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Supraspinatus Muscle Tendon Lesion and Its Relationship with Long Head of the Biceps Lesion*

Lesão do tendão do músculo supraespinal e sua relação com a lesão do tendão da cabeça longa do bíceps

Cassiano Diniz Carvalho[1] Carina Cohen[1] Paulo Santoro Belangero[1] Alberto de Castro Pochini[1] Carlos Vicente Andreoli[1] Benno Ejnisman[1]

[1] Orthopedics and Traumatology Department, Centro de Traumatologia do Esporte (CETE), Escola Paulista de Medicina, Universidade Federal de São Paulo (Unifesp), São Paulo, SP, Brazil

Address for correspondence Cassiano Diniz Carvalho, Rua Teixeira Santana 185, Fundinho, Uberlândia, 38400-196, Brasil (e-mail: cassianodiniz@labsforfit.com.br).

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Abstract

Objective To identify the clinical, radiological, and arthroscopic correlation of long head of the biceps tendon injuries and their influence on pain when associated with rotator cuff injuries.

Methods Between April and December 2013, 50 patients were evaluated, including 38 (76%) women and 12 (24%) men, with a mean age of 65.1 years old. The patients were operated by the Shoulder and Elbow Group, Discipline of Sports Medicine, Orthopedics and Traumatology Department, Universidade Federal de São Paulo. The subjects underwent repair of the rotator cuff lesion with clinical, radiological and/or arthroscopic evidence of involvement of the long head of the biceps tendon.

Results An association between pain at palpation of the intertubercular groove of the humerus and high-grade partial lesions (partial rupture of the tendon affecting more than 50% of its structure) was observed at the arthroscopy ($p = 0.003$). There was also an association between the high-grade lesion of the long head of the biceps and injury to the supraspinatus muscle tendon ($p < 0.05$). For each centimeter of the supraspinatus muscle tendon injury, the patient presented a 1.7 higher probability of having a high-grade lesion at the long head of the biceps.

Conclusion Pain at the anterior shoulder region during palpation of the intertubercular groove of the humerus may be related to high-grade lesions to the long head of the biceps. Rotator cuff injury and its size are risk factors for high-grade injuries to the long head of the biceps tendon.

Keywords
- long head of the biceps
- tendinopathy
- rotator cuff
- tenotomy
- tenodesis

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Resumo

Objetivo Identificar a correlação clínica, radiológica, e artroscópica das lesões do tendão da cabeça longa do bíceps e sua influência na dor do paciente quando associada às lesões do manguito rotador.

Métodos Entre abril e dezembro de 2013, foram avaliados 50 pacientes, sendo 38 (76%) do sexo feminino e 12 (24%) do sexo masculino, com idade média de 65,1 anos. Os pacientes foram operados pelo Grupo de Ombro e Cotovelo da Disciplina de Medicina Esportiva do Departamento de Ortopedia e Traumatologia da Universidade Federal de São Paulo. Os indivíduos foram submetidos a reparo da lesão do manguito rotador com evidência clínica, radiológica e/ou artroscópica de acometimento do tendão da cabeça longa do bíceps.

Resultados Observou-se associação entre dor à palpação do sulco intertubercular do úmero com lesão parcial de alto grau (ruptura parcial acometendo mais de 50% do tendão) na artroscopia ($p = 0,003$). Encontramos ainda uma associação entre a lesão de alto grau da cabeça longa do bíceps e a lesão do tendão do músculo supraespinhal ($p < 0,05$), sendo que, para cada centímetro de lesão do tendão do músculo supraespinhal, o paciente apresenta probabilidade 1,7 maior de ter uma lesão de alto grau da cabeça longa do bíceps.

Conclusão A dor na região anterior do ombro à palpação do sulco intertubercular do úmero pode estar relacionada às lesões de alto grau da cabeça longa do bíceps. A lesão do manguito rotador e o seu tamanho são fatores de risco para lesão de alto grau do tendão da cabeça longa do bíceps.

Palavras-chave

- cabeça longa do bíceps
- tendinopatia
- manguito rotador
- tenotomia
- tenodese

Introduction

Throughout history, the long head of the biceps (LHB) brachii tendon has been the subject of great controversy, being considered either a major source of shoulder pain or an insignificant structure.[1] Kessell and Watson[2] described it as an easy-to-blame but hard-to-condemn structure.

