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The effect of arthroscopic coracoplasty on subscapularis strength in cases of subcoracoid impingement in the absence of subscapularis tear

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Abstract

Subcoracoid impingement leads to anterior shoulder pain, and arthroscopic subcoracoid decompression (coracoplasty) is the preferred treatment in recalcitrant cases. The purpose of the present study was to evaluate the effect of coracoplasty on the severity of anterior shoulder pain and the strength of the subscapularis muscle and to correlate it with the preoperative and postoperative coracohumeral distance (CHD) (t:transverse, s:sagittal). Sixteen patients without any subscapularis tendon tears who underwent arthroscopic subcoracoid decompression and rotator cuff repair with 2 years follow-up were included. Preoperative and postoperative 2-year assessments of function and pain were performed using the modified Kennedy–Hawkins test, power grading of various subscapularis muscle tests, and ASES scores. Preoperative and postoperative coracohumeral distance (tCHD, sCHD) and coracoid overlap (CO) were measured using MRIs before and after surgery. The Mean Hawkins pain score and coracoid overlap were decreased. The strength scores for subscapularis strength testing, ASES score, maximum degree of internal rotation, and coracohumeral distance increased ($P < .05$). Changes in belly press strength were negatively correlated with postoperative tCHD (r = –0.6, $P = .04$) and postoperative sCHD (r = –0.7, $P = .008$). A significant increase in the internal rotation range of the shoulder, subscapularis strength, and relief of anterior shoulder pain was observed. However, this increase was inversely proportional to the postoperative CHD, indicating the mechanical effect of the coracoid on subscapularis strength.

Abbreviations: ASES = American Shoulder and Elbow Surgeons shoulder score, BH = Bear hug test, BP = Belly press test, CO = Coracoid overlap, LO = Lift-off test, sCHD = sagittal oblique coracohumeral distance, tCHD = transverse coracohumeral distance.

Keywords: coraco-humeral distance, coracoid impingement, coracoplasty, decompression.

1. Introduction

Reduction of the coracohumeral space is a dynamic pathology leading to subcoracoid impingement. The roller-wringer effect of the stenotic subcoracoid space causes anterior shoulder pain and subscapularis tendon tear.[1] According to reports, shoulder pain is observed in 14.7 out of every 1000 patients.[2]However, the incidence or prevelance of subcoracoid impingement has not been reported in any published literature. Patients often complain of anterior shoulder pain, which is aggravated by forward flexion, adduction, and internal rotation of the shoulder and manifests itself in daily life, especially with overhead activities such as writing on a whiteboard and hanging laundry.[3] Detailed clinical and radiological evaluations must be conducted to distinguish other pathologies that cause anterior shoulder pain such as cervical disc disease, biceps tendinopathy, and shoulder instability.

Among physical therapy methods; rest, rotator cuff strengthening exercises and anti-inflammatory medications are the first-line treatment algorithm. If conservative treatments are not effective, arthroscopic subcoracoid decompression (coracoplasty) is an effective method to reduce symptoms.[3] However, only a few papers or case series exist regarding the benefits of this procedure in the current literature.[1,4–8] In addition, most authors have included cases with accompanying subscapularis tears in their studies. As reported, partial-thickness or full-thickness

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

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subscapularis tear repair for isolated or combined cuff tears is crucial to maintain rotator cuff integrity for joint stability and capabilities.[9,10] However, no study has presented the effect of this procedure on measurable CHD and its correlation with various subscapularis strength tests.[4,11–13] The aim of our study was to evaluate the effect of coracoplasty on the reduction of anterior shoulder pain and the strength of the subscapularis muscle and to correlate these parameters with CHD measured preoperatively and postoperatively. We hypothesized that coracoplasty would increase the subscapularis strength parallel to the amount of CHD gained postoperatively.

