Research Square

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The capture test for screening long head of the biceps tendon and pulley lesions: a prospective diagnostic accuracy study

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Research Article

Keywords: long head of the biceps tendon, biceps pulley, shoulder arthroscopy, physical examination, diagnostic accuracy, capture test

Posted Date: June 8th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-9606643/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

Clinical diagnosis of long head of the biceps tendon (LHBT) lesions and biceps pulley lesions remains challenging because commonly used physical examination tests show variable diagnostic accuracy. This study evaluated the diagnostic value and reliability of a new clinical maneuver, the capture test, for screening LHBT and pulley lesions.

Methods

In this prospective diagnostic accuracy study, consecutive patients scheduled for shoulder arthroscopy because of shoulder pain and functional limitation between February 2022 and February 2024 were assessed. The capture, Yergason, Speed, uppercut and backward traction (BT) tests were performed using a standardized preoperative protocol. Arthroscopic findings were used as the reference standard. Sensitivity, specificity, predictive values, likelihood ratios, McNemar comparisons, binary logistic regression and kappa statistics were used to assess diagnostic performance and reliability.

Results

Of 277 screened patients, 182 met the eligibility criteria and underwent arthroscopic verification. Arthroscopy identified 118 LHBT lesions, 121 pulley lesions and 110 combined LHBT and pulley lesions. For LHBT lesions, the capture test showed a sensitivity of 0.77 and a specificity of 0.57. For pulley lesions, the capture test showed a sensitivity of 0.84 and a specificity of 0.44. The capture test had the highest sensitivity among the evaluated tests for both outcomes. Inter-rater agreement for the capture test was good (kappa = 0.634–0.737), and intra-examiner agreement was good to excellent (kappa = 0.741–0.852).

Conclusions

The capture test is a reproducible physical examination maneuver with high sensitivity for screening LHBT and pulley lesions. Because its specificity is modest, it should be interpreted as a screening adjunct rather than a stand-alone confirmatory test.

Background

Lesions of the long head of the biceps tendon (LHBT) are common causes of anterior shoulder pain and impaired shoulder function [5, 16]. The LHBT originates from the supraglenoid tubercle and superior labrum, traverses the glenohumeral joint, and exits through the intertubercular groove, also known as the bicipital groove [6]. Because the LHBT crosses the shoulder and is influenced by elbow and forearm

position, shoulder motion, elbow flexion and forearm rotation can alter tendon tension and may provoke symptoms in pathologic conditions [11, 17, 27]. In addition to its potential role as a pain generator, the LHBT contributes to glenohumeral stability through its depressor effect on the humeral head and its relationship with the superior labrum and rotator interval [24].

Accurate clinical diagnosis of LHBT and pulley lesions remains difficult. A complete diagnostic pathway includes history taking, physical examination and imaging; however, imaging results may be affected by scanner quality, acquisition protocol and reader experience. Physical examination is inexpensive, repeatable and immediately available in the outpatient setting, but the diagnostic performance of individual tests for LHBT and pulley lesions has been inconsistent across studies [10, 15, 25]. This inconsistency is partly explained by the close anatomic relationship among the LHBT, biceps pulley, superior labrum, subscapularis and supraspinatus, which can make it difficult to isolate the symptomatic structure clinically [6, 13, 26].

Commonly used clinical tests include the Speed, Yergason, uppercut and backward traction (BT) tests. The clinical utility of traditional and new tests for biceps-labrum complex pathology has been investigated previously [1], and the Speed test has also been evaluated arthroscopically at the bicipital groove [3]. Reported sensitivity and specificity for the Speed and Yergason tests vary widely [4, 10, 25]. The BT test was proposed to reproduce symptoms by placing the shoulder in extension and rotation, thereby emphasizing the role of posterior traction in LHBT and pulley evaluation [15]. Cadaveric observations also suggest that shoulder extension can increase visualization and tension of the LHBT within the bicipital groove [9].

