male	9	34.6
Female	17	65.4
Arm		
Dominant	14	53.8
Not dominant	12	46.2

A complete tenotomy was obtained in all patients. No intra or peri-operative complications occurred. All patients were discharged 2 hours after the procedure without neurological or cardiovascular symptoms.
The median follow-up was 41 months (IQR = 22; range 8-63). The median VAS score decreases from 8.5 (IQR = 2.0) to 3.5 (IQR = 4) at final follow-up. Median QuickDASH score improved from 67.1 (IQR = 13.7) at baseline to 21.6 (IQR = 15.9) at follow-up. Results of the Wilcoxon signed-rank test indicate that VAS pain levels and QuickDASH scores significantly improved at follow-up, relative to baseline ($p < 0.001$).
We recorded mild pain or discomfort in 8 cases (30.8%) and hematomas at the level of bicipital muscle belly in the early days after the surgery in six cases (23.1%), with a complete recovery in two weeks for all the patients. At follow-up, seven patients (26.9%) presented a Popeye deformity, six (23.1%) referred to a subjective reduction of strength in the arm that underwent surgery, and four (18.2%) reported the occurrence of cramps or spasms. Only one patient needed second shoulder surgery, specifically a reverse shoulder arthroplasty and the mean satisfaction score was 4.1/5 (median 5/5; IQR 2) and 22 patients (84.6%) referred that they would undergo the same procedure again.
There was a significant ($p < 0.001$) negative association between the level of satisfaction and both the VAS and the QuickDASH score at follow-up.
Complete results are reported in **table II**.

DISCUSSION

Most of our patients showed, at short- and medium-term follow-up, improvement in pain and function, after ultrasound assisted tenotomy, recorded on specific questionnaires. Our tenotomy technique is a simple technique that does not require hospitalization and allows one to perform the procedure on an outpatient basis. We believe that in

Table II. Clinical outcomes and adverse events recorded.

Patient	VAS pre	VAS post	QuickDash pre	QuickDash post	Satisfaction (1-5)	Pain	Cramping	Hematomas	Loss of subjective strengh	Popeye deformity	Would repeat the procedure
1	10	5	54.5	15.9	5						Yes
2	8	5	70.5	34.5	3					X	Yes
3	10	8	79.5	59.1	2		X				Yes
4	8	9	65.9	63.6	4					X	Yes
5	7	4	34.1	18.2	5						Yes
6	10	1	70.5	6.8	5						Yes
7	9	2	63.6	18.2	5						Yes
8	9	1	68.2	15.9	5						Yes
9	9	0	70.5	18.2	5						Yes
10	8	0	59.1	9.1	4		X				Yes
11	8	8	45.5	47.7	1			X	X		No
12	10	8	75	59.1	3	X	X	X	X	X	No
13	7	0	63.6	4.5	5			X			Yes
14	6	1	68.2	31.8	5						Yes
15	8	8	45.5	29.5	2		X		X	X	No
16	10	2	72.7	25	5	X					Yes
17	7	1	47.7	29.5	5		X		X	X	Yes
18	10	3	68.2	20.5	5	X		X			Yes
19	9	0	56.8	2.3	5					X	Yes
20	10	4	72.7	22.7	3		X	X			Yes
21	8	3	75	27.3	5		X		X	X	Yes
22	10	1	59.1	4.5	5			X			Yes
23	6	1	9.1	0	5						Yes
24	8	10	75	79.5	1	X	X		X		No
25	10	5	65.9	25	5						Yes
26	8	1	68.2	20.5	5						Yes

an elderly population with LHB tendinopathy, which is not responsive to rehabilitation treatment, LHB tenotomy may be a good and minimally invasive treatment option. Arthroscopic biceps tenotomy or tenodesis provides effective treatments for symptomatic LHB tendinopathy (12, 15). There is no consensus in the literature on tenotomy *versus* tenodesis for LHB tendon injuries because most studies have a low level of evidence (16, 17). A clear benefit of tenotomy is a simple, well-tolerated procedure, less rehabilitation protocol required, and a faster return to activity (18, 19).

Tenotomy is generally reserved for older patients, who are undemanding, unlikely to be unhappy with the cosmetic deformity, and unable or unwilling to comply with postoperative care after tenodesis (20). We observed biceps deformity following tenotomy (Popeye deformity) in six patients, but none of the patients complained about the aesthetic problem. Four patients, on the other hand, complained of a subjective loss of strength, with occasional cramps and spasms, but none of the patients were restricted in their daily activities or hobbies. Although cosmetic deformity (Popeye's sign), cramping, fatigue pain, and supination strength loss could be adverse effects of LHB tendon tenotomy. Kelly *et al*. noted that Popeye's sign is less likely to cause discomfort in older or obese patients, and fatigue cramps are more frequent in younger patients (21, 22).

Percutaneous US-assisted surgery represents a minimally invasive, cost-effective, and reliable procedure associated with rapid recovery and return to activity. Local anesthesia

allows a shorter procedural time and easy management of complicated patients. The current standard procedure for tenotomy is arthroscopically. The arthroscopic technique should be performed in the operating room and requires a special instrumental environment and a surgical team consisting of at least an orthopedic surgeon, a nurse and an anesthetist. Some patients are not willing to undergo the procedure in the operating room and other patients may have comorbidities with contraindication to general and/or loco-regional surgery (23, 24).