2. Methods

This study was approved by the Dokuz Eylül University Institutional review board ethics committee, in accordance with the principles of the Declaration of Helsinki by obtaining written consent form from the patients (Document Nr:2022/31-12). Written informed consent was obtained from all patients. We retrospectively evaluated patients who underwent arthroscopic subcoracoid decompression and rotator cuff repair at a medical faculty hospital between June 2018 and February 2020 with a minimum 24-month follow-up period. Subcoracoid impingement was diagnosed based on physical examination, MRI, and intraoperative findings. For the physical examination, the coracoid impingement test (forward flexion, adduction, and internal rotation) was mainly used to aggravate the contact between the coracoid process and the lesser tubercle. After the pain was aggravated, a subcoracoid lidocaine injection was administered for a more precise diagnosis of subcoracoid impingement. Demographic data (age, sex, dominant hand side, etc), preoperative and postoperative 2-year clinical outcomes, and radiological findings were obtained from the patients' medical records. Preoperative and postoperative 2-year clinical outcomes were assessed by an author of this study from the Department of Physical Treatment and Rehabilitation with pain levels (0: no pain- 5: max pain) measured with modified Kennedy–Hawkins test "forced adduction and internal rotation,"[3] power grading (0: no strength to 5: normal strength) of bear hug test (BH), belly press test (BP) and lift-off test (LO) (strength for tests ssc),[12] American Shoulder and Elbow Surgeons shoulder score (ASES), active range of internal rotation. Radiological examinations, including preoperative and postoperative magnetic resonance imaging (MRI) with the arm at neutral rotation, were performed by specialists from the Department of Radiology. The shortest distances between the humeral head and the coracoid process on the transverse (tCHD) (Fig. 1A) and sagittal oblique sections (sCHD) (Fig. 1B), the coracoid overlap (CO) (Fig. 1C), the distance in the transverse plane between the glenoid fossa, and the most prominent aspect of the coracoid process were measured both preoperatively and postoperatively. The mediolateral (ML) (Fig. 1D) and anteroposterior (AP) (Fig. 1E) tear sizes of the supraspinatus tendon were measured in coronal and sagittal oblique views.[14,15] The degree of rotator tendon retraction, fatty infiltration, and acromion type was assessed according to the Patte, Goutallier, and Bigliani classifications, respectively.[16,17] Tendon integrity on postoperative MRI was graded as either healed or unhealed.[18,19] The indications for surgery were a subcoracoid impingement, both diagnosed clinically

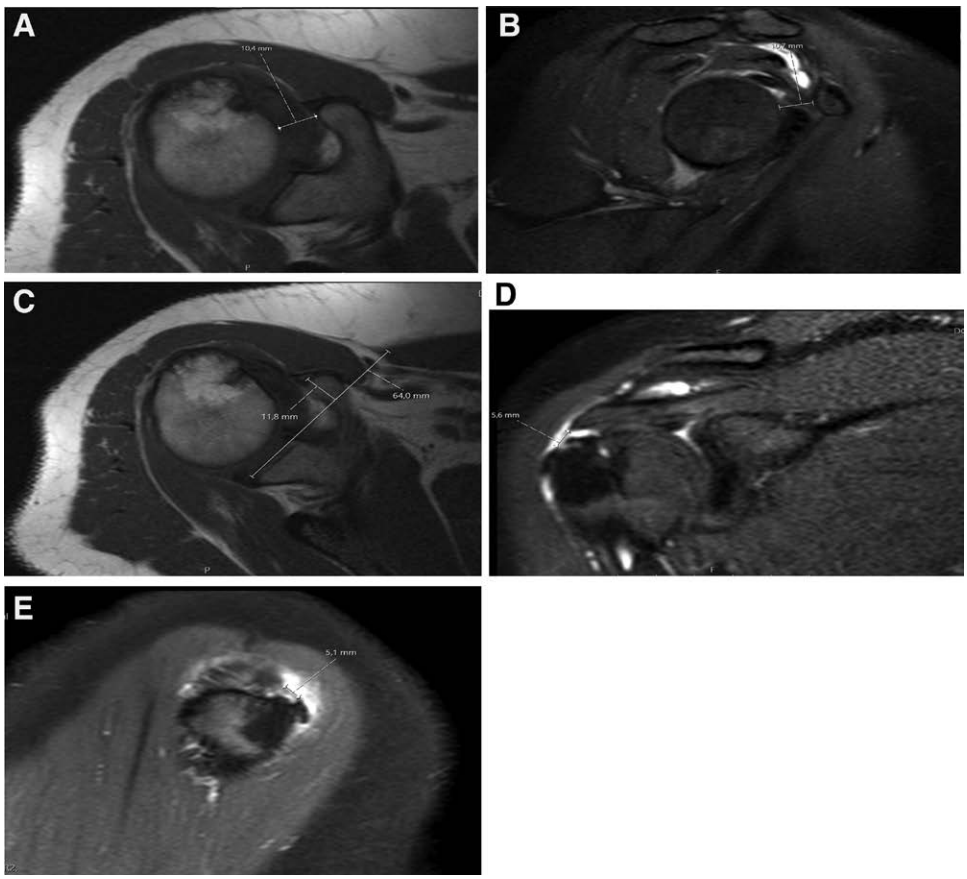

Figure 1. (A) The measurement of the shortest distances between the humeral head and coracoid process on axial sections of MRI. (B) The measurement of the shortest distances between the humeral head and coracoid process on parasagittal sections of MRI. (C) The measurement of the coracoid overlap defined as the distance in the transverse plane between the glenoid fossa, and the most prominent aspect of the coracoid process on axial sections of MRI. (D) The measurement of the mediolateral tear size on coronal oblique MRI views. (E) The measurement of the anteroposterior tear size on sagittal oblique MRI views.

