Joint Diseases and Related Surgery

Jt Dis Relat Surg
2023;34(1):24-31

ORIGINAL ARTICLE

Treatment outcomes of tendinitis of long head of the biceps brachii tendon by different surgeries based on the concept of enhanced recovery after surgery

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Long head of the biceps brachii tendon (LHBT) is a common cause of shoulder pain and dysfunction in patients with rotator cuff diseases, and its repeated frictional strain is usually considered to be a cause of local inflammation and local microenvironment variations, thereby leading to pain.[1] Long head of the biceps (LHB) tendinitis, an inflammatory tenosynovitis, occurs when the tendon moves along its restricted path in the bicipital groove,[2] which has the manifestation of anterior shoulder pain that would be aggravated in the of overuse, similar to other types of tendinopathy. The tendon sheath of LHBT, an extension of synovial joints, has a close association with the rotator cuff. Besides, it is proved that the tendon sheath is synchronously innervated by sensory and sympathetic nerves. As a result, the

Received: July 20, 2022
Accepted: August 19, 2022
Published online: December 01, 2022

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Doi: 10.52312/jdrs.2022.796

Citation: Chen Q, Shen P, Zhang B, Chen Y, Zheng C. Treatment outcomes of tendinitis of long head of the biceps brachii tendon by different surgeries based on the concept of enhanced recovery after surgery. Jt Dis Relat Surg 2023;34(1):24-31. doi: 10.52312/jdrs.2022.796

ABSTRACT

Objectives: This study aims to evaluate the therapeutic effects of tenotomy and tenodesis of the long head of the biceps brachii tendon (LHBT) under shoulder arthroscopy based on the concept of enhanced recovery after surgery (ERAS) on long head of the biceps (LHB) tendinitis.

Patients and methods: Between January 2019 and January 2021, a total of 80 LHB tendinitis patients (44 males, 36 females; mean age: 55.3±4.5 years; range, 45 to 72 years) were included. The patients were randomly divided into the group of tenotomy of LHBT under shoulder arthroscopy (tenotomy group, n=40) and group of tenodesis of LHBT under shoulder arthroscopy (tenodesis group, n=40). Tenotomy group was randomly subdivided into Tenotomy-1 and Tenotomy-2 groups including 20 patients in each group to receive conventional treatment and treatment plan guided by ERAS concept, respectively. Similarly, the tenodesis group was randomly subdivided into Tenodesis-1 and Tenodesis-2 groups including 20 patients in each group. Their postoperative shoulder joint functions and pain were compared.

Results: The Visual Analog Scale score showed a significant difference between Tenotomy-1 group and Tenodesis-1 group at one, three, and six months after surgery ($p<0.05$). However, there was no significant difference at nine months after surgery ($p>0.05$). In the tenotomy group, although the operation time was shorter, the patients were more prone to develop Popeye deformity after surgery. The American Shoulder and Elbow Surgeon score, Western Ontario Rotator Cuff Index, Constant-Murley shoulder score had no significant differences between the tenotomy and tenodesis groups; however, there was a significant difference between the conventional treatment group (Tenotomy-1 group and Tenodesis-1 group) and ERAS treatment group (Tenotomy-2 group and Tenodesis-2 group) ($p<0.05$).

Conclusion: The clinical efficacy is similar between tenotomy and tenodesis of LHBT under shoulder arthroscopy. While selecting surgical approaches, comprehensive assessment should be performed based on all conditions of patients. Besides, therapeutic schedules should be upgraded and optimized with the help of the ERAS concept after admission to minimize the pain of patients, reduce the potential risk of surgery, and help patients recover quickly.

Keywords: Biceps brachii tendon, enhanced recovery after surgery, shoulder arthroscopy; tendinitis, tenodesis, tenotomy.

pain in the affected area is more evident, severely affecting the quality of life of individuals.[3]

Currently, it is commonly treated via two surgical methods, namely tenotomy and tenodesis, using arthroscopy in clinics. As for the selection of the two surgical methods, there are still some controversies, mainly related to the prognosis, effect, shoulder joint score and appearance deformity.[4]

Enhanced recovery after surgery (ERAS) is a series of evidence-based perioperative optimization processes.[5] It can relieve perioperative stress response, reduce the risk of complications, and accelerate postoperative recovery through the cooperation between anesthesiology, surgery, nutriology and nursing departments, as well as various measures.[6] The ERAS concept has been widely applied in colorectal surgery,[7] thoracic surgery,[8] and orthopedic surgery.[9] Besides, rehabilitation under the guidance of ERAS concept can reduce the incidence rate of postoperative complications, save costs, and accelerate the recovery of functions after surgery.[10]

In the present study, we, for the first time, aimed to evaluate the therapeutic effects of tenotomy and tenodesis of LHBT under shoulder arthroscopy based on ERAS concept on LHB tendinitis and to provide valuable evidence for future clinical treatment.