In agreement with the findings of our study, other authors (25-28) have demonstrated the feasibility of this surgical technique although the first percutaneous US-guided LHB tendon tenotomy technique published by Levy *et al.* reported a 25% success rate using cadaver shoulders (29). They noted the unreliability of that procedure. The low success rate could result from the presence of an intact rotator cuff in all shoulders which for the authors, could make it more difficult to ultrasound the intra-articular LHB tendon, where they tried to cut the tendon.

With our technique managing to isolate in LHB we have achieved 100% of tenotomies, without risking copious bleeding or failure of the procedure by not being able to cut all the biceps. The decision to perform an intra-articular tenotomy was made based on the rationale of possible impingement of the proximal stump of the LHB.

However, the absence of complications due to the abandonment of the proximal intra-articular stump can be confirmed by the results of this study. There are no paper focusing on this point. In our study, satisfaction and pain scores improved at follow-up, so the proximal stump should not be a source of pain or dysfunction in the shoulder. Another reason for failure and iatrogenic damage could be attributed to the nature of the tendon. It is slippery and mobile so percutaneous tenotomy can be achieved after more than one attempt. However, using multiple attempts increases the chances of iatrogenic injuries, such as injury to the subscapularis tendon or humeral cartilage or injury to the recurrent circumflex artery (29).

In case of anterosuperior cuff rupture, the pulley system of the LHB tendon is lost and the tendon is very unstable with a lot of mobility (30).

The use of the 18G needle described in this article is useful to identify and fix the tendon on the groove to be as precise as possible allowing only one attempt to cut.

A relatively small amount of literature concerning percutaneous tenotomy of the LHB tendon was published. Case report of Greditzer *et al.* and case series of Sconfienza *et al.* shows a good result and improvement of pain after US-guided percutaneous tenotomy (27, 28).

Greditzer *et al.* used an arthroscopic hook to cut the LHB in their case report and needed three passes with the hook scalpel to completely release the tendon, while Sconfienza *et al.* needed an average of 4 cuts of the tendon to ensure successful tenotomy with a #11 scalpel in their series of eleven patients.

Both groups described a complete percutaneous ultrasound-guided technique and needed more than one attempt to completely cut the tendon. This procedure, although minimal, involves a quantified incision by the authors of between 0.5 and 0.7 cm.

Using of a slightly larger incision (1.5-2.0 cm instead of 0.5-0.7 cm) ensures the certainty of tenotomy and control of possible bleeding from the injury of the recurrent circumflex branch of the axillary artery.

The adverse effects reported in our study were pain and biceps cramping in the first few days after surgery with a resolution of symptoms after a few weeks. In line with the available evidence (31, 32), around 27% of patients reported aesthetic deformity of the arm (Popeye sign). Four patients declared they would not undergo the same procedure at the final follow-up. One patient who before declined a major operation underwent a resolving operation with an RSA after one year of treatment; two patients experienced worsening symptoms mainly due to shoulder arthritis responsible for a "grating" sensation inside the joint during movement. Two patients experienced worsening symptoms mainly due to shoulder arthritis, responsible for a "grating" sensation inside the joint during movement. Additionally, one patient reported no benefit from the procedure.

As demonstrated by Boileau *et al.*, patients with pseudo paralysis of the shoulder did not benefit from the procedure. They did not recover active elevation of the shoulder above the horizontal level (12).

The shoulder with true pseudo paralysis is non-functional, which means ineffective active elevation of the arm. In contrast, a shoulder with painful elevation loss is functional but active elevation is limited due to pain. True pseudo paralysis can be differentiated from the painful loss of elevation using the landing test (33).

Only patients with a functional shoulder without glenohumeral osteoarthritis are candidates for a tenotomy. Patients with a non-functional shoulder and glenohumeral osteoarthritis or humeral head necrosis are candidates for a reverse shoulder arthroplasty (12, 34).

The weakness of this study retrospective study is represented by a relatively limited cohort of patients. Another limitation is due to the lack of a control group performed arthroscopically. However, there are such significant differences in cost, procedure time, and procedure modali-

ties between the two procedures that they should not be compared. Furthermore, a major procedure was refused/contraindicated in these patients. However, a study with a more significant number of patients will make it possible to quantify better the frequency of complications associated with this procedure and to analyze any impinging problems caused by the persistent tendon stump in the joint.

CONCLUSIONS

The study confirmed reliability of percutaneous LHB tendon tenotomy with a minimally invasive technique, with high grade or satisfaction of the patients. This is a safe procedure with low adverse events and major complication. This surgical procedure could become an alternative to arthroscopic procedures.

FUNDINGS

None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

SC: investigation, data collection, writing – original draft. MN: writing – review & editing, formal analysis. MG, RS: data collection, formal analysis. MP: formal and statistical analysis. SG: supervision. SN: investigation, writing – review & editing, supervision.

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CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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