There is still no consensus on the true role of the LHB tendon in shoulder biomechanics. Nevertheless, its function, as well as its important role in static and dynamic stabilization, have been investigated by different authors.[3] Several authors have noted an important stabilizing role,[4] in addition to humeral head centralization at the secondary glenoid, as described by Pagnani.[5]

In 1934, biceps tendinitis was questioned by Codman,[6] who even doubted there was a tendinous inflammatory process, and considered that the pain was much more likely caused by supraspinatus muscle tendon injuries. Codman was unable to prove biceps involvement in any of his cases. From the 50's, several authors considered biceps tendinitis an important cause of shoulder pain, and treated it with tenodesis.[2,7] In 1950 DePalma[7] described degenerative tendon changes and their conservative and surgical treatment. In 2015, Godinho et al[8] described a new surgical technique for LHB tenodesis.

The LHB tendon is 9 cm long,[9] and it is divided into an intra-articular and an extra-articular portion; the extra-articular portion is fibrocartilaginous and slides on the intertubercular groove of the humerus. Such a division, however, is not 100% accurate. The humeral head moves as on a rail to the tendon, whereas the tendon does not move in relation to the bicipital groove.[2,10] Therefore, the arm position dictates the relationship between the intra- and extra-articular portions. For instance, during arm adduction and extension, most of the tendon is intra-articular. In contrast, in extreme abduction, only a small part of the tendon is intra-articular.[1]

As such, LHB tendinopathy may arise from repeated friction, traction and glenohumeral rotation, which result in pressure and shear forces. Since the intertubercular groove is a constricted environment, it is usually affected by the inflammatory process.[11]

Diagnostic tests for LHB tendon injuries have limited clinical utility when applied alone.[12]

Today, magnetic resonance imaging (MRI) is the most used complementary test for LHB tendon injury diagnosis. Studies indicate that MRI sensitivity ranges from 52% to 69.8%, with 86% to 98% of specificity for complete lesions.[13] However, the arthroscopic evaluation is considered the gold standard for intra-articular LHB tendon injury diagnosis.[14]

Neviaser et al[15] observed a close relationship between LHB tendinopathy and rotator cuff injuries on arthrography and intraoperative observation of macroscopic changes.

The present study aimed to evaluate the clinical, radiological, and arthroscopic correlation of the LHB tendon lesions associated with rotator cuff injuries and their relationship with referred shoulder pain.

Materials and Methods

A total of 56 patients were evaluated and operated on by a surgeon from the Shoulder and Elbow Group, Discipline of

Sports Medicine, Orthopedics and Traumatology Department, Universidade Federal de São Paulo, São Paulo, Brazil, from April to December 2013. In total, 6 patients were excluded from the initial sample of 56 subjects. Among the excluded patients, two had incomplete MRI data, three had no intraoperative LHB tendon lesion, and one subject did not agree to sign the informed consent form (ICF). Of the remaining 50 patients, 38 (76%) were female and 12 (24%) were male, with a mean age of 65.1 years.

The inclusion criteria were patients with anterior shoulder pain submitted to rotator cuff injury repair and with clinical, radiological and/or arthroscopic evidence of LHB tendon involvement.

The exclusion criteria were patients who underwent rotator cuff lesion repair with no indication of tenotomy due to the lack of symptoms related to LHB lesion or absence of injury at the time of the arthroscopy, as well as patients with no rotator cuff lesion associated with LHB injury.

The patients were questioned and examined by specialists from the Brazilian Society of Shoulder and Elbow Surgery (Sociedade Brasileira de Cirurgia do Ombro e Cotovelo, SBCOC). The MRI scans were performed using the Achieva 1.5T (Philips, Amsterdam, Netherlands) scanner, and they were evaluated by two experienced surgeons, who were also SBCOC members, according to the same criteria specified in the data collection form; the Patte classification and rotator cuff lesion quantification in centimeters were used to define the degree of tendon retraction.

The patients were placed in the beach chair position, under general anesthesia and brachial plexus block, and submitted to arthroscopy for rotator cuff injury repair and intra- and extra-articular LHB tendon evaluation through macroscopic lesion analysis. With the scope at the posterior portal and the arthroscopic hook at the anterior portal, the LHB was dislocated inferiorly, bringing the extra-articular portion of the tendon into the joint.

The tip of the arthroscopic hook served as a measuring instrument to grade the thickness of the LHB lesion. The measurement was performed 1.5 cm from the labral insertion of the LHB tendon.

