Joint Diseases and Related Surgery

Jt Dis Relat Surg
2022;33(1):142-148

ORIGINAL ARTICLE

Subacromial impingement as a predictor of proximal biceps tendon disorders

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ABSTRACT

Objectives: This study aims to investigate the relationship between proximal biceps tendon disorders and the degree of subacromial impingement in patients who underwent arthroscopic subacromial debridement.

Patients and methods: Between January 2015 and June 2021, a total of 110 patients (44 males, 66 females; mean age: 52.5±11.43 years; range, 15 to 78 years) who underwent arthroscopic subacromial decompression were retrospectively analyzed. The degree of the subacromial impingement observed during arthroscopy was classified into four stages according to the Neer classification. We classified proximal biceps tendon disorders as five grades according to the Nirschl classification. The proportional relationship between subacromial impingement and biceps tendinopathy severity was analyzed.

Results: While biceps tendon degeneration was found to be significantly lower in patients with mild or no subacromial impingement, high rates of severe biceps tendon degeneration were observed in patients with high degree of subacromial impingement. A total of 75% of the patients who had no subacromial impingement had no biceps tendon disorder. Approximately 50% of the patients with Stage 1 subacromial impingement did not have biceps disorder, 31.3% had inflammation, and 12.5% had minor degeneration. In Stage 2 subacromial impingement group, the ratio of inflammation (42.9%) and minor degeneration (42.9%) of biceps tendon greatly increased, and the highest rate of biceps tendon degeneration was observed in the most advanced stage (Stage 3) subacromial impingement group (39.3%) (p=0.001).

Conclusion: The stage of subacromial impingement is correlated with the degree of biceps degeneration. Therefore, one should keep in mind that the presence of advanced subacromial impingement may indicate advanced biceps tendon pathologies.

Keywords: Biceps tendinopathy, shoulder arthroscopy, subacromial impingement.

The functional role of the long head of the biceps tendon in shoulder joint has not fully understood, yet.[1,2] However, biceps tendon disorders are significant cause of severe shoulder pain and functional limitation and, therefore, should be treated effectively.[3,4] It is crucial to reveal the relationship between biceps disorders and other accompanying shoulder diseases, since the treatment of a local shoulder lesion may not cure all shoulder complaints.

The long head of the biceps tendon originates from the supraglenoid tubercle and superior labrum, crosses intra-articular space and extends distally through the intertubercular sulcus.[3] The stability of the biceps tendon is provided by the medial arc formed by the adjacent coracohumeral ligament (CHL) and superior glenohumeral ligament (SGHL) and the posterior arch formed by the CHL and the posterior muscle fibers of the supraspinatus tendon.[5,6] The stabilizing role of the transverse humeral ligament (THL) is less established.[7]

Biceps tendinopathies are seen in a wide spectrum; from mild inflammation to delamination, from fringing to major degeneration and even complete spontaneous rupture, particularly in cases where the subacromial area is greatly narrowed.[8,9] The

Received: November 25, 2021
Accepted: January 10, 2022
Published online: March 28, 2022

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Doi: 10.52312/jdrs.2022.499

Citation: Can Fİ, Gültaç E, Şahin İG, Kılınç CY, Hürriyet Aydoğan N. Subacromial impingement as a predictor of proximal biceps tendon disorders. Jt Dis Relat Surg 2022;33(1):142-148.

close neighborhood between the subacromial and glenohumeral spaces raises the question of whether the disorders of the anatomical structures in these spaces are related to each other. In a study of Varacallo and Mair,[8] the close relationship of proximal biceps tendon with the shoulder ligaments and rotator cuff muscles caused high stress exposure and wear to the biceps tendon due to tendon friction.[8]