PATIENTS AND METHODS

This prospective study was conducted at Department of Orthopedics, Ningbo No. 2 Hospital between January 2019 and January 2021. A total of 80 LHB tendinitis patients (44 males, 36 females; mean age: 55.3±4.5 years; range, 45 to 72 years), excluding those complicated with other severe shoulder injury diseases, treated were included. After the admission, procedures of the two surgical methods, their respective merits and demerits, and common postoperative symptoms were explained to patients in detail. Besides, they underwent all necessary preoperative examinations. Next, they were evenly divided into two groups using a random number table, namely group of tenotomy of LHBT under shoulder arthroscopy (tenotomy group, n=40) and group of tenodesis of LHBT under shoulder arthroscopy (tenodesis group, n=40). Half of the patients in the tenotomy group (Tenotomy-1 group) were selected using a random number table for conventional treatment, while the other half (Tenotomy-2 group) were treated with the treatment plan guided by ERAS concept. Tenodesis group was also evenly subdivided into Tenodesis-1 group (conventional treatment) and Tenodesis-2 group (therapeutic regimen under the guidance of ERAS concept) using a random number table. Inclusion criteria were as follows: patients aged ≥45 years old; having a diagnosis by preoperative examination as LHB tendinitis, accompanied by rotator cuff tear in some cases; ineffective or suboptimal outcomes after conservative treatment for ≥4 months before surgery; and those whose imaging and physical examination results supported the diagnosis. Exclusion criteria were as follows: patients complicated with other shoulder joint diseases; receiving shoulder surgery in the past; poor compliance or mental disorders; and severe dysfunction of heart, liver or kidney. After discharge, all patients were followed up for over nine months with a mean follow-up time of 9.24±0.10 months.

Conventional treatment regimen

Before surgery, patients were provided with related matters and precautions of surgery and anesthesia, and encouraged to have functional exercises early in the postoperative period. Non-steroidal anti-inflammatory drugs (NSAIDs) were taken for analgesia on Day 0 to 3 after surgery, and in the case of obvious pain on Day 4 to 7 after surgery. All patients were encouraged to exercise early after surgery, revisit regularly, and obtain guidance on rehabilitation.

Therapeutic regimen under the guidance of ERAS concept

The patients received psychological stress interventions immediately after admission and were introduced with the therapeutic regimen and prognosis of LHB tendinitis. In addition, their questions were actively answered, and they were guided to face the disease squarely. The fear of patients about the disease was, thus, eliminated, ensuring psychological comfort. Next, surgery-related matters and the environment of the operating room were introduced to the patients by virtue of pictures, videos and other materials, decreasing the worries and fears of patients about surgery. Moreover, joint measures for analgesia that would be taken during and after surgery were explained and the fear of patients about the pain was able to be relieved. Furthermore, the time, measures, and recommendations for each rehabilitation stage after surgery were introduced and patients could fully understand the importance of rehabilitation and treatment compliance. Self-controlled intravenous analgesic pump and NSAIDs were utilized for analgesia on Day 0 to 3 after surgery. On Day 4 to 7 after surgery, NSAIDs were orally taken for

analgesia (twice a day, one tablet/time). Postoperative rehabilitation training was conducted on patients by stages.