On the basis of these anatomic and biomechanical considerations, we developed a new physical examination maneuver, the capture test. The maneuver combines resisted forearm rotation with controlled downward pressure over the proximal humerus, with the aim of increasing stimulation of the LHBT and pulley complex. We hypothesized that the capture test could be used as a screening test for LHBT and pulley lesions. Therefore, this study aimed to compare the diagnostic performance of the capture test with conventional shoulder examination tests using arthroscopy as the reference standard and to evaluate the inter-rater and intra-examiner reliability of the capture test.

Methods

Study design and setting

This was a single-center prospective diagnostic accuracy study. The study was conducted at Xinhua Hospital Affiliated to Dalian University and included consecutive patients scheduled to undergo shoulder arthroscopy for shoulder pain and functional limitation between February 2022 and February 2024. Reporting was structured according to the requirements for Research articles in Journal of Orthopaedic Surgery and Research, and diagnostic accuracy reporting principles were considered where applicable.

The study was approved by the Institutional Review Board of Xinhua Hospital Affiliated to Dalian University (approval No. 46622) and was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants before enrollment.

Participants

Initially, 277 consecutive patients scheduled for shoulder arthroscopy were screened. The exclusion criteria were as follows: (1) previous ipsilateral shoulder surgery or upper-extremity fracture, (2) inability to complete the physical examination, (3) current shoulder infection or chronic inflammatory arthritis during or before surgery, and (4) preoperative diagnosis of calcific tendinopathy of the rotator cuff.

After initial screening, 14 patients were excluded because of previous ipsilateral shoulder surgery, 6 because of difficulty cooperating with physical examination, 6 because of ipsilateral shoulder fracture, 11 because of calcific tendinopathy, 54 because they did not undergo arthroscopic surgery, and 4 because of shoulder infection. Finally, 182 patients were included in the study and underwent arthroscopic verification.

Physical examination protocol

Each patient underwent a complete shoulder examination within 2 weeks before surgery. The examined maneuvers were the Speed test, BT test, Yergason test, uppercut test and capture test. All tests were performed according to a standardized protocol. The order of tests was randomized by lottery to reduce sequence bias.

All tests were independently performed and recorded at two separate sessions, typically during outpatient intake and 1 day before surgery. The sessions were 3–5 days apart. Examinations were performed by the surgeon and two trained non-surgeon examiners. Examiners were not allowed to view the results recorded by other examiners, and data sheets were completed immediately after each examination.

Yergason test

The patient's elbow was flexed to 90 degrees and the forearm was placed in a neutral position. The patient was asked to externally rotate the forearm against examiner-applied resistance. Pain in the anterior shoulder was considered a positive result.

Speed test

The patient's elbow was fully extended and the shoulder was flexed 90 degrees forward. The examiner applied downward pressure to the forearm while the patient resisted. Anterior shoulder pain was

considered a positive result.

Backward traction test

The BT test was performed with the patient standing and the affected shoulder relaxed. The examiner stood on the same side as the painful shoulder, placed one hand over the glenohumeral joint line to stabilize the shoulder, held the wrist with the other hand, and pulled the involved arm backward into maximal external and internal rotation. Anterolateral shoulder pain or painful clicking at maximal external or internal rotation was considered a positive result.

Uppercut test

The patient stood with the affected shoulder in neutral position, the elbow flexed to 90 degrees, the forearm raised and the fist clenched. The patient was asked to move the hand rapidly toward the chin in an uppercut-like motion while the examiner resisted the movement. Pain in the involved shoulder during resisted motion was considered a positive result.

Capture test

The capture test was performed with the patient standing, the shoulder relaxed and the elbow flexed to 90 degrees. The examiner stood on the same side as the painful shoulder, placed one hand on the proximal humerus and applied mild downward pressure. The other hand held the wrist. The patient was instructed to externally rotate the forearm while the examiner applied resistance. Pain in the anterior shoulder was considered a positive result (Fig. 1).