The MRI scans were performed using T1- and T2-weighted spin-echo techniques. The variables included LHB injury signs, presence and size of the rotator cuff lesion (Patte classification), and the presence of associated lesions, such as type-II superior labral tear from anterior to posterior (SLAP) lesion.

During surgery, macroscopic LHB tendon lesions, such as redness, fibrillation, flattening, partial injury, tendon dislocation, pulley injury, type-II SLAP lesion, and rotator cuff tendon injury, including the subscapularis muscle, which is directly related to LHB dislocation, were evaluated.

The study was approved by the Ethics in Research Committee at Hospital São Paulo and all patients signed the ICF.

The numerical variables were expressed as means and standard deviations (SDs), medians and quartiles (Qs), minimum and maximum values, whereas the categorical variables were expressed as absolute and relative frequencies.

The associations between pain and the physical tests, the MRI and the intraoperative findings were assessed by simple logistic regression models.

The analyses were performed using the Statistical Package for the Social Sciences (SPSS, SPSS, Inc., Chicago, IL, US) software, version 18, adopting a significance level of 5%.

The agreement and disagreement between LHB tendon injuries at the physical examination, MRI scans and arthroscopy, specifically high-grade partial LHB lesion and SLAP lesion, were evaluated using the McNemar nonparametric test, adopting a 5% significance level.

Results

The final sample consisted of 50 symptomatic patients who underwent rotator cuff lesion repair with symptoms and/or magnetic resonance imaging indicating LHB tendon involvement.

Symptom duration ranged from 2 to 240 months, and half of the patients had symptoms for at least 12 months. The right shoulder was affected in 70% of the subjects, and the affected limb was the dominant one for 72% of the patients.

At the physical examination, half of the patients had up to 160° (Q1 = 140° and Q3 = 180°) of active flexion range and up to 180° (Q1 = 170° and Q3 = 180°) of passive range. Pain at palpation of the LHB tendon at the humerus intertubercular groove was observed in 66% of the patients. In the special physical tests, 72% of the patients were positive for the O'Brien test, 78% were positive for the Palm Up test, and 40% were positive for the Yergason test.

The MRI showed that 92% of the patients had biceps tendinopathy, and 1 patient presented a total rupture (2.0%). Regarding the supraspinatus muscle tendon, 4% presented a partial bursal lesion; 4% had a partial intra-articular injury; and the remaining subjects presented total tendon injury, with tendon retraction ranging from 0.9 cm to 5 cm, with a median value of 2.9 cm.

The imaging evaluation also revealed that 42% of the patients presented infraspinatus muscle tendon injury; 32% had subscapularis muscle tendon injury; 14% presented LHB tendon dislocation; and 4% had type-II SLAP lesion.

During the arthroscopy, 60% of the patients had an LHB tendon lesion involving more than 50% of its thickness. The changes included redness in 88% of the patients (►**Figure 1**); flattening in 54% (►**Figure 2**); fibrillation in 86%; partial rupture in 60%; and biceps dislocation in 20% of the subjects.

Other LHB tendon-related injuries were observed during the arthroscopy: 24% of the patients had subscapularis muscle tendon injury; 22% presented pulley injury; and 6% had type-II SLAP lesion.

►**Table 1** shows the descriptive analyses of the numerical variables from the clinical evaluation, physical examination and radiological findings in our 50 patients.

►**Table 2** shows the gender distribution, the dominance of the affected limb, and the categorical variables from the physical examination.

►**Table 3** shows the radiological evaluation (MRI) findings regarding the LHB tendon lesion, its dislocation in relation to

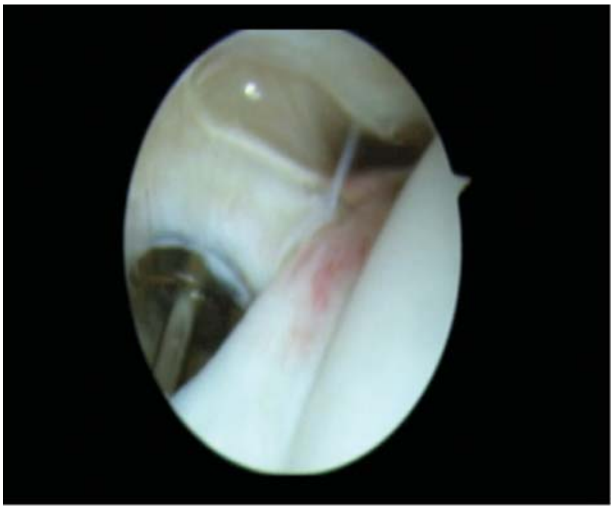

Fig. 1 Long head of the biceps (LHB) brachii tendon redness.

