Biceps tendon instability with or without pulley tears: an arthroscopic diagnostic study

Jo-Ting Kao

Bone and Joint Research Center, Department of Orthopaedic Surgery, Chang Gung Memorial Hospital-Linkou

Chih-Hao Chiu

Bone Joint Research Center, Department of Orthopaedic Surgery, Chang Gung Memorial Hospital-Linkou and University College of Medicine

Kuo-Yau Hsu

Bone and Joint Research Center, Department of Orthopaedic Surgery, Chang Gung Memorial Hospital-Linkou and University College of Medicine

Shih-Sheng Chang

Bone and Joint Research Center, Department of Orthopaedic Surgery, Chang Gung Memorial Hospital-Linkou and University College of Medicine

Yi-Sheng Chan

Bone and Joint Research Center, Department of Orthopaedic Surgery, Chang Gung Memorial Hospital-Linkou and University College of Medicine

Alvin Chao-Yu Chen (✉ alvinchen@cgmh.org.tw)

Bone and Joint Research Center, Department of Orthopaedic Surgery, Chang Gung Memorial Hospital-Linkou and University College of Medicine <https://orcid.org/0000-0003-0111-490X>

Research article

Keywords: arthroscopy, biceps tendon, pulley lesion, ramp test, anterior shoulder pain

Posted Date: February 12th, 2020

DOI: <https://doi.org/10.21203/rs.2.23263/v1>

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Abstract

Background To investigate long head of the biceps tendon (LHBT) instability and biceps reflection pulley (BRP) lesions with dynamic arthroscopy in patients with refractory anterior shoulder pain and determine associated intraarticular pathologies.

Methods Patients with refractory anterior shoulder pain and arthroscopically-diagnosed LHBT instability were enrolled. LHBT instability was confirmed by either static dislodge from the groove or subluxation induced by the hook probe (ramp test), and the integrity of BRP and concomitant intra-articular lesions were investigated. Demographics and arthroscopic findings were compared between patients with and without BRP tear.

Results A total of 40 patients with refractory anterior shoulder pain and arthroscopically-diagnosed LHBT instability identified through review of medical records at a single surgeon's practice from 2014 to 2017 were enrolled. BRP tear was noted in 25 patients (group A) and superior glenohumeral ligament (SGHL) insufficiency through ramp test, in 15 patients (group B). No significant difference of patient characteristics was observed between the two groups. Concomitant intraarticular pathologies were noted in 27 patients, including 19 in group A (76%) and eight in group B (53%), without significant group-wise difference ($P = 0.083$). The incidence of articular-side subscapularis tear was significantly higher in group A ($P = 0.021$), and those of the other intraarticular pathologies were similar between groups A and B. Fraying at the articular side of the subscapularis and supraspinatus tendons was frequent in group B, without difference of incidence as compared to group A ($P = 0.5$ and $P = 0.084$, respectively).

Conclusions LHBT instability was a common disorder in patients with refractory shoulder pain. In patients with refractory anterior shoulder pain, dynamic assessment of BRP lesions and SGHL insufficiency and meticulous survey of associated intra-articular pathologies, including subscapularis tear are necessary for making accurate diagnosis.

Background

Anterior shoulder pain is a common presentation in orthopedic clinics, but its diagnosis and imaging remain a challenge. The long head of the biceps tendon (LHBT) is considered as a common source of pain, especially in the anterior shoulder. The concept of anterosuperior shoulder impingement (ASI) was proposed to explain the relationship between anterior shoulder pain and LHBT pathologies of the biceps reflection pulley (BRP) and subscapularis tendon.¹ Anatomically, LHBT turns at a sharp angle as it leaves the glenohumeral joint and moves toward the bicipital groove; BRP acts as a tendoligamentous sling that stabilizes LHBT at the turning point before entry in the bicipital groove.² Habermeyer et al. reported that ASI was caused by BRP lesions including degenerative changes, macro-trauma, or repetitive micro-trauma, which results in LHBT instability.³ The ramp test is an arthroscopic technique that determines the integrity of the BRP pulley which reflects intra-articular LHBT stability.⁴ Due to lack of definite diagnostic

tools, the BRP and LHBT lesions were usually detected and classified with rotator cuff pathologies, whereas the isolated pulley lesions remained underrecognized.^{3,5,6}

This study aimed to investigate symptomatic LHBT instability and BRP lesions in patients with refractory anterior shoulder pain. We hypothesized that lesions of the pulley complex of LHBT are common and representative pathologies in those patients.