Arthroscopic reference standard

Arthroscopic findings were used as the reference standard. Arthroscopy was performed by a senior sports medicine surgeon with more than 20 years of experience. The surgeon was blinded to the registered preoperative physical examination data sheets but had access to routine preoperative clinical information and imaging required for patient care.

Arthroscopy was performed in the beach-chair or lateral decubitus position using standard posterior viewing and anterior or anterolateral portals to assess intra-articular structures. Posterior viewing and lateral approaches were used to assess subacromial pathology. During assessment of the LHBT, the tendon was probed and pulled out of the bicipital groove as far as possible to reduce the risk of missing hidden lesions.

Pulley lesions were classified according to the four types described by Habermeyer et al. [8]. Type I indicated isolated superior glenohumeral ligament injury; type II indicated superior glenohumeral ligament injury with partial articular-sided supraspinatus tear; type III indicated superior glenohumeral

ligament injury with tear of the upper third of the subscapularis; and type IV indicated superior glenohumeral ligament injury with combined partial articular-sided supraspinatus tear and tear of the upper third of the subscapularis.

LHBT lesions were assessed dynamically for stability and macroscopically for tendon quality. Stability was classified as centered or subluxated; subluxation was recorded when the tendon reached the upper border of the medial wall of the bicipital groove. Macroscopic assessment classified the LHBT as normal, tendinopathic or torn [14, 19, 20]. Tear severity was categorized by the percentage of tendon involvement. Tendinopathy was diagnosed by visible inflammation, fraying or wear of the LHBT. SLAP lesions were recorded according to the Snyder classification [21].

Data collection and blinding

At each clinical examination session, the three examiners independently recorded the results of each maneuver on separate data sheets. Results from different examiners and time points were recorded independently to minimize recall and communication bias. The arthroscopic surgeon completed a separate intraoperative record immediately after surgery. The lesions of primary interest were LHBT and pulley lesions.

Statistical analysis

Statistical analyses were performed using SPSS version 27.0 (IBM Corp., Armonk, NY, USA). Arthroscopic findings were used as the reference standard. Sensitivity was calculated as true positives divided by the sum of true positives and false negatives. Specificity was calculated as true negatives divided by the sum of true negatives and false positives. Accuracy was calculated as the sum of true positives and true negatives divided by the total sample. Positive predictive value, negative predictive value, positive likelihood ratio and negative likelihood ratio were calculated using standard definitions.

The diagnostic value of the capture test was compared with that of conventional tests using the McNemar test for paired data. Binary logistic regression was used to assess the independent predictive value of each examination maneuver. Inter-rater and intra-examiner reliability were assessed using kappa statistics. Kappa values greater than 0.80 were interpreted as excellent agreement, 0.61–0.80 as good agreement, 0.41–0.60 as moderate agreement, 0.21–0.40 as fair agreement and 0.20 or lower as poor agreement. A two-sided p value less than 0.05 was considered statistically significant. No formal sample-size calculation was performed because this was an exploratory evaluation of a new examination maneuver.

Results

Patient characteristics and arthroscopic findings

A total of 182 patients underwent surgical intervention and were included in the final analysis. The cohort included 77 males (42.3%) and 105 females (57.7%), with an age range of 22–68 years. Right-

shoulder surgery was performed in 144 patients (79.1%), and the dominant side was involved in 138 patients (75.8%). No patient underwent bilateral surgery. Sixty-eight patients (37.4%) reported smoking, and 42 patients (23.1%) had diabetes mellitus. Shoulder pain was reported by 155 patients (85.2%), and the mean duration of symptoms was 9.7 +/- 2.7 months.