Fig. 2 Long head of the biceps (LHB) brachii tendon flattening.

the bicipital gutter, and associated rotator cuff injuries and SLAP lesion.

►**Table 4** presents the morphological characteristics of the LHB tendon, its dislocation in relation to the bicipital gutter, and associated subscapularis muscle tendon injury and SLAP lesion observed during the arthroscopy.

There was an association between pain at palpation of the intertubercular groove of the humerus and high-grade partial LHB lesion (partial rupture affecting more than 50% of the LHB tendon – ►**Figures 3** and **4**) during the arthroscopy ($p = 0.003$). Patients with pain at palpation of the intertubercular groove of the humerus had an 83% probability of having a significant LHB lesion involving more than 50% of the thickness of the tendon. As such, the positive patients were 1.7 times more likely to develop a significant lesion, unlike the negative patients.

There was no evidence of statistically significant associations between other special tests (Palm Up, O'Brien and Yergason) and high-grade partial LHB lesion ($p > 0.05$).

►**Table 5** evaluates the associations between pain at palpation of the intertubercular groove of the humerus, special physical tests, magnetic resonance imaging findings and intraoperative findings.

In this specific group of patients, all of them presenting supraspinatus muscle tendon injury and some degree of LHB tendon injury, high-grade LHB lesion was directly related to the size of the supraspinatus tendon lesion ($p < 0.05$); for each centimeter of supraspinatus muscle tendon injury, the risk of having a high-grade LHB lesion was 1.7 higher. Thus, in patients with supraspinatus muscle tendon injuries that are 1 cm and 3 cm long, the chance of having a significant LHB lesion is 41.4% and 67.1% respectively.

►**Table 6** shows the associations between LHB tendinopathy on the MRI and physical examination tests and intraoperative findings; there was no evidence of association between tendinopathy on the MRI and the analyzed variables ($p > 0.05$). However, there was an association between subscapularis muscle tendon injury on the MRI and LHB dislocation during the arthroscopy ($p < 0.001$). It is noteworthy that the probability of an individual with total subscapularis muscle tendon injury to present intraoperative LHB dislocation is of 91%, corresponding to a 55-fold increased risk in patients with this lesion.

The McNemar test was applied to evaluate the agreement between the physical examination tests and the characteristics

Table 1 Descriptive measurements of the numerical variables in a sample consisting of 50 patients

Variable	Average (standard deviation)	Median (1st quartile; 3rd quartile)	Range minimum – maximum
Clinical evaluation			
Age (years)	65.1 (6.2)	65 (60; 69)	51–83
Symptom duration (months)	30.7 (41.4)	12 (7; 36)	2–240
Physical exam			
Active flexion (°)	152.2 (31.7)	160 (140; 180)	80–180
Passive flexion (°)	173.2 (13.8)	180 (170; 180)	110–180
Radiological evaluation: magnetic resonance imaging			
Size of the lesion at the supraspinatus muscle tendon (cm)	2.8 (1.2)	2.9 (1.5; 3.7)	0.9–5.0

Table 2 Descriptive analysis of the clinical evaluation and physical exam categorical variables

Clinical evaluation	
Gender	
Female	38 (76.0)
Male	12 (24.0)
Affected shoulder	
Right	35 (70.0)
Left	15 (30.0)
Dominant shoulder	
No	14 (28.0)
Yes	36 (72.0)
Physical exam	
Pain during humerus intertubercular groove palpation	
No	17 (34.0)
Yes	33 (66.0)
O'Brien test	
Negative	14 (28.0)
Positive	36 (72.0)
Palm Up test	
Negative	11 (22.0)
Positive	39 (78.0)
Yergason test	
Negative	30 (60.0)
Positive	20 (40.0)

Table 3 Descriptive analysis of the radiological evaluation – magnetic resonance imaging