Tenotomy of LHBT by shoulder arthroscopy

Following successful anesthesia, the patients were in the beach chair position, and the operating area was disinfected and covered with sterile towels and sheets. The standard posterior shoulder arthroscopic approach was, then, positioned and the lens was placed inside for preliminary exploration. The rotator cuff was incomplete at the attachment site of humerus, and partial tear could be seen. The damaged rotator cuff was repaired, and the rupture of the supraspinatus tendon was explored and resected through the incision, in which the tendon was cut and flipped upwards to form a tongue-shaped tendon flap. Then, a small bone groove was made on the bone surface of the humeral surgical neck adjacent to the tendon rupture, and two bone holes were drilled to the side of the greater tubercle. Through the bone holes, the tongue-shaped tendon flap was pulled downwards and outwards and sutured with mattress-suture to the bone groove, with its two sides sutured to the subscapularis and infraspinatus tendons, respectively. Afterwards, inflamed synovial tissues around LHBT in the joint cavity were completely removed through the anterior approach. The arthroscopy was, then, pulled out from the joint cavity and entered the subacromial space. Next, the subacromial fibrous tissues were cleaned up to enlarge the subacromial space. Besides, the lateral acromion approach was established under observation via the posterior approach. Finally, LHBT was cut off using a blue rongeur in the superior glenoid labrum of the glenoid cavity as close to the beginning of the tendon as possible, and then the remaining biceps tendon tissues in the joint cavity were completely removed by an electrotome for vaporization and a planer. After surgery, the incision was sutured and, then, bandaged with sterile dressings. The affected limb was fixed and protected with a special brace in the abduction neutral position.

Tenodesis of LHBT by shoulder arthroscopy

After successful anesthesia, the patients were in the lateral position, and the surgical area was disinfected and draped with sterile towels and sheets. The standard shoulder arthroscopic posterior approach was positioned, and the lens was placed for preliminary exploration. The rotator cuff was incomplete at the attachment site of humerus, and partial tear could be seen. The damaged rotator cuff was repaired, and the rupture of the supraspinatus tendon was explored and resected through the incision, in which the tendon was cut and flipped upwards to form a tongue-shaped tendon flap. Then, a small bone groove was made on the bone surface of the humeral surgical neck adjacent to the tendon rupture, and two bone holes were drilled to the side of the greater tubercle. Through the bone holes, the tongue-shaped tendon flap was pulled downwards and outwards and sutured with mattress-suture to the bone groove, with its two sides sutured to the subscapularis and infraspinatus tendons, respectively. Through the anterior approach, the inflamed synovial tissue around part of LHBT in the joint cavity was completely removed. The arthroscope was withdrawn from the joint cavity and placed into the subacromial space, under which the subacromial fibrous cord tissue was cleaned up to expand the subacromial space. Meanwhile, the lateral acromial approach was created through observation via the posterior approach. At the site adjacent to the anterior approach, a lumbar puncture needle was percutaneously punctured through LHBT to position LHB. The positioning lumbar puncture needle was found through the lateral approach, near which LHBT was found, and a second needle was inserted at a distance of about two horizontal fingers laterally away from the first needle. Then, the two needles were taken out, and the surgical operation and observation approaches were created at the sites of the two needles, respectively. Then, the LHBT sheath was thoroughly released using an electrotome for vaporization through the operation approach to fully expose the tendon. After exposure, LHBT was pushed aside with an instrument to expose the intertubercular sulcus and, then, the bottom of sulcus was slightly polished with a grinding head, until there was a fresh bone bed. Subsequently, a rivet with two threads was used. One thread was pulled out from the root of the rivet with a threader, disassociated and passed through the bottom of the tendon. After removal of the hook, the tendon was reduced and, then, firmly fixed with the other thread using a knot pusher under arthroscopic monitoring. The excess thread was cut off. Finally, the vision was switched to the joint cavity, the tendon was cut off at the proximal end, and the biceps tendon stump in the joint cavity was completely removed. After surgery, the incision was sutured and bandaged with sterile dressing and film. The affected limb was fixed and protected using a special brace in an abduction neutral position.

Grading criteria

The operation time was observed, recorded, and compared between the tenotomy and tenodesis groups. The Visual Analog Scale (VAS) score was given to all patients at different time points.[11] The American Shoulder and Elbow Surgeon (ASES) score,[12] Western Ontario Rotator Cuff Index (WORC),[13] operation time, Constant-Murley shoulder score,[14] and incidence rates of Popeye deformity and cramping pain were compared between the two groups.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 26.0 software (IBM Corp., Armonk, NY, USA). Data were expressed in mean ± standard deviation (SD) or number and frequency, where applicable. The indices were analyzed and compared before and after operation through paired t-test. Intergroup comparison was conducted by independent-samples t-test. Numerical data were compared through the chi-square (χ^2) test. A p value of <0.05 was considered statistically significant.

RESULTS

Overall data

There were a total of 40 patients in the tenotomy group and the mean follow-up was 9.2±2.3 months. There were a total of 40 patients in tenodesis group and the mean follow-up was 9.4±3.4 months. There was no significant difference in the overall data such as sex and age between the two groups (p>0.05).