Table 1
Diagnostic performance of the clinical tests for LHBT and pulley lesions

Target lesion	Test	Sensitivity	Specificity	LR+	LR-	PPV	NPV
LHBT lesion	Speed test	0.44	0.68	1.38	0.83	0.72	0.40
LHBT lesion	BT test	0.69	0.63	1.86	0.50	0.77	0.52
LHBT lesion	Yergason test	0.55	0.61	1.39	0.74	0.72	0.42
LHBT lesion	Capture test	0.77	0.57	1.78	0.40	0.77	0.57
LHBT lesion	Uppercut test	0.66	0.70	2.17	0.49	0.80	0.52
Pulley lesion	Speed test	0.40	0.61	1.02	0.99	0.67	0.34
Pulley lesion	BT test	0.76	0.50	1.53	0.47	0.75	0.51
Pulley lesion	Yergason test	0.42	0.49	0.81	1.20	0.62	0.29
Pulley lesion	Capture test	0.84	0.44	1.51	0.36	0.75	0.58
Pulley lesion	Uppercut test	0.66	0.42	1.13	0.82	0.69	0.38

Abbreviations: BT, backward traction; LHBT, long head of the biceps tendon; LR-, negative likelihood ratio; LR+, positive likelihood ratio; NPV, negative predictive value; PPV, positive predictive value.

Arthroscopy identified LHBT lesions in 118 patients (64.8%), pulley lesions in 121 patients (66.5%) and combined LHBT and pulley lesions in 110 patients. Detailed intraoperative findings are shown in Table 2.

Table 2
Intraoperative findings

Intraoperative finding	Number of patients
Normal LHBT	64 (35.2%)
LHBT lesion	118 (64.8%)
Complete tear	11 (9.3% of LHBT lesions)
Tendinopathy	40 (34.2% of LHBT lesions)
Tear < 50%	33 (27.9% of LHBT lesions)
Tear > 50%	34 (28.6% of LHBT lesions)
Normal SLAP complex	138 (75.9%)
SLAP lesion	44 (24.1%)
SLAP type I	13 (29.5% of SLAP lesions)
SLAP type II	17 (38.6% of SLAP lesions)
SLAP type III	11 (25.0% of SLAP lesions)
SLAP type IV	3 (6.8% of SLAP lesions)
Normal pulley	61 (33.5%)
Pulley lesion	121 (66.5%)
Pulley type I	22 (18.2% of pulley lesions)
Pulley type II	24 (19.8% of pulley lesions)
Pulley type III	35 (28.9% of pulley lesions)
Pulley type IV	40 (33.1% of pulley lesions)
Abbreviations: LHBT, long head of the biceps tendon; SLAP, superior labrum anterior and posterior.	

Diagnostic performance for LHBT lesions

The diagnostic performance of each test for LHBT lesions is summarized in Table 1. The capture test showed the highest sensitivity for LHBT lesions (0.77), with a specificity of 0.57. In comparison, the sensitivity and specificity were 0.55 and 0.61 for the Yergason test, 0.44 and 0.68 for the Speed test, 0.69 and 0.63 for the BT test, and 0.66 and 0.70 for the uppercut test.

Diagnostic performance for pulley lesions

The diagnostic performance of each test for pulley lesions is summarized in Table 1. The capture test showed the highest sensitivity for pulley lesions (0.84), with a specificity of 0.44. In comparison, the

sensitivity and specificity were 0.42 and 0.49 for the Yergason test, 0.40 and 0.61 for the Speed test, 0.76 and 0.50 for the BT test, and 0.66 and 0.42 for the uppercut test.

Subgroup observation and regression analysis

Among the 11 patients with complete LHBT rupture, no patient had negative results across all tests. Positive results were recorded in 5 patients for the capture test, 5 for the Speed test, 6 for the Yergason test, 6 for the uppercut test and 5 for the BT test. These findings should be interpreted descriptively because of the small number of complete ruptures.

Binary logistic regression analysis showed that the capture test had the largest odds ratio among the evaluated maneuvers for both pulley lesions and LHBT lesions (Table 3).