Radiological evaluation: magnetic resonance imaging	
Long head of the biceps (LHB) brachii lesion	
Total lesion	1 (2.0)
Negative	3 (6.0)
Positive	46 (92.0)
Infraspinatus muscle tendon lesion	
No	29 (58.0)
Yes	21 (42.0)
Subscapularis muscle tendon lesion	
No	34 (68.0)
Yes	16 (32.0)
Supraspinatus muscle tendon retraction	
I	8 (16.0)
II	29 (58.0)
III	9 (18.0)
No	4 (8.0)
LHB dislocation	
No	43 (86.0)
Yes	7 (14.0)
Superior labral tear from anterior to posterior (SLAP) lesion, type II	
No	48 (96.0)
Yes	2 (4.0)

of the lesions on the MRI and intraoperatively observed during the arthroscopy. We observed that palpation of the intertubercular groove of the humerus is a good test to detect high-grade LHB tendon lesions. Similarly, the MRI agreed with the arthroscopy for SLAP lesions and LHB dislocation.

Discussion

Patients with LHB tendon disease often complain of pain at the anterior shoulder region, especially at the humerus intertubercular groove. The symptoms may be difficult to distinguish from those of other shoulder disorders, especially rotator cuff injuries.[16]

Despite the lack of statistical significance, there was a similar positivity between the Palm Up test and the intraoperative presence of high-grade LHB tendon injury (78% and 60% respectively). Bennett et al[17] reported that the Palm Up test has a high sensitivity (90%) for macroscopic LHB tendon lesions; although to a lesser extent, such high sensitivity was also observed in the present study.

The positivity on the O'Brien test was of 72%. Only 4% of the tests were positive for SLAP injury on the MRI. At the intraoperative evaluation, however, 6% of the patients presented with this lesion. The McNemar test assessed the agreement between physical examination, MRI and arthroscopy findings. It showed a discrepancy between O'Brien's positivity and both MRI and arthroscopy, demonstrating that this isolated test is not suitable for SLAP lesion diagnosis.[18] However, the incidence of SLAP lesion on the MRI and arthroscopy showed a statistically significant agreement.

The literature is controversial regarding the ability of the O'Brien test alone to detect SLAP injuries. Ben Kibler et al[12] demonstrated that it has a moderate sensitivity (61%), which is consistent with the results found by Godinho et al,[19] who observed a sensitivity of 66.7%. This test is not able to reproduce the peel back movement that occurs in the LHB to trigger the symptoms. Nonetheless, the O'Brien test has a moderate ability to diagnose SLAP lesions,[16] which was not consistent with our results. On the other hand, another authors concluded that this test is not a sensitive diagnostic indicator and observed a high incidence of false-positive patients, possibly due to associated shoulder injuries (rotator cuff injury, for example).[20,21]

No single test is sufficient for SLAP lesion diagnosis. A combination of the available tests can increase the efficiency of lesion identification, although the result of this association is insignificant when compared to any test applied alone.[18]

Table 4 Descriptive analysis of the variables evaluated during surgery

Surgical procedure: arthroscopy	
Redness	
No	6 (12.0)
Yes	44 (88.0)
Flattening	
No	23 (46.0)
Yes	27 (54.0)
Fibrillation	
No	7 (14.0)
Yes	43 (86.0)
Partial, high-grade long head of the biceps (LHB) brachii lesion	
No	20 (40.0)
Yes	30 (60.0)
LHB dislocation	
No	40 (80.0)
Yes	10 (20.0)
Subscapularis muscle tendon lesion	
No	38 (76.0)
Yes	12 (24.0)
Pulley injury	
No	39 (78.0)
Yes	11 (22.0)
Superior labral tear from anterior to posterior (SLAP) lesion, type II	
No	47 (94.0)
Yes	3 (6.0)
Snyder classification of the SLAP lesion	
II	3 (6.0)
No	47 (94.0)

In total, 40% of the patients had a positive result in the Yergason test. However, only 20% of the patients had LHB tendon dislocation on the arthroscopy, and 14% were diagnosed with it on the MRI. Similarly, the McNemar test showed a disagreement between the Yergason test and the incidence of lesions on both the MRI and arthroscopy, demonstrating that this isolated test is not suitable for LHB dislocation diagnosis. However, lesion incidence on the MRI and arthroscopy presented a statistically significant agreement.

Consistent with our results on the Yergason test, Ben Kibler et al[12] demonstrated that it has high specificity and low sensitivity, being more accurate to rule out a lesion than to detect it.