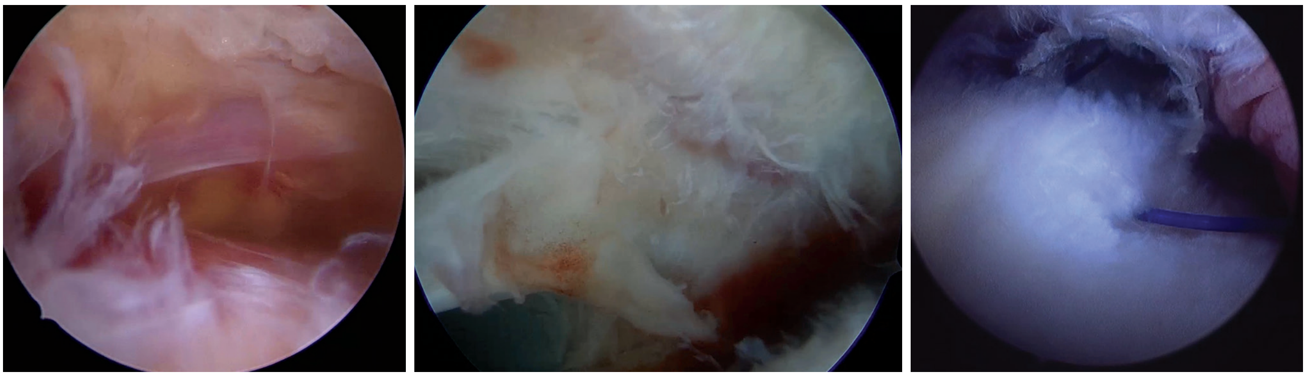
Although there are studies in the literature suggesting a relationship between rotator cuff disorders and biceps tendinitis, to the best of our knowledge, there is no study examining the proportional relationship between subacromial impingement advancement and biceps lesions in terms of specific classification of the disorders.[10,11] In the present study, we aimed to evaluate the relationship between proximal biceps tendon disorders and the severity of subacromial impingement in patients who underwent arthroscopic subacromial debridement.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at Muğla Sıtkı Koçman University Training and Research Hospital, Department of Orthopedics and Traumatology between January 2015 and June 2021. A total of 140 patients who underwent arthroscopic shoulder surgery were analyzed. After exclusion of the patients with subluxation or dislocation of proximal biceps tendon, massive rotator cuff rupture, acute traumatic conditions, inflammatory diseases such as rheumatoid arthritis, patients with septic arthritis history, 110 patients (44 males, 66 females; mean age: 52.5±11.4 years; range, 15 to 78 years) were found to be eligible for the study. Biceps subluxation/dislocation was excluded from the study considering the possibility of false results due to the deterioration of normal anatomical location and impaired relationship with the subacromial area because of the displacement of the tendon. A written informed consent was obtained from each patient. The study protocol was approved by the Institutional Review Board (IRB No: 159/Date: 21.07.2020). The study was conducted in accordance with the principles of the Declaration of Helsinki.

All surgeries were performed by a single surgeon in the beach chair position. When the glenohumeral joint was inspected during arthroscopy, an examination probe was used to pull the biceps tendon inferiorly to examine the whole tendon in terms of morphological changes such as thickening, inflammation, delamination, defibrillation or rupture. Afterwards, tenotomy or tenodesis was performed to biceps tendon. The subacromial space and the anatomical structures were, then, evaluated, such as coracoacromial ligament (CAL), acromion, subacromial and subdeltoid bursa, supraspinatus and infraspinatus tendons, acromioclavicular and coracoacromial joint. Subacromial impingement was carefully evaluated, particularly the CAL and acromion, and bursectomy and/or rotator cuff repair was, then, performed, if necessary. In our routine practice, we use the Velpeau® bandage for all patients to fix the operated shoulder without abduction pillow and passive range of motion are allowed as our standard postoperative protocol to prevent joint stiffness.

The amount of subacromial impingement was classified as four stages according to the Neer classification[12] by examining the arthroscopic video images recorded during surgery of the patients who underwent arthroscopic shoulder surgery.