Table 3
Binary logistic regression results

Target lesion	Test	OR	p value
Pulley lesion	Capture test	19.1	< 0.05
Pulley lesion	BT test	14.6	< 0.05
Pulley lesion	Yergason test	1.5	< 0.05
Pulley lesion	Uppercut test	1.2	< 0.05
Pulley lesion	Speed test	0.59	< 0.05
LHBT lesion	Capture test	26.1	< 0.05
LHBT lesion	BT test	20.7	< 0.05
LHBT lesion	Speed test	0.07	< 0.05
LHBT lesion	Uppercut test	3.34	< 0.05
LHBT lesion	Yergason test	0.52	< 0.05

Abbreviations: BT, backward traction; LHBT, long head of the biceps tendon; OR, odds ratio.

Reliability analysis

Inter-rater agreement for the capture test among the three examiners was good, with kappa values of 0.664, 0.634 and 0.737. Intra-examiner agreement was good to excellent, with kappa values of 0.741, 0.852 and 0.831. Reliability results for all tests are shown in Table 4.

Table 4
Inter-rater and intra-examiner reliability scores for the clinical tests

Reliability assessment	Test	Examiner 1 vs 2	Examiner 1 vs 3	Examiner 2 vs 3
Inter-rater	Capture test	0.664	0.634	0.737
Inter-rater	Yergason test	0.514	0.682	0.384
Inter-rater	Speed test	0.482	0.654	0.461
Inter-rater	BT test	0.674	0.725	0.547
Inter-rater	Uppercut test	0.641	0.561	0.722
Intra-examiner	Capture test	0.741	0.852	0.831
Intra-examiner	Yergason test	0.614	0.622	0.784
Intra-examiner	Speed test	0.682	0.754	0.761
Intra-examiner	BT test	0.654	0.625	0.647
Intra-examiner	Uppercut test	0.781	0.631	0.528
Abbreviation: BT, backward traction.				

Discussion

This study evaluated a new physical examination maneuver, the capture test, for screening LHBT and pulley lesions in patients undergoing shoulder arthroscopy. The principal finding was that the capture test had the highest sensitivity among the examined maneuvers for both LHBT lesions (0.77) and pulley lesions (0.84). The test also showed good inter-rater agreement and good to excellent intra-examiner agreement, suggesting that the maneuver can be reproduced after standardized training. However, the specificity of the capture test was modest, especially for pulley lesions, indicating that it should be used as a screening test rather than a stand-alone confirmatory test.

The diagnostic behavior of the capture test may be explained by the mechanical environment created during the maneuver. Resisted forearm rotation activates the biceps while downward pressure and shoulder positioning may increase contact and tension between the LHBT and surrounding pulley structures. Anatomic and biomechanical evidence indicates that the long and short heads of the biceps differ in their rotational contributions, supporting the rationale for using resisted forearm rotation to provoke LHBT-related symptoms [12]. Arthroscopic observation suggests that shoulder extension can increase compression and passive traction of the LHBT (Fig. 2). This may make lesions of the intra-articular tendon, bicipital groove and pulley complex more likely to become symptomatic during the examination.

The biceps pulley is formed by the superior glenohumeral ligament, coracohumeral ligament and fibers from the subscapularis and supraspinatus tendons [13, 26]. Because LHBT lesions and pulley lesions

frequently coexist [2, 8, 23, 26], a maneuver that stresses the LHBT-pulley complex may be clinically valuable. In this cohort, 110 of 182 patients had combined LHBT and pulley lesions, supporting the close clinical relationship between these structures.

The diagnostic performance of traditional tests in the present study was broadly consistent with prior reports showing variable sensitivity and specificity. Li et al. reported that the BT test had sensitivity and accuracy of 74% and 68%, respectively, for diagnosing LHBT lesions [15]. Holtby and Razmjou reported limited sensitivity for the Speed and Yergason tests [10], whereas Cardoso et al. reported different estimates in a surgical population [4]. Taylor et al. emphasized the need for comprehensive evaluation of the biceps-labrum complex and bicipital tunnel rather than reliance on a single maneuver [25]. The present findings support that view: the capture test improves screening sensitivity but does not replace imaging, clinical judgment or arthroscopic assessment when treatment decisions are being made.