Taylor et al[22] observed that palpation of the intertubercular groove of the humerus and the O'Brien test have high sensitivity (97.8% and 95.7% respectively). On the other hand, the Palm Up and Yergason tests are very specific (86.7% and 97.9% respectively), but present low sensitivity. Therefore, when the O'Brien test and humerus intertubercular groove palpation are negative, we can safely exclude the presence of an extra-articular LHB lesion.

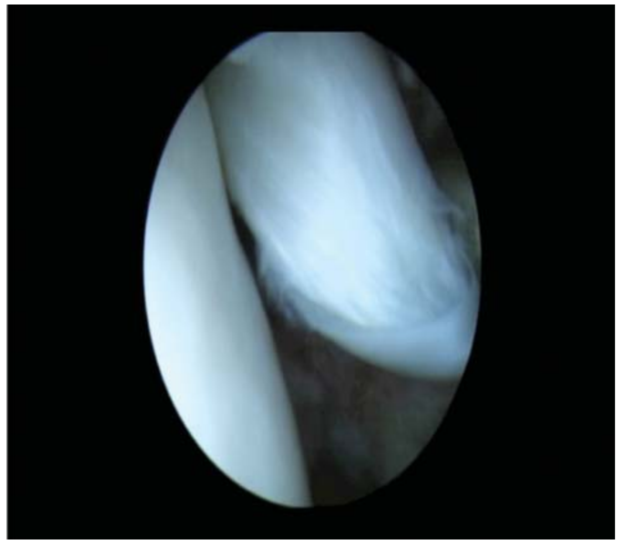

Fig. 3 High-degree lesion at the long head of the biceps (LHB) brachii tendon, affecting over 50% of its thickness.

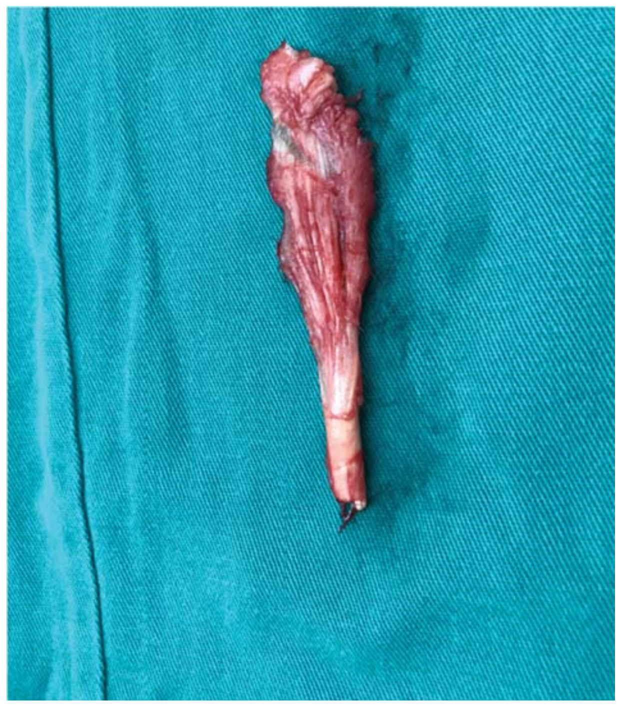

Fig. 4 Proximal portion of the long head of the biceps (LHB) brachii tendon, with a lesion affecting over 50% of its thickness, after tenotomy.

Analyzing our results regarding the special tests previously described, as well as data found in the literature, we observed that tests applied together are more successful in the diagnosis than the tests applied alone.[18]

Long head of the biceps tendon injuries are complex and multifactorial. They are didactically defined as biceps-labral complex lesions, which are divided in labral LHB insertion

Table 5 Association between pain and physical tests, magnetic resonance imaging findings and intraoperative findings.