Subacromial bursitis (Stage 1 subacromial impingement) | Coracoacromial ligament degeneration (Stage 2 subacromial impingement) | Full-tickness rotator cuff rupture (Stage 3 subacromial impingement)

FIGURE 1. The stages of subacromial impingement (Stage 1-3).

Subsequently, subacromial impingement degrees were also grouped into subgroups. The patients without subacromial impingement were classified as Stage 0, patients with bursal hypertrophy as Stage 1, patients with fibrosis and minor CAL fringing as Stage 2, and finally patients with rotator cuff tears, biceps ruptures, bone changes and major CAL fringing were classified as Stage 3 subacromial impingement (Figure 1).

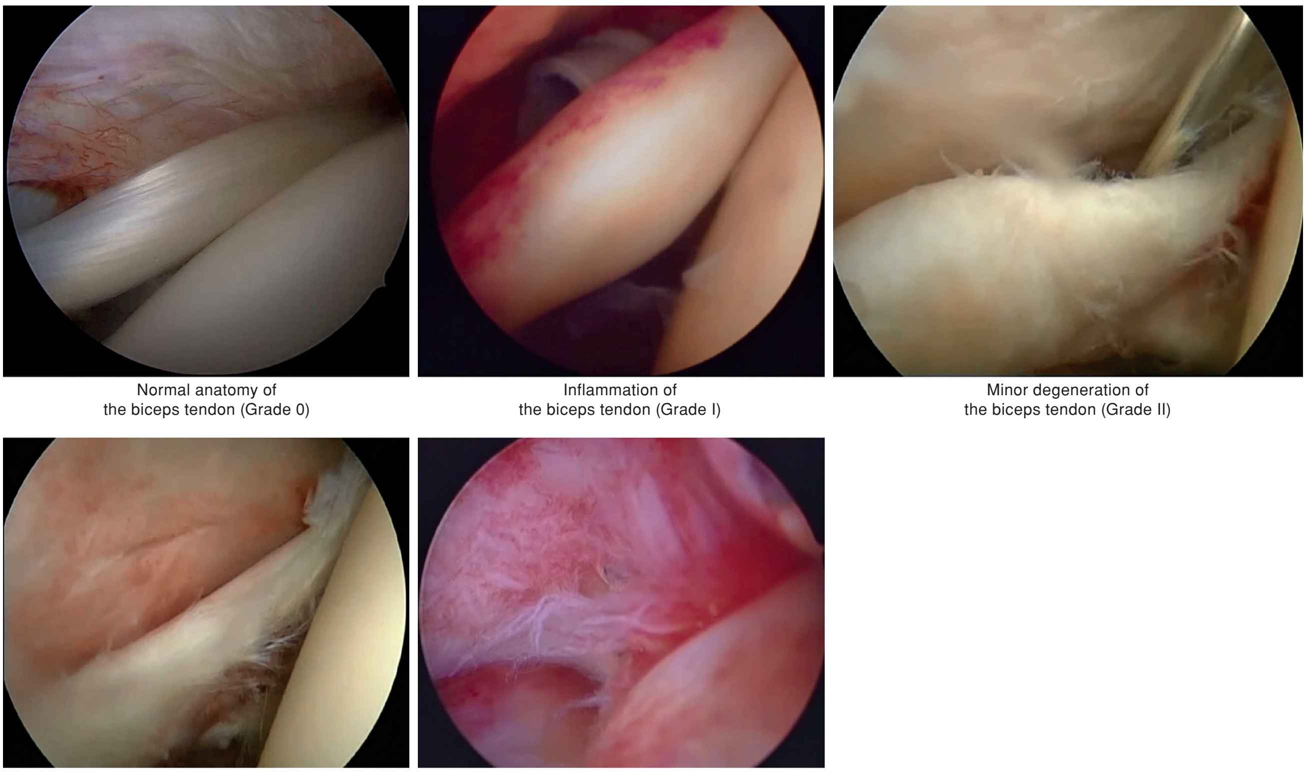
The proximal biceps tendons were examined from the anterior portal with the usage of a probe and the morphological changes were inspected all around by pulling the tendon inferiorly. Subsequently, morphological biceps tendon changes were classified according to the classification systems of tendinopathy developed by Nirschl and Ashman,[13] as normal (Grade 0), hyperemia and inflammation of tendon outer layer Grade I, fringing of the tendon fibers (minor degeneration) Grade II, delamination and separation of tendon fibers (major degeneration) Grade III, and complete spontaneous degenerative rupture Grade IV (Figure 2). Then, by comparing the degree of subacromial impingement and biceps tendon disorders statistically, a significant relationship between these two disorders was investigated. While comparing the results, the term "stage" was used for subacromial impingement staging and "grade" for biceps tendon disorders to avoid confusion.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency, where applicable. The cross-tabulation and chi-square tests were used and the accepted alpha error was 5% with a statistical power (1-β) was 80%. Association and relationship between multiple subgroup categorical variables were analyzed with Pearson chi-square test. The study was carried out at 95% confidence level and $p<0.05$ was considered statistically significant.