Shoulder joint pain

After the operation, shoulder joint pain was significantly relieved in both groups compared to that before the operation. The relief of shoulder joint pain was significantly better in the ERAS-treated patients than that in the patients undergoing routine treatment. The VAS score had significant differences between Tenotomy-1 group and Tenodesis-1 group at one, three, and six months after the operation (p<0.05), while it had no significant difference at nine months after the operation (p>0.05). During the postoperative follow-up, there was a significant difference in the VAS score between Tenotomy-1 group and Tenotomy-2 group, and also between Tenodesis-1 group and Tenodesis-2 group (p<0.05) (Table I).

Operation time

The mean operation time was 27.3±3.7 min in the tenotomy group and 59.7±4.3 min in the tenodesis group, indicating a statistically significant difference (p<0.01).

Incidence rates of Popeye deformity and cramping pain

Popeye deformity occurred in 15 patients in the tenotomy group and 0 patients in the tenodesis group, indicating that patients receiving tenotomy were more prone to develop Popeye deformity than those undergoing tenodesis. The incidence rates of Popeye deformity and cramping pain were higher in the Tenotomy-1 group than those in Tenotomy-2 group (p<0.01). The ERAS-treated patients had a lower risk of developing Popeye deformity and cramping pain than those undergoing routine treatment (p<0.01) (Table II).

ASES scores

The ASES scores significantly increased in both groups after the operation compared to that before the operation. The ASES score of ERAS-treated patients was improved more significantly than that in patients undergoing routine treatment. There was no statistically significant difference in the ASES

TABLE I
VAS score at different time points

Groups	Tenotomy (n=40)		Tenodesis (n=40)			
	Tenotomy-1	Tenotomy-2	Tenodesis-1	Tenodesis-2		
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	t	*p*
Before operation	8.34±0.89Δ	8.55±0.91Δ	8.23±1.21*	7.96±0.97*	1.967	0.048
1st month after operation	6.28±0.76*	5.65±0.92*	6.89±0.75*	6.11±0.68*	-2.102	0.032
3rd months after operation	5.27±0.54*	4.12±0.83*	5.97±0.68*	4.87±0.55*	-3.221	0.004
6th months after operation	3.23±0.24*	2.34±0.45*	4.01±0.21*	2.98±0.33*	-2.454	0.002
9th months after operation	1.92±0.41*	1.23±0.21*	1.67±0.22*	1.21±0.23*	2.324	0.323

SD: Standard deviation; * p<0.05: Significant difference between two groups; Δ p>0.05: No difference between two groups.

scores between Tenotomy-1 group and Tenodesis-1 group (p>0.05). However, at one, three, and six months after the operation, the ASES score displayed a significant difference between Tenotomy-1 group and Tenotomy-2 group, and also between Tenodesis-1 group and Tenodesis-2 group (p<0.05) (Table III).

WORC

The WORC significantly increased in both groups after the operation compared to that before the operation. In addition, the WORC of ERAS-treated patients was improved more significantly than that in patients undergoing routine treatment. There was no statistically significant difference in the WORC between Tenotomy-1 group and Tenodesis-1 group (p>0.05). However, at one, three, and six months after the operation, the WORC showed a significant difference between Tenotomy-1 group and Tenotomy-2 group, and also between Tenodesis-1 group and Tenodesis-2 group (p<0.05) (Table IV).

Constant-Murley shoulder scores

At six months after the operation, the Constant-Murley shoulder score significantly increased in

TABLE II
Incidence rates of Popeye deformity and cramping pain

Groups	Tenotomy (n=40)				Tenodesis (n=40)				
	Tenotomy-1		Tenotomy-2		Tenodesis-1		Tenodesis-2		
	n	%	n	%	n	%	n	%	*p*
Popeye deformity	15Δ	75	10Δ	50	1	5	0	0	<0.001*
Cramping pain	3Δ	15	0Δ		0		0	0	<0.001*

* Tenotomy-1 group *vs.* Tenotomy-2 group; Δ p<0.01: significant difference between two groups.

TABLE III
ASES scores at different time points

Groups	Tenotomy (n=40)		Tenodesis (n=40)		
	Tenotomy-1	Tenotomy-2	Tenodesis-1	Tenodesis-2	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	*p*
Before operation	48.22±17.61Δ	48.45±17.45Δ	47.32±15.91*	48.64±16.34*	0.748°
1st month after operation	61.11±22.00*	69.65±18.92*	65.21±19.70*	72.11±17.68*	0.832°
3rd months after operation	72.71±23.20*	79.12±17.83*	74.52±17.91*	80.87±21.55*	0.604°
6th months after operation	77.23±16.87*	82.34±16.45*	79.45±17.89*	83.98±20.33*	0.802°
9th months after operation	81.21±18.21Δ	83.23±19.21Δ	82.34±21.21Δ	84.21±19.23Δ	0.523°

ASES: American Shoulder and Elbow Surgeon; SD: Standard deviation; * p<0.05: Significant difference between two groups; Δ p>0.05: No difference between two groups; ° Tenotomy-1 group *vs.* Tenodesis-1 group.