		Pain during humerus intertubercular groove palpation		*p*-value
		No	Yes	
Physical exam				
O'Brien test	Negative ($n = 14$)	6 (42.9)	8 (57.1)	ns
	Positive ($n = 36$)	11 (30.6)	25 (69.4)	
Palm Up test	Negative ($n = 11$)	6 (54.5)	5 (45.5)	ns
	Positive ($n = 39$)	11 (28.2)	28 (71.8)	
Yergason test	Negative ($n = 30$)	12 (40.0)	18 (60.0)	ns
	Positive ($n = 20$)	5 (25.0)	15 (75.0)	
Magnetic resonance imaging				
LHB tendinopathy	No ($n = 3$)	1 (33.3)	2 (66.7)	ns
	Yes ($n = 46$)	16 (34.8)	30 (65.2)	
Infraspinatus muscle tendon lesion	No ($n = 29$)	12 (41.4)	17 (58.6)	ns
	Yes ($n = 21$)	5 (23.8)	16 (76.2)	
Subscapularis muscle tendon lesion	No ($n = 34$)	13 (38.2)	21 (61.8)	ns
	Yes ($n = 16$)	4 (25.0)	12 (75.0)	
LHB dislocation	No ($n = 43$)	14 (32.6)	29 (67.4)	ns
	Yes ($n = 7$)	3 (42.9)	4 (57.1)	
SLAP lesion	No ($n = 48$)	17 (35.4)	31 (64.6)	ns
	Yes ($n = 2$)	0 (0.0)	2 (100.0)	
Intraoperative				
Redness	No ($n = 6$)	4 (66.7)	2 (33.3)	ns
	Yes ($n = 44$)	13 (29.5)	31 (70.5)	
Flattening	No ($n = 23$)	7 (30.4)	16 (69.6)	ns
	Yes ($n = 27$)	10 (37.0)	17 (63.0)	
Fibrillation	No ($n = 7$)	3 (42.9)	4 (57.1)	ns
	Yes ($n = 43$)	14 (32.6)	29 (67.4)	
Partial, high-grade LHB lesion	No ($n = 20$)	12 (60.0)	8 (40.0)	0.003
	Yes ($n = 30$)	5 (16.7)	25 (83.3)	
LHB dislocation	No ($n = 40$)	13 (32.5)	27 (67.5)	ns
	Yes ($n = 10$)	4 (40.0)	6 (60.0)	
Subscapularis muscle tendon lesion	No ($n = 38$)	13 (34.2)	25 (65.8)	ns
	Yes ($n = 12$)	4 (33.3)	8 (66.7)	
Pulley injury	No ($n = 39$)	13 (33.3)	26 (66.7)	ns
	Yes ($n = 11$)	4 (36.4)	7 (63.6)	
SLAP lesion	No ($n = 47$)	16 (34.0)	31 (66.0)	ns
	Yes ($n = 3$)	1 (33.3)	2 (66.7)	

Abbreviations: LHB, long head of the biceps brachii; SLAP, superior labral tear from anterior to posterior; ns.
Note: Results expressed as absolute and relative frequencies.

lesions (SLAP lesions); intra-articular tendon body and tendon pulley lesions; and extra-articular lesions at the humerus intertubercular groove. Given this interaction between regions that could harbor painful injuries to the LHB tendon, a set of three tests has been proposed to increase the diagnostic accuracy compared to the isolated tests. The following associated tests were proposed: humerus intertubercular groove palpation; the throwing test (with the arm abducted at 90°, the elbow flexed at 90° and maximum external rotation, the patient initiates a throwing motion against a resistance imposed by the examiner); and the O'Brien test.[18,22]

Table 6 Correlation between long head of the biceps brachii (CLB) lesion at magnetic resonance imaging (MRI), physical tests and intraoperative findings

		LHB lesion at MRI		*p*-value
		No ($n = 3$)	Yes ($n = 47$)	
Physical exam				
Pain during humerus intertubercular groove palpation	No	1 (33.3)	16 (34.0)	ns
	Yes	2 (66.7)	31 (66.0)	
O'Brien test	Negative	2 (66.7)	12 (25.5)	ns
	Positive	1 (33.3)	35 (74.5)	
Palm Up test	Negative	0 (0.0)	11 (23.4)	ns
	Positive	3 (100.0)	36 (76.6)	
Yergason test	Negative	2 (66.7)	28 (59.6)	ns
	Positive	1 (33.3)	19 (40.4)	
Intraoperative				
Redness	No	1 (33.3)	5 (10.6)	ns
	Yes	2 (66.7)	42 (89.4)	
Flattening	No	1 (33.3)	22 (46.8)	ns
	Yes	2 (66.7)	25 (53.2)	
Fibrillation	No	0 (0.0)	7 (14.9)	ns
	Yes	3 (100.0)	40 (85.1)	
Partial, high-grade LHB lesion	No	1 (33.3)	19 (40.4)	ns
	Yes	2 (66.7)	28 (59.6)	
LHB dislocation	No	2 (66.7)	38 (80.9)	ns
	Yes	1 (33.3)	9 (19.1)	
Subscapularis muscle tendon lesion	No	1 (33.3)	37 (78.7)	ns
	Yes	2 (66.7)	10 (21.3)	
Pulley injury	No	1 (33.3)	38 (80.9)	ns
	Yes	2 (66.7)	9 (19.1)	
SLAP lesion	No	3 (100.0)	44 (93.6)	ns
	Yes	0 (0.0)	3 (6.4)	
Snyder classification of the SLAP lesion	II	0 (0.0)	3 (6.4)	ns
	No	3 (100.0)	44 (93.6)	