Because diagnostic accuracy metrics are not always interpreted consistently in clinical practice, clear communication of sensitivity, specificity and likelihood ratios is important [22]. Likelihood ratios provide a clinically meaningful interpretation of test results because they combine sensitivity and specificity and can be applied across different pretest probabilities [7, 18]. In the present study, the positive likelihood ratios of the physical examination maneuvers were generally modest and did not reach thresholds that would be considered strongly confirmatory. The capture test showed the lowest negative likelihood ratio among the evaluated tests for both LHBT and pulley lesions, indicating that a negative result may be more useful for reducing the probability of disease than a positive result is for confirming disease. This supports its role as a screening adjunct in outpatient assessment.

The capture test is somewhat more complex than conventional maneuvers, which could theoretically increase the learning curve and inter-examiner variability. Nevertheless, the reliability analysis showed good inter-rater agreement and good to excellent intra-examiner agreement. These results suggest that, when performed using a standardized protocol, the capture test has acceptable clinical reproducibility.

Limitations

This study has several limitations. First, although the examination protocol was standardized, the tests were performed by multiple examiners, and examiner-specific technique could not be completely eliminated. Second, because the capture test had been used clinically before formal study initiation, learning effects and examiner familiarity may have influenced performance. Third, arthroscopy was used as the reference standard; although direct visualization is clinically robust, some hidden bicipital groove lesions may still be missed despite probing. Fourth, the arthroscopic surgeon was blinded to the registered physical examination data sheets but was aware of routine clinical diagnosis and may have reviewed imaging during routine care. Fifth, the capture test may provoke substantial pain in some patients, which can reduce cooperation and limit test completion. Sixth, SLAP lesions were recorded but were not the primary outcome of this analysis. Because SLAP, LHBT and pulley lesions often coexist,

future studies should evaluate whether the capture test can contribute to the diagnosis and treatment stratification of SLAP lesions.

Conclusions

The capture test showed high sensitivity and acceptable reliability for screening LHBT and pulley lesions in patients undergoing shoulder arthroscopy. Its modest specificity means that a positive result should be interpreted together with history, other physical examination findings and imaging. The capture test may be useful as a simple clinical screening adjunct for suspected LHBT and pulley lesions.

Abbreviations

BT
backward traction
CHL
coracohumeral ligament
LHBT
long head of the biceps tendon
LR-
negative likelihood ratio
LR+
positive likelihood ratio
NPV
negative predictive value
OR
odds ratio
PPV
positive predictive value
SGHL
superior glenohumeral ligament
SLAP
superior labrum anterior and posterior.

Declarations

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of Xinhua Hospital Affiliated to Dalian University (approval No. 46622). Written informed consent was obtained from all participants.

Clinical trial number

Clinical trial number: not applicable.

Consent for publication

Written informed consent for publication of potentially identifiable clinical images was obtained from the participants shown in the figures. The signed consent forms will be made available to the journal upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

Authors' information

Not applicable.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Author Contribution

Author contributionsJ.G. and L.X. contributed to the conception and design of the study. J.G. wrote the main manuscript text and prepared the figures and tables. B.W. and X.X. were responsible for patient recruitment, clinical examination, and data collection. D.X. contributed to data curation and statistical analysis. L.X. supervised the study, performed the arthroscopic assessments, and revised the manuscript critically for important intellectual content. All authors read and approved the final manuscript.