TABLE IV
WORC at different time points

Groups	Tenotomy (n=40)		Tenodesis (n=40)		
	Tenotomy-1	Tenotomy-2	Tenodesis-1	Tenodesis-2	
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	*p*
Before operation	37.21±15.45Δ	36.43±17.21Δ	34.22±15.41*	35.65±14.84*	0.293°
1st month after operation	44.31±19.00*	49.55±17.92*	42.31±16.50*	49.21±17.38*	0.935°
3rd months after operation	54.45±21.34*	59.43±17.23*	54.32±18.61*	59.56±20.43*	0.187°
6th months after operation	63.13±17.67*	70.24±16.65*	69.35±17.19*	74.28±18.33*	0.893°
9th months after operation	72.11±16.21Δ	76.63±16.91Δ	71.54±20.21Δ	75.96±19.43Δ	0.676°

WORC: Western Ontario Rotator Cuff Index; SD: Standard deviation; * p<0.05: Significant difference between two groups; Δ p>0.05: No difference between two groups; ° Tenotomy-1 group *vs.* Tenodesis-1 group.

TABLE V
Constant-Murley shoulder scores before and after operation

Groups	Tenotomy (n=40)		Tenodesis (n=40)			
	Tenotomy-1	Tenotomy-2	Tenodesis-1	Tenodesis-2		
	Mean±SD	Mean±SD	Mean±SD	Mean±SD	t	*p*
Before operation	36.12±7.45Δ°	36.45±6.23Δ°	36.11±6.82Δ°	36.27±7.11Δ°	-0.456*	0.799*
6th months after operation	69.56±6.34Δ°	74.47±5.67Δ°	70.21±6.56Δ°	75.31±6.77Δ°	-0.637*	0.828*

SD: Standard deviation; * Tenotomy-1 group *vs.* Tenodesis-1 group; Δ p<0.05: Significant difference between two groups at different time points; ° p>0.05: No significant difference between routine group and ERAS group.

both groups compared to that before the operation (p<0.05). The mean Constant-Murley shoulder score was increased from 36.12±7.45 points before the operation to 69.56±6.34 points at six months after the operation in Tenotomy-1 group, from 36.45±6.23 points before the operation to 74.47±5.67 points at six months after the operation in Tenotomy-2 group, from 36.11±6.82 points before the operation to 70.21±6.56 points at six months after the operation in Tenodesis-1 group, and from 36.27±7.11 points before the operation to 75.31±6.77 points at six months after the operation in Tenodesis-2 group. There was no statistically significant difference in the Constant-Murley shoulder score after the operation between Tenotomy-1 group and Tenodesis-1 group (p>0.05) (Table V).

DISCUSSION

Inflammatory alterations and degenerative lesions are the major pathological changes in LHB tendinitis, which may be caused by local traction, friction and trauma,[15] and there has been no satisfactory prevention method yet. On the basis of fully understanding the physiological and pathological states of patients, the ERAS concept allows rational perioperative management by optimizing, improving and combining a series of medical and nursing behaviors, which can increase physiological comfort, decrease psychological pressure, and promote rapid recovery.[16] Bogani et al.[17] found that the ERAS concept mitigated the stress response of patients in the practice of gynecological oncology, reduced the incidence of complications, increased the comfort, and speeded up the postoperative recovery. Lee et al.[18] reported that gastric cancer surgery based on the ERAS concept shortened the hospital stay length, relieved pain, and decreased the risk of complications. Taken together, surgery combined with the ERAS concept are obviously beneficial to the facilitation of rehabilitation, reduction of complications, and alleviation of pain. Nevertheless, whether this concept still works in the perioperative period of LHBT patients has seldom been referred.

Like a previous literature,[19] the main findings in this study is that the therapeutic regimen developed under the guidance of the ERAS concept contributed more to patients' postoperative recovery than conventional treatment, which was effective in relieving pain, improving the ASES score, WORC, and Constant-Murley score, and reducing the postoperative incidence of Popeye deformity and cramping pain. Therefore, integrating the ERAS concept into the clinical treatment of LHB tendinitis would improve the efficiency of rehabilitation and reduce the incidence of postoperative complications in patients.