RESULTS

The operated sides included 60 right (54.5%) and 50 left (45.5%) shoulders. Of our 110 patients, eight patients had Stage 0 (7.3%), 32 patients had Stage 1 (29.1%), 14 patients had Stage 2 (12.7%), and 56 patients had Stage 3 (50.9%) subacromial impingement.



Normal anatomy of the biceps tendon (Grade 0)

Inflammation of the biceps tendon (Grade I)

Minor degeneration of the biceps tendon (Grade II)

Major degeneration of the biceps tendon (Grade III)

Rupture of the biceps tendon (Grade IV)

FIGURE 2. The grades of biceps disorders (Grade 0-IV).

As the patients grouped by biceps tendon disorders, 28 patients had Grade 0 (25.5%), 34 patients had Grade I (30.9%), 12 patients had Grade II (10.9%), 24 patients had Grade III (21.8%), and 12 patients had Grade IV (10.9%) biceps tendon disorders (Table I).

A total of 75% of the patients with no subacromial impingement (Stage 0) had no biceps tendon disorder. In only 25% of patients with Stage 0 impingement, inflammation and tendon hyperemia were observed around the biceps tendon (Grade I).

A total of 50% of the patients with Stage 1 subacromial impingement did not have any biceps disorder. The most common biceps disorder in this group was inflammation with a rate of 31.3% (Grade I). While minor degeneration (Grade II) was observed in the second frequency (12.5%), major changes (Grade III) were observed in a small number of patients with a rate of 6.3%. One of the important findings among the results was that there was no spontaneous tendon rupture (Grade IV) among patients with Stage 0 and 1 subacromial impingement.

The most dramatic outcome in patients with Stage 2 subacromial impingement was that none of these patients had undamaged biceps tendon. The most common biceps disorder in these patients was minor (Grade II) and major (Grade III) degeneration with both a rate of 42.9%. Spontaneous tendon rupture, which is Grade IV, began to be observed initially in this group (14.3%).

In patients with Stage 3 subacromial impingement, the most common biceps tendon disorder was major degeneration with a rate of 39.3% (Grade III). The second most common biceps disorder in this group was inflammation with a rate of 28.6%, while tendon rupture, which was categorized as Stage 4 biceps disorder, was mostly observed in this group with a rate of 17.9%.