Methods

The study was approved by our institutional review board (IRB no. 201901127B0). Retrospective review was conducted of the medical records of patients underwent shoulder arthroscopic surgery performed by a single surgeon from 2014 to 2017; prospectively collected records were submitted for analyses. The eligibility criterion was refractory anterior shoulder pain for more than 3 months without symptomatic rotator cuff tear. Patients with a preoperative diagnosis of complete rotator cuff tear through magnetic resonance imaging (MRI) or with symptoms of frozen shoulder were excluded. Finally, 40 patients with complete informed consent forms were enrolled including 17 men and 23 women, with mean age of 51.2 (range 19–74) years. Right shoulder involvement was observed in 24 patients, of who, 21 were right handed, and left shoulder involvement, in 16 patients, of who, five were left handed. Traumatic events were reported by 35 patients (87.5%), including 18 sports-related, seven work-related, and 10 fall accidents; with regard to sports-related injuries, in eight patients it was due heavy resistance training, in six, overhead exercises, in two each, contact sports and boxing training, and in the remaining five patients (12.5%), due to no known major traumatic episode. The mean duration of symptoms was 6.3 (range 3–18) months. Lack of response to local steroid injection was noted in 14 patients (35%).

Arthroscopic technique

In all patients, arthroscopic examination was conducted under general anesthesia at beach semi-sitting position of the patient with a 30° 4-mm arthroscope through a standard posterior portal. Glenohumeral inspection was conducted starting from the superior labrum of LHBT toward the posterior labrum. Labrum detachment with posterior peel-back was defined as a superior labrum anterior and posterior (SLAP) lesion and the lesion was classified according to the method of Snyder.⁷ Arthroscopic inspection was continued along the posterior and inferior labrum, glenohumeral articulation, anterior labrum including the glenohumeral ligaments, and finally up to the articular side of the subscapularis tendon. Dynamic examination of the tissue tension and integrity with hook probe was performed in the superior subscapularis footprint, BRP sling including the superior glenohumeral ligament (SGHL), and coracohumeral ligament (CHL). Biceps stability and integrity were evaluated by ramp test, and simultaneously, articular insertion of the supraspinatus tendon was examined under different directions of shoulder rotation. ASI was defined as intra-articular impingement of the superior subscapularis insertion against the anterosuperior glenoid labrum under flexion-adduction of the shoulder. Presence of fraying change, tendon tear, and inducible tendon subluxation was recorded and videotaped (Video). The

subacromial space was arthroscopically examined through the standard posterior portal. All arthroscopic findings were documented in digitized standard operation records.

Statistical analysis

Descriptive statistics were calculated for key variables. An independent sample t-test was used for normally distributed, continuous data (patient age and symptom duration); Mann-Whitney U-test, for categorical data (sex, side of injury, and associated pathologies). P-value of < 0.05 was considered to be statistically significant.

Results

In all 40 patients, synovitis was identified along LHBT and the bicipital groove (Fig. 1); patients were divided into two groups: group A with pulley tear and group B without pulley tear. Comparison of demographic data and associated intra-articular pathologies was performed between the two groups. No significant differences of the patient age, gender, dominant shoulder involvement, traumatic events, and pain duration were observed (Table 1). Pulley tear was detected in 25 patients (63%; group A); of those patients, involvement of the medial pulley was observed in 22 patients including 10 cases of complete tear (Fig. 2A) and 12 of partial tears (Fig. 2B), and lateral pulley, in five patients all with complete tear. Among those five individuals, two cases of complete tear of both the medial and lateral pulleys, with subsequent medial subluxation of LHBT were observed. No gross disruption of the BRP sling was observed in the remaining 15 patients (37%; group B); however, in the ramp test, ligamentous insufficiency was revealed based on induced LHBT instability (Fig. 3).

Table 1
Comparison of patient demographics

Characteristics	Group A: Pulley tear + (N = 25)	Group B: Pulley tear – (N = 15)	P-value
Mean age (years)	49.6	53.9	0.160
Sex			0.186
Women	13 (52%)	10 (67%)	
Men	12 (48%)	5 (33%)	
Side			
Right shoulder of the dominant arm	11 (44%)	10 (67%)	0.174
Traumatic	22 (88%)	13 (87%)	0.453
Sports	11 (44%)	6 (47%)	0.437
Work related	6 (27%)	1 (8%)	0.061
Fall and others	5 (23%)	6 (64%)	0.191
Pain duration (months)	6.1	6.6	0.330

In arthroscopic examination, concomitant intra-articular pathologies were noted in 27 patients (67.5%) including 19 in group A (76%) and eight in group B (53%), without significant differences between the two groups ($P = 0.083$). Comparative arthroscopic findings of associated pathologies including the change of tear or fraying of the supraspinatus and subscapularis tendons, partial tear of LHBT, and type II SLAP lesions are presented in Table 2. Supraspinatus tear was noted in six patients (15%), including small, full-thickness tears in four patients and partial thickness articular-sided tears in two patients, and fraying in another six patients (15%). After probing of tendon insertion at the lesser tuberosity, presence of each articular-sided subscapularis tear (Fig. 4A) and tendon fraying (Fig. 4B) were differentially visualized, among which, four cases of articular subscapularis tear (16%) were observed in group A and none in group B; no significant difference of the incidence of subscapularis involvement was obtained ($P = 0.021$). ASI was noted in seven patients (18%), including five cases of pulley tear (group A) and two cases of SGHL insufficiency confirmed by ramp test; in all seven patients with ASI, tear or fraying change of the subscapularis tendon at the articular side was observed. Partial tear of LHBT was observed in five patients, and type II SLAP lesion in seven patients, including five cases in group A and two cases in group B.