Besides, this study also revealed that the risk of Popeye deformity was higher in the tenotomy group than that in the tenodesis group, while no significant differences were found in the pain, elbow flexion, supination, and strength (ASES score, WORC and Constant-Murley score) between the tenotomy group and tenodesis group. Different reports regarding Popeye deformity after LHBT tenotomy and tenodesis under the shoulder arthroscope can be found in the literature. Wolf et al.[20] conducted biomechanical analysis on the biceps brachii after tenotomy and tenodesis, and found that the risk of displacement of the distal biceps tendon was higher after tenotomy. Frost et al.[21] discovered that the incidence rate of Popeye deformity after LHBT tenotomy was 3 to 70%, basically consistent with that (62.5%) found in this study. According to major studies, the incidence rate of shoulder deformity increases after LHBT tenotomy compared to that after tenodesis.[22-24] In a recent retrospective study by Godenèche et al.,[25] during the 10-year follow-up, no deformity occurred at all after LHBT tenodesis or tenotomy. A total of 11.4% of patients undergoing tenodesis suffer from Popeye deformity, possibly as the biceps tendon has insufficient tension or the tendon is in a position where the biceps tendon

is over-relaxed. Virk and Nicholson[26] reported that the overall risk of pain and cramp was lower, while the pain on palpation of the biceps was more obvious after LHBT tenodesis. Besides, there are also various reports on postoperative elbow flexion and supination strength. In the present study, the elbow flexion and supination strength had no significant differences after tenodesis and tenotomy. Castricini et al.[27] found that the elbow flexion strength on the surgical side was lower than that on the contralateral side at six months, but no significant difference was observed in the elbow flexion strength after the two procedures. The further explanation is that LHBT tends to be a structure stabilizing the shoulder joint rather than a structure assisting the elbow motion and, therefore, the functional test has a limited effect. The role of LHBT may not be really assessed by the elbow flexion and supination strength. Since both LHBT tenodesis and tenotomy eliminate any effect stabilizing the shoulder, similar results can be obtained after the two procedures.[28-30]

Recently, it has been found by postoperative magnetic resonance imaging (MRI) that the incidence rate of rotator cuff retear has no significant difference after LHBT tenodesis and tenotomy. In a prospective randomized-controlled trial, Lee et al.[31] found through MRI at 12 months after the operation that 80.4% of the biceps tendon was still in the bicipital sulcus in the tenotomy group. The overall success rate of LHBT tenodesis is 90.3% according to the maintenance status of the fixed tendon. Moreover, Lim et al.[32] analyzed the risk factors in LHBT tenotomy and confirmed that the incidence of Popeye deformity was only related to male, and other factors had no correlation with deformity, elbow flexion strength and spastic arm pain. Voss et al.[33] recently observed that the incidence rate of complications after LHBT tenodesis had no increase between patients aged ≥65 years and <65 years. In the present study, neither age nor sex was the confounding factor of the results.

Nonetheless, this study still has certain limitations such as relatively small sample size, short follow-up time, and single sample source. Therefore, further multi-center, large-scale, prospective studies are needed to confirm these findings.

In conclusion, satisfactory clinical efficacy can be achieved by both LHBT tenodesis and tenotomy under the shoulder arthroscope on LHB tendinitis, without a significant difference in the efficacy. Although LHBT tenotomy requires shorter operation time and is effective in early pain relief, the incidence rates of Popeye deformity and cramping pain after tenotomy are higher than those after tenodesis. The therapeutic regimen developed based on the ERAS concept can effectively facilitate the postoperative recovery of patients and, to some extent, it can mitigate the occurrence of complications caused by LHBT tenotomy. Therefore, the patient's condition should be comprehensively considered and assessed while selecting the procedure, and the therapeutic regimen should be upgraded and optimized with the help of the ERAS concept after hospitalization, thereby minimizing the pain of patients, reducing the potential risk in operation, and contributing to quick recovery.

Ethics Committee Approval: The study protocol was approved by the Ningbo No. 2 Hospital Ethics Committee (date: 04.01.2019, no: YJ-NBEY-KY-2022-128-01). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Designed this study and prepared this manuscript: Q.C., P.S.; Collected and analyzed clinical data: B.Z., Y.C., C.Z.; All authors approved the final version of this manuscript.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

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