Acknowledgements

AI-assisted language editing was used to improve grammar, clarity and journal formatting. The authors reviewed and verified the final manuscript and take full responsibility for its content.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Figures

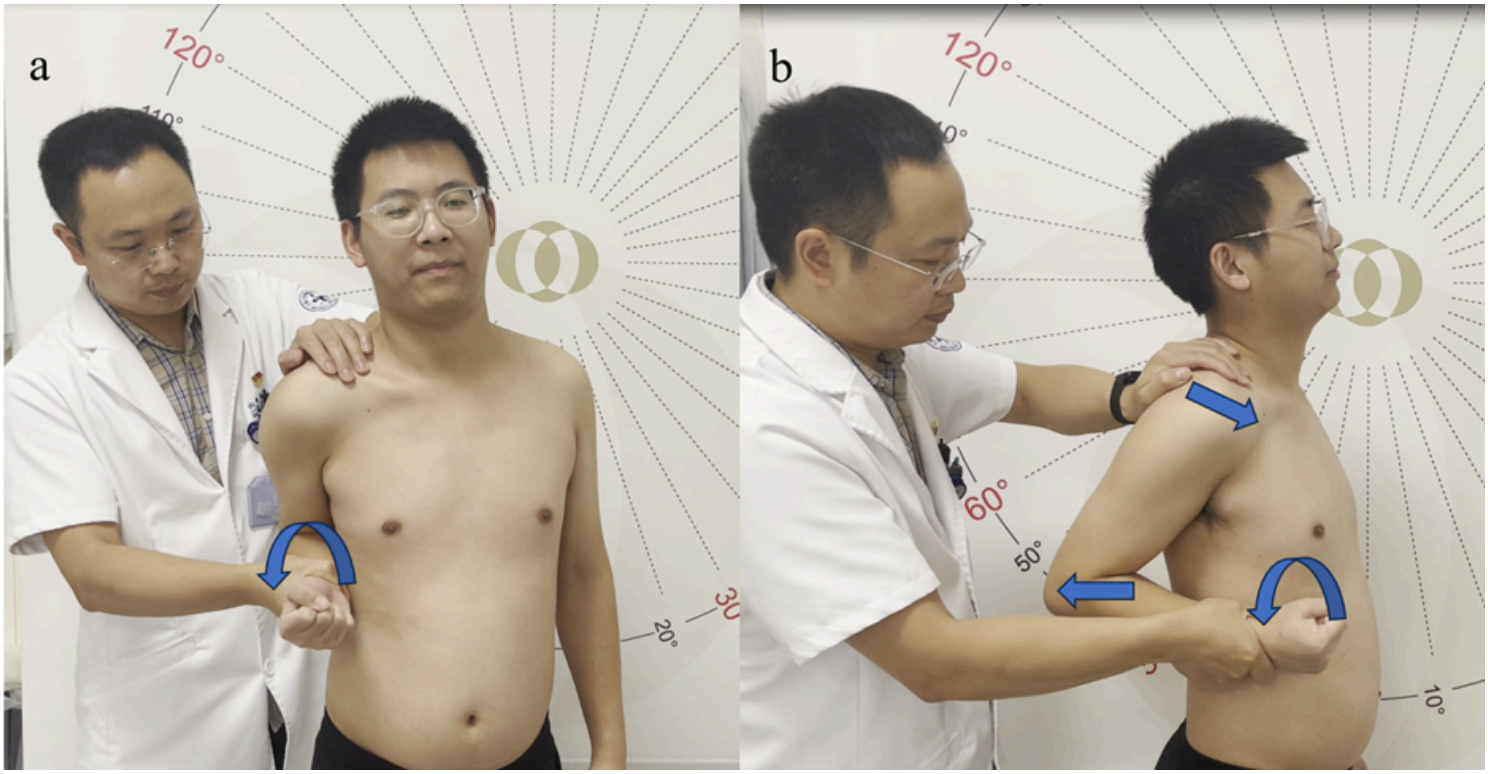


Figure 1

Capture test. (a) Anterior view of the capture test. (b) Lateral view of the capture test.