Table 2
Comparison of arthroscopic findings

Arthroscopic findings	Group A: Pulley tear + (N = 25)	Group B: Pulley tear – (N = 15)	P-value
Supraspinatus tendon			
Tear	5 (20%)	1 (7%)	0.107
Fraying	2 (8%)	4 (27%)	0.084
Subscapularis tendon			
Tear	4 (16%)	0	0.021*
Fraying	5 (20%)	3 (20%)	0.500
Tear of LHBT [†]	4 (16%)	1 (7%)	0.179
SLAP lesion [‡]	5 (20%)	2 (13%)	0.294
ASI [£]	5 (20%)	2 (13%)	0.294
† LHBT: Long head of biceps tendon			
‡ SLAP: Superior labrum anterior and posterior			
£ASI: Anterosuperior impingement			

Discussion

The results of our study revealed a prevalence of approximately two-thirds cases of BRP tear in LHBT instability manifesting as anterior shoulder pain of more than 3 months duration, and an association of subscapularis tear with BRP tear. To the best of our knowledge, there were few studies to report dynamic acquisition of BRP integrity and biceps instability in patients with refractory anterior shoulder pain. In the comparison of patients with and without BRP tear, patient demographics revealed no significant group-wise differences with regard to age, sex, etiology, and pain duration. Traumatic events comprised the most common etiology, which was compatible with previous studies on pulley lesions.³⁻⁶

Diagnostic limitation of ASI

LHBT injury was a common pain source, and in agreement, the lesions of the surrounding BRP sling (including SGHL and CHL) and superior part of the subscapularis tendon were contributing factors of LHBT instability and painful dysfunction.^{2,8} Despite recent advancement in imaging diagnosis of LHBT pathologies and rotator cuff lesions, arthroscopic techniques are still the main approach to confirm or

detect hidden lesions that support diagnosis of LHBT instability and BRP tear.⁹⁻¹¹ Habermeyer et al. reported that ASI pathogenesis leads to anterior shoulder pain during internal rotation, flexion, and adduction of the arm;³ those authors highlighted that early detection of lesions in the pulley system and LHBT instability is key to avoid ASI progression.³ Currently, no diagnostic standards are available for disorder of the pulley structure or LHBT instability. Ultrasound achieved success in dynamic assessment of LHBT, but not that of BRP integrity and detection of concomitant intra-articular pathologies, which required further arthroscopic investigation.^{12,13} Dynamic arthroscopic examination of the pulley structures is a useful tool for early detection of symptoms that may progress to ASI, such as BRP lesions including partial tear and SGHL insufficiency.³

Ramp test

The ramp test has been used as an arthroscopic technique to confirm intra-articular LHBT subluxation. Expanded cadaveric dissection validated the significance of arthroscopic observations and the result of ASI.⁴ Subsequent ramp testing for LHBT excursion and SGHL integrity enabled dynamic assessment of BRP sling insufficiency and LHBT instability,¹⁴ which are easier to perform than current diagnostic techniques for the same purpose. In brief, a hook probe introduced at the regular anterior portal was used to retract LHBT toward the pulley sling. The intact BRP system acts as a static constraint to resist medial translocation of LHBT, and in such situation, probing reveals V-shaped LHBT; whereas, in case of tearing or loss of normal tension of the pulley structure, LHBT moves medially and acquires a U-shaped conformation. In the present study, regular arthroscopic examination revealed intact BRP structure in more than one-third of patients and the results of ramp test confirmed SGHL insufficiency associated with LHBT instability. The ramp test successfully detected LHBT instability in case of SGHL insufficiency with grossly intact BRP structure, which is in contrast to the findings of missed underlying BRP lesions and LHBT instability in previous studies without dynamic acquisition.^{15,16} This phenomenon may be explained by the fact that refractory anterior shoulder pain is commonly underreported.