TABLE I

Percentage and numerical relationship of subacromial impingement stages with biceps disorders grades

	Biceps disorders					
	None (Grade 0)	Inflammation (Grade I)	Minor degeneration (Grade II)	Major degeneration (Grade III)	Rupture (Grade IV)	Total
Subacromial impingement						
Stage 0						
Count	6	2	0	0	0	8
% within subacromial impingement	75.0	25.0	0.0	0.0	0.0	100.0
% within biceps disorders	21.4	5.9	0.0	0.0	0.0	7.3
% of total	5.5	1.8	0.0	0.0	0.0	7.3
Stage 1						
Count	16	10	4	2	0	32
% within subacromial impingement	50.0	31.3	12.5	6.3	0.0	100.0
% within biceps disorders	57.1	29.4	33.3	8.3	0.0	29.1
% of total	14.5	9.1	3.6	1.8	0.0	29.1
Stage 2						
Count	0	6	6	0	2	14
% within subacromial impingement	0.0	42.9	42.9	0.0	14.3	100.0
% within biceps disorders	0.0	17.6	50.0	0.0	16.7	12.7
% of total	0.0	5.5	5.5	0.0	1.8	12.7
Stage 3						
Count	6	16	2	22	10	56
% within subacromial impingement	10.7	28.6	3.6	39.3	17.9	100.0
% within biceps disorders	21.4	47.1	16.7	91.7	83.3	50.9
% of total	5.5	14.5	1.8	20.0	9.1	50.9
Total						
Count	28	34	12	24	12	110
% within subacromial impingement	25.5	30.9	10.9	21.8	10.9	100.0
% within biceps disorders	100.0	100.0	100.0	100.0	100.0	100.0
% of total	25.5	30.9	10.9	21.8	10.9	100.0

TABLE II
Cross-tabulation of consolidated groups in terms of patient count (number) and percentage

	Biceps disorders		
	Minor degeneration (Grade I+II+III)	Major degeneration (Grade IV+V)	Total
Subacromial impingement			
Minor Impingement (Stage 0+1)			
Count	39	1	40
% within subacromial impingement	97.5	2.5	100.0
% within biceps disorders	60.9	2.2	36.4
% of total	35.5	0.9	36.4
Moderate Impingement (Stage 2)			
Count	13	1	14
% within subacromial impingement	92.9	7.1	100.0
% within biceps disorders	20.3	2.2	12.7
% of total	11.8	0.9	12.7
Major impingement (Stage 3)			
Count	12	44	56
% within subacromial impingement	21.4	78.6	100.0
% within biceps disorders	18.8	95.7	50.9
% of total	10.9	40.0	50.9
Total			
Count	64	46	110
% within subacromial impingement	58.2	41.8	100.0
% within biceps disorders	100.0	100.0	100.0
% of total	58.2	41.8	100.0

The subacromial impingement stages and biceps disorders grades were consolidated to assess the severity among two disorders. Stage 0 and 1 subacromial impingement were combined and named as “minor impingement”, Stage 2 was moderate and Stage 3 was major impingement group. In biceps tendinopathy group, Grade I, II, and III were combined to form “minor degeneration” group, while Grade IV and V were combined to form “major degeneration” group. When the subacromial impingement stages and biceps disorders grades were consolidated; the biceps tendon degeneration degree increased parallel to subacromial impingement severity (Table II). A statistically significant relationship was observed between the degree of the subacromial impingement and the degree of biceps tendon degeneration (p=0.001).

DISCUSSION

Numerous associated shoulder pathologies including external/subacromial impingement have been described as etiological factors for biceps tendinopathies due to the close neighborhood of these structures.[8,14] In 1982, Neviaser et al.[15] established the relationship between increasing tendon inflammation with the increasing severity of rotator cuff tendinopathy. In this context, we attempted to examine the relationship between proximal biceps tendon disorders with the other disorders in the subacromial space adjacent to the tendon. For this purpose, we investigated subacromial impingement patients in terms of biceps tendon disorders from mild inflammation to partial or complete rupture in proximal biceps tendon. Although there are studies suggesting that there is a relationship between biceps disorders with rotator cuff ruptures in the literature, no study has been found examining the relationship between the severity and, particularly, the type of biceps tendinopathy and subacromial impingement severity, with proportions, to the best of our knowledge. Subacromial impingement syndrome is the most common disease of the shoulder, constituting 44 to 60% of all complaints in patients presenting with shoulder pain during clinical practice[16,17] and can be seen in a wide clinical spectrum from subacromial bursitis to partial or full thickness rotator cuff tears.[18,19] Biceps tendinitis occurs as a result of inflammation of the long head of the biceps brachii and is characterized by pain originating from the anterior shoulder and descending toward the lower arm along the tendon trace. A high prevalence of tendinitis in biceps tendon has been reported in certain occupations (fish-processing workers, assembly-line packers, etc.).[20,21] In our study, we also observed that the incidence of patients with both subacromial impingement and biceps tendon pathology is quite common in our clinical practice.

