Subacromial impingement as a predictor of proximal biceps tendon disorders

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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.[1] 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 arc formed by the CHL and the posterior muscle fibers of the supraspinatus tendon.[3,4] The stabilizing role of the transverse humeral ligament (THL) is less established.[5]

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.

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
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)](image1)
![Coracoacromial ligament degeneration (Stage 2 subacromial impingement)](image2)
![Full-thickness rotator cuff rupture (Stage 3 subacromial impingement)](image3)

**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.

**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

| Subacromial impingement | Biceps disorders | None (Grade 0) | Inflammation (Grade I) | Minor degeneration (Grade II) | Major degeneration (Grade III) | Rupture (Grade IV) | Total |
|-------------------------|-----------------|---------------|-----------------------|-------------------------------|-------------------------------|-------------------|-------|
| **Stage 0**              |                 |               |                       |                               |                               |                   | 8     |
| Count                   |                 | 6             | 2                     | 0                             | 0                             | 0                 | 100.0 |
| % 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**              |                 |               |                       |                               |                               |                   | 32    |
| Count                   |                 | 16            | 10                    | 4                             | 2                             | 0                 | 100.0 |
| % 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**              |                 |               |                       |                               |                               |                   | 14    |
| Count                   |                 | 0             | 6                     | 6                             | 0                             | 2                 | 100.0 |
| % 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**              |                 |               |                       |                               |                               |                   | 56    |
| Count                   |                 | 6             | 16                    | 2                             | 22                            | 10                | 100.0 |
| % 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**               |                 | 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 |
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, Neviser 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

| 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 |
Subacromial impingement and biceps tendinopathies

1. Akbari N, Ozen S, Şenlikçi HB, Haberal M, Çetin N. Ultrasound-guided versus blind subacromial corticosteroid and local anesthetic injection in the treatment of subacromial impingement syndrome: A randomized study of efficacy. Jt Dis Relat Surg 2020;31:115-22.

2. Krupp RJ, Kevern MA, Gaines MD, Kotara S, Singleton SB. Long head of the biceps tendon pain: Differential diagnosis and treatment. J Orthop Sports Phys Ther 2009;39:55-70.

REFERENCES

1. Akbari N, Ozen S, Şenlikçi HB, Haberal M, Çetin N. Ultrasound-guided versus blind subacromial corticosteroid and local anesthetic injection in the treatment of subacromial impingement syndrome: A randomized study of efficacy. Jt Dis Relat Surg 2020;31:115-22.

2. Krupp RJ, Kevern MA, Gaines MD, Kotara S, Singleton SB. Long head of the biceps tendon pain: Differential diagnosis and treatment. J Orthop Sports Phys Ther 2009;39:55-70.

Van Rijn et al.\textsuperscript{[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.\textsuperscript{[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.\textsuperscript{[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 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.

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3. Sethi N, Wright R, Yamaguchi K. Disorders of the long head of the biceps tendon. J Shoulder Elbow Surg 1999;8:644-54.
4. Hsu SH, Miller SL, Curtis AS. Long head of biceps tendon pathology: Management alternatives. Clin Sports Med 2008;27:747-62.
5. Bennett WF. Visualization of the anatomy of the rotator interval and bicipital sheath. Arthroscopy 2001;17:107-11.
6. Arai R, Mochizuki T, Yamaguchi K, Sugaya H, Kobayashi M, Nakamura T, et al. Functional anatomy of the superior glenohumeral and coracohumeral ligaments and the subscapularis tendon in view of stabilization of the long head of the biceps tendon. J Shoulder Elbow Surg 2010;19:58-64.
7. Khan R, Satyapal KS, Naidoo N, Lazarus L. Long head of biceps brachii tendon and transverse humeral ligament morphometry and their associated pathology. Folia Morphol (Warsz) 2020;79:359-65.
8. Varacallo M, Mair SD. Proximal Biceps Tendinitis and Tendinopathy. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022. Available at: https://www.ncbi.nlm.nih.gov/books/NBK533002/
9. Ahrens PM, Boileau P. The long head of biceps and associated tendinopathy. J Bone Joint Surg [Br] 2007;89:1001-9.
10. Murti AM, Vosburgh CL, Neviaser TJ. The incidence of pathologic changes of the long head of the biceps tendon. J Shoulder Elbow Surg 2000;9:382-5.
11. Curtis AS, Snyder SJ. Evaluation and treatment of biceps tendon pathology. Orthop Clin North Am 1993;24:33-43.
12. Neer CS 2nd. Impingement lesions. Clin Orthop Relat Res 1983;(173):70-7.
13. Nirschl RP, Ashman ES. Elbow tendinopathy: Tennis elbow. Clin Sports Med 2003;22:813-36.
14. Goldberg SS, Bigliani LU. Shoulder impingement revisited: Advanced concepts of pathomechanics and treatment. Instr Course Lect 2006;55:17-27.
15. Neviaser TJ, Neviaser RJ, Neviaser JS, Neviaser JS. The four-in-one arthroplasty for the painful arc syndrome. Clin Orthop Relat Res 1982;(163):107-12.
16. van der Windt DA, Koes BW, de Jong BA, Bouter LM. Shoulder disorders in general practice: Incidence, patient characteristics, and management. Ann Rheum Dis 1995;54:959-64.
17. Vecchio P, Kavanagh R, Hazleman BL, King RH. Shoulder pain in a community-based rheumatology clinic. Br J Rheumatol 1995;34:440-2.
18. Harrison AK, Flatow EL. Subacromial impingement syndrome. J Am Acad Orthop Surg 2011;19:701-8.
19. Szyluk K, Jasiński A, Koczy B, Widorowski W, Widuchowski J. Subacromial impingement syndrome—most frequent reason of the painful shoulder syndrome. Pol Merkur Lekarski 2008;25:179-83.
20. Luopajärvi T, Kuorinka I, Virolainen M, Holmberg M. Prevalence of tenosynovitis and other injuries of the upper extremities in repetitive work. Scand J Work Environ Health 1979;5 suppl 3:48-55.
21. Nordander C, Ohlsson K, Balogh I, Rylander L, Pålsson B, Skerfving S. Fish processing work: The impact of two sex dependent exposure profiles on musculoskeletal health. Occup Environ Med 1999;56:256-64.
22. Atik Oğ. Overuse and abuse of cortisone. Eklem Hastalik Cerrahisi 2017;28:1.
23. van Rijn RM, Huisstede BM, Koes BW, Burdorf A. Associations between work-related factors and specific disorders of the shoulder—a systematic review of the literature. Scand J Work Environ Health 2010;36:189-201.
24. Dines D, Warren RF, Inglis AE. Surgical treatment of lesions of the long head of the biceps. Clin Orthop Relat Res 1982;(164):165-71.
25. Scapinelli R, Candiotto S, Ferrari GP, Iacobellis C. Subcutaneous rupture of the tendon of the long head of the biceps brachii in subacromial impingement syndrome. Chir Organi Mov 1999;84:229-37.