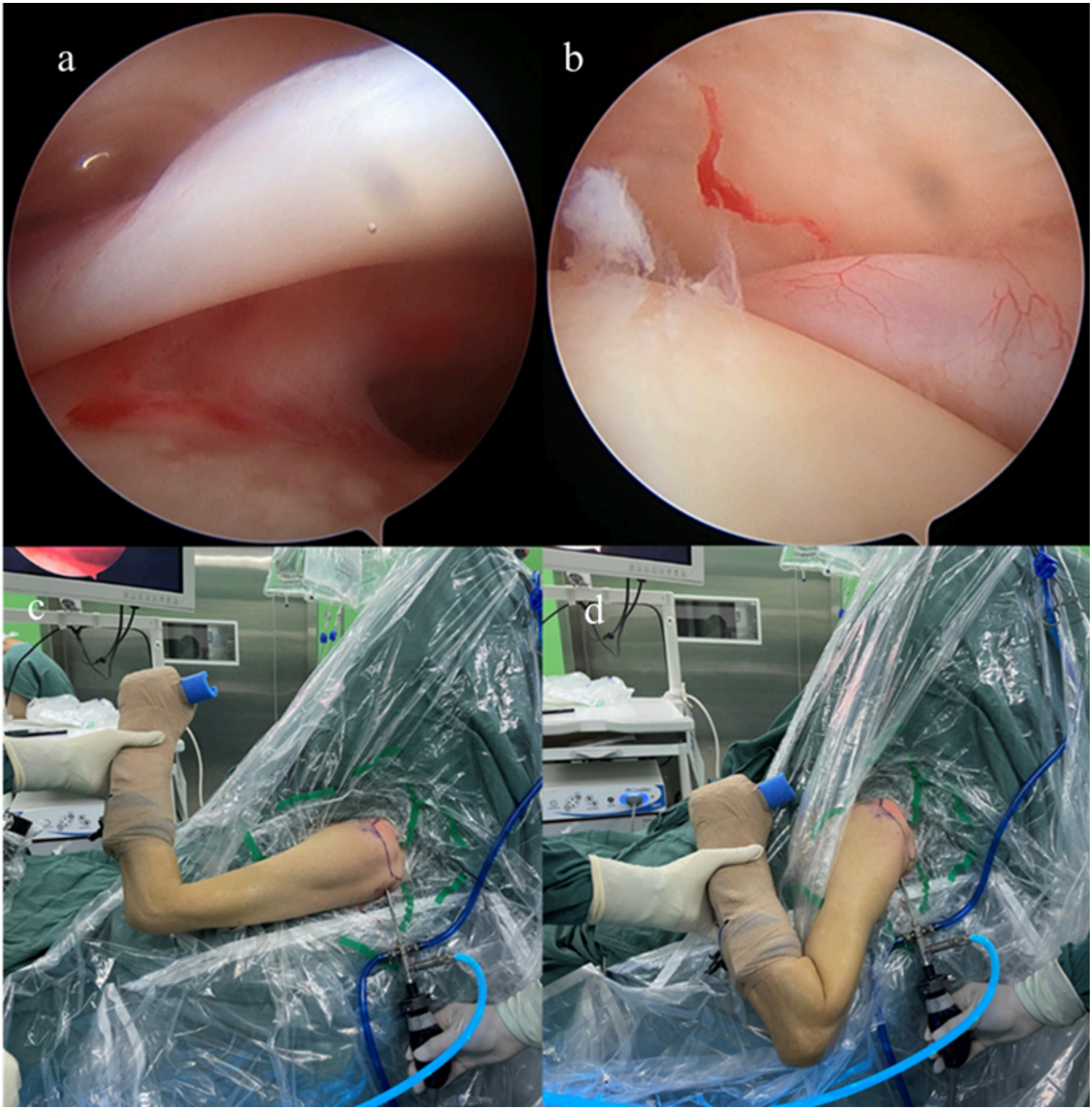


Figure 2

Intraoperative visualization. (a) Separation of the LHBT from surrounding structures in the neutral shoulder position. (b) Compression of the LHBT by surrounding structures during posterior extension of the shoulder. (c, d) Corresponding shoulder positions.