The most crucial point in our study is that there is a significant relationship between both disorders and the proportional relationship increases in parallel as the disorder stages increase (p=0.001). The vast majority of the patients who did not have any subacromial impingement did not have any abnormal biceps tendon. Varacallo and Mair[8] reported that accompanying or pre-existing subacromial impingement could directly endanger tendon itself. The authors clarified that biceps tendinitis usually begins with the early phases of inflammation secondary to repetitive friction which expands the tendon diameter and creates more friction and this progress gets a vicious circle.[9] The resulting increased pressure and specific traction of the tendon parts induces the tendon to pathological shear forces. As these pathological tendon changes progress, the tendon part that thickens and gets stuck in the subacromial area, becomes fixed and progresses to macroscopically fringing leading eventually to rupture.[8] The increasing severity of biceps tendinopathy in parallel with the increase in impingement severity supports the theory that the macroscopic biceps tendon degeneration occurs due to mechanical shear and friction forces. The fact that the more CAL fringes and begins to deteriorate, the more biceps disruption is seen in the later stage impingement also supports this hypothesis. As a matter of fact, friction theory seems to be reasonable as the reason for the higher incidence of biceps tendinopathy in patients with severe subacromial impingement in our study. Meanwhile, the most frequent occurrence of biceps rupture was seen in the most advanced stage subacromial impingement. This finding also supports the hypothesis that the biceps tendon is deteriorated mostly due to mechanical friction and compression. Apart from mechanical reasons, corticosteroids, which are frequently used in the conservative treatment of subacromial impingement, may also cause weakening and rupture of the biceps tendon[22]

Van Rijn et al.[23] presented a systematic review investigating work-related factors and specific disorders of the shoulder joint and reported that there were high-quality studies suggesting that high repetitive work causing biceps tendinitis was associated with subacromial impingement. Dines et al.[24] indicated that the role of biceps tendon in shoulder pain was difficult to determine and is easily overestimated, as shoulder pain might originate from biceps tendon, as well as from subacromial compression and, therefore, these two conditions needed to be differentiated. In conclusion, they suggested that inflammation in biceps tendon might be caused due to subacromial impingement and, if not treated, surgery would also fail. Scapinelli et al.[25] performed a study investigating the relationship between spontaneous biceps rupture and subacromial impingement, and they concluded that ruptures of the long head of the biceps were mostly of degenerative nature, secondary to mechanical impingement and structural degenerations in the bicipital groove.

The shoulder joint is a highly mobile joint. Therefore, the intra-articular structures are constantly exposed to physical forces and friction. For this reason, it seems to be inevitable that diseases of neighboring structures in the shoulder are related to each other. Our study was conducted based on the theory that the severity of the biceps tendinopathy was affected by the severity of the subacromial impingement and our results also support this theory. Nevertheless, the study needs to be supported by further studies investigating this cause-effect relationship.

The retrospective nature and relative low number of subgroups are the main limitations of our study.

In conclusion, our study results suggest that clinicians should have a high index of suspicion regarding biceps tendon disorders in patients presenting with subacromial impingement. Therefore, one should keep in mind that the presence of advanced subacromial impingement may indicate advanced biceps tendon degeneration.

Declaration of conflicting interests

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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