Pulley lesions and associated intra-articular pathologies

CHL and SGHL comprise the pulley system that stabilizes the intra-articular LHBT before entry in the bicipital groove.^{5,14} Rotator cuff tears were considered to be associated with the BRP lesions based on their anatomical relationship^{2,5} and concurrent prevalence.^{3,6,15-18} The fibers of the supraspinatus and subscapularis are interwoven with SGHL which have combined function of chief stabilizer of LHBT,⁵ and SGHL lesions are strongly associated with partial tear of the rotator fibers at the articular side. In our study, we observed significant higher prevalence of articular subscapularis tear in the pulley-tear group, while fraying change of the supraspinatus and subscapularis tendons were common findings in both the pulley-tear group and no-tear group. Based on the collective findings of our study and those of other studies,^{4-6,15,19} BRP lesions are progressive pathologies that cause recalcitrant shoulder pain, and can lead to articular tendon tears adjacent to the pulley sling. Due to anatomical proximity, the articular subscapularis lesions were more commonly associated with BRP tears^{5,20-22} than the other intra-articular lesions, and are a potentially useful diagnostic reference for pulley tear and bicep instability.

Moreover, we observed only a trend of higher incidence of the other lesions of LHBT tear, SLAP lesion, and ASI in the pulley-tear group versus the no-tear group, without statistical significance.

Limitations

Our study has several limitations. First, retrospective analysis of small sample size was conducted, and all diagnoses, arthroscopic procedures, and recording of intra-operative findings were performed by a single senior surgeon. Second, interobserver analysis was not conducted, and functional outcomes were not included. Finally, severity of SGHL insufficiency and corresponding LHBT instability were not objectively graded.

Conclusion

In the patients with anterior shoulder pain, pulley lesions of BRP and LHBT instability were common shoulder disorders detected by arthroscopy. The ramp test allowed dynamic assessment of SGHL insufficiency and LHBT instability and should be considered an essential arthroscopic diagnostic procedure. Subscapularis tear and fraying were common associated lesions, and meticulous evaluation of those should be performed in patients with refractory anterior shoulder pain.

Abbreviations

LHBT

long head of the biceps tendon

BRP

biceps reflection pulley

SGHL

superior glenohumeral ligament

ASI

anterosuperior shoulder impingement

MRI

magnetic resonance imaging

SLAP

superior labrum anterior and posterior

CHL

coracohumeral ligament

Declarations

Ethics Approval and Consent to participate

Institutional review board approval (IRB no. 201901127B0) from Chang Gung Medical Foundation was obtained to perform a review of patient records and radiographs. Informed consent was obtained from all

patients.

Consent for publication

Not Applicable.

Availability of supporting data

The datasets generated during the current study are available from the corresponding author on reasonable request.

Competing interests

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article. The authors report no competing interests.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions

In this study, ACYC is the single surgeon for all cases and responsible for study design. JTK is contributed to data collection and major writing of this article. CHC and KYH contributed to statistical analysis and manuscript review. SSC assisted in radiographic assessment. YSC together with ACYC is contributed to arthroscopic data reading. All authors read and approved the final manuscript.

Acknowledgements

Not applicable

Authors' information

Jo-Ting Kao, MD; Chih-Hao Chiu, MD; Kuo-Yau Hsu, MD; Shih-Sheng Chang, MD; Yi-Sheng Chan, MD; Alvin Chao-Yu Chen, MD

Institution: Bone and Joint Research Center, Department of Orthopaedic Surgery

Chang Gung Memorial Hospital-Linkou & University College of Medicine; Taiwan, R.O.C

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Supplementary File Legend

Video. Arthroscopy viewing from standard posterior portal with the probe through anterior working portal in the right shoulder shows superior labrum tear, biceps tenosynovitis with positive ramp test and partial tear of the medial pulley.

Figures

Figure 2

Arthroscopy viewing from standard posterior portal in the right shoulder shows tenosynovitis lesion (blue arrow) along the biceps long head tendon (LHBT) and bicipital groove (green arrow). HH: humeral head.

Figure 3

Arthroscopy viewing from standard posterior portal in the left shoulder showing pulley lesions of the biceps (LHBT) and the bicep pulley system. (A) Complete tear of medial pulley (yellow arrow) with positive ramp test (blue arrow). (B) Partial tear (hollow arrow). HH: humeral head.

Figure 6

The right shoulder of a 20-year-old male baseball pitcher who experienced painful throwing for 6 months. (A) Arthroscopy viewing from standard posterior portal acquired before the ramp test, and (B) that showing positive results of the ramp test of medial pulley insufficiency (green arrow). LHBT: long head of biceps tendon; SB: subscapularis tendon; HH: humeral head; *: medial biceps reflection pulley.

Figure 8

Arthroscopy viewing from standard posterior portal in the right shoulder showing subscapularis lesion. (A) Partial tear at the articular side (green arrow). (B) Fraying of the subscapularis tendon through probing. HH: humeral head; SB: subscapularis tendon; *: medial biceps reflection pulley.

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