Abbreviations: LHB, long head of the biceps brachii; MRI, magnetic resonance imaging; SLAP, superior labral tear from anterior to posterior; ns.

The MRI is the most common tool to diagnose intra-articular LHB tendon lesions. In our study, the MRI was positive in 92% of the patients, and 59.6% of them had a high-grade LHB lesion (affecting more than 50% of the tendon). There was a 90% agreement between the MRI and arthroscopy when redness, flattening and high-grade partial injury were considered as macroscopic signs of injury.

In contrast, Malavolta et al[23] observed a moderate sensitivity (67%) and a high specificity (98%) on the MRI. These authors only evaluated total LHB tendon ruptures, whereas we also considered inflammatory signs and partial injuries, which may explain the higher incidence of positive tests.

Mohtadi et al[13] observed a lower prevalence of diagnosis on the MRI and a lower agreement between the MRI and the arthroscopy, of 66% and 37.7% respectively. We attributed this disagreement to the fact that the population evaluated in our study was older (mean age of 65.1 years versus 46.2 years in the study by Mohtadi et al[13]), considering that the incidence of LHB tendon injuries associated with rotator cuff injuries increases with age.

The only statistically significant correlation between the physical examination and the arthroscopic evaluation found in our study was pain at palpation of the intertubercular groove of the humerus, which was observed in 83% of the patients with lesions affecting more than 50% of the LHB tendon thickness. Partial injury is the most common indication for tenotomy and tenodesis.[24] Accordingly, surgeons must be prepared for a possible LHB tendon procedure if the suspicion on the physical examination is confirmed during surgery.

Current histological studies have questioned whether alterations observed in imaging scans and arthroscopy can really characterize LHB inflammation. Streit et al[25] concluded that anterior shoulder pain does not appear to be related to an inflammatory process at the extra-articular portion of the LHB tendon in most cases. Of the 26 patients evaluated, only 2 presented histological alterations consistent with chronic inflammation, and none had histological alterations characteristic of an acute inflammatory process.

The association between rotator cuff injuries and LHB tendon injuries is well known in the medical literature,[15] and although several studies confirm their anatomical relationship, only a few are devoted to a more detailed investigation.[26] The literature reports that the association between these 2 lesions ranges from 78.5% in a smaller sample ($n = 28$)[24] to 22% in a larger sample ($n = 207$) as observed by Braum et al.[27]

Lafosse et al[21] observed a strong relationship between LHB lesion and rotator cuff injury size. Thus, our study corroborates the literature and adds a risk relationship not yet described between these two variables. We observed that, for every centimeter of supraspinatus muscle tendon injury, the patient has a 1.7-fold greater risk of developing a high-grade LHB tendon lesion. The incidence ranges from 41.4% to 67.1% for 1- and 3-cm lesions respectively.

The patients who underwent biceps surgery concurrently with rotator cuff lesion repair had better outcomes compared to those submitted to the isolated cuff repair.[28] Chechia et al[29] demonstrated a 93.4% satisfaction rate in patients undergoing rotator cuff repair associated with LHB tenodesis. Ikemoto et al[30] observed better results in patients submitted to tenodesis associated with tenotomy compared to those who underwent isolated tenotomy, noting that the latter also presented satisfactory results.

The present study had limitations regarding its sample, even though a 50-patient population is compatible with the Brazilian literature. For a test power of 50% and 90%, a sample of 208 and 300 patients respectively would be required. Other limiting factors were the absence of a control group with patients without LHB tendon lesions, and the fact that this was a specific population, composed mostly of female patients with a mean age of 65.1 years.

The fact that we did not find significant associations between the variables does not mean that they do not exist; in reality, the sample size may have been responsible for the non-significance in the analyses.

Conflict of Interests
The authors have no conflict of interests to declare.

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