and radiologically, recalcitrant to conservative treatments that included nonsteroidal anti-inflammatory medicine use, physical therapy modalities, and lifestyle changes for a minimum of 3 months. The exclusion criteria were as follows: incomplete follow-up and medical records, previous shoulder operation, concomitant subscapularis tear, biceps lesion, capsular or labral pathology, glenohumeral osteoarthritis, large or massive tear size, grade 3 or grade 4 cuff arthropathy, type 3 acromion decompression during surgery, and concomitant cervical disc pathology. After implementing these criteria, 16 patients who underwent arthroscopic subcoracoid decompression and rotator cuff repair with a years of follow-ups were included in the study. Sample size determination and power analysis were performed using the G power software. The power analysis indicated that the minimum sample size to yield a statistical power of at least.8 with an alpha of.05, and a medium effect size (d = 0.5) was 15 to compare preoperative and postoperative measurements.

All operations were performed by an experienced surgeon. The patient was positioned in the lateral decubitus position with the arm in 45° abduction and 15° flexion under 10 lb longitudinal traction. Coracoplasty was performed from the standard posterior portal to increase the size of the space from approximately 4–5 mm to 9 mm (Fig. 2) using the size of the burr as a template. The subscapularis tendon was then evaluated for tears through the anterolateral portal using the probe. Thereafter, the rotator cuff tear was repaired with double-row technique. Patients used the abduction pillow for 4 weeks and gradually started passive range of motion exercise the day after the surgery. At the end of 4 weeks, active-assisted exercises and gradual strengthening exercises were initiated.

All analyses were performed by a professor from the department of biostatistics using SPSS v.25.0 (Statistical Packages for the Social Sciences, Version 25.0. Armonk, NY: IBM Corp, 2016). Descriptive statistics are presented as mean ± standard deviation (x ± SD) or median (range). The Wilcoxon signed-rank test was used to compare the preoperative and postoperative data. Correlations between the measured parameters were assessed using Spearman correlation analysis. Statistical significance was set at $P < .05$.

3. Results

Seven male and 9 female patients were followed up for 2 years. The mean age of the patients was 55.8 ± 10.3 years (range 43–70 years). The mean Hawkins test pain score, coracoid overlap decreased, and strength scores for BH, BP, LO, ASES score, degree of internal rotation, and coracohumeral distances increased ($P < .05$) (Table 1). The mean AP and ML tear sizes were 11 ± 7 and 16 ± 9 mm, respectively. The mean grades of retraction and fatty infiltration were 1.5 ± 0.5, 1 ± 0.7, respectively. There were 5 type I and 11 type II acromions in the study group. All rotator cuff tendon tears healed.

Changes in BP strength were found to be negatively correlated with postoperative tCHD (r = –0.6, $P = .04$) and postoperative sCHD (r = –0.7, $P = .008$), and changes in ASES score were also negatively correlated with postoperative CO (r = –0.7, $P = .004$). The positive correlation between the changes in LO strength and postoperative CO was almost statistically significant ($R = 0.6$, $P = .05$). Other correlations, including the degree of fatty degradation, retraction, acromion type, and tendon healing, were not statistically significant (Table 2).

4. Discussion

The most important finding of the present study was that coracoplasty is an efective and safe procedure to reduce anterior shoulder pain related to subcoracoid impingement and to increase the strength of the subscapularis muscle at the 2-year follow-up. However, interestingly, the gain in subscapularis strength was negatively correlated with postoperative coracohumeral distance.

Internal rotation, forward flexion and adduction have been shown to cause anterior shoulder pain due to decreased coracohumeral distance.[20] Although Lo et al[1] have previously shown that subcoracoid impingement and stenosis are common accompanying findings of subscapularis tears, not all patients have subscapularis tears.[4,7,13] We excluded patients with subscapularis tears from our study.

The most recent comprehensive report by Park et al[13] reported satisfactory outcomes for subcoracoid impingement, particularly with an increase in internal rotation compared to the control group. They described cases of coracoid impingement in which anterior shoulder pain was present with a CHD distance of 6 mm on the preoperative MRI. Unlike the present study, most patients had subscapularis tears (20 of 23 patients). Similarly, Garofalo et al[4] reported satisfactory relief of pain after 1-year follow-up of 13 patients after arthroscopic coracoplasty however again 4 of the patients had simultaneous subscapularis tears.

The relationship between subcoracoid impingement and subscapularis tears and the need for prophylactic coracoplasty is controversial. Tollemar et al[21] reported a similar 11 CHD mm and 16 mm CO in both groups and concluded that coracoplasty may not be a necessary part of subscapularis tear repair. Ayanoglu et al[22] evaluated 57 patients with isolated subscapularis tears and concluded that concomitant coracoplasty during arthroscopic repair may not be a necessary routine. Similarly, although the postoperative CHD distance increased to 8.4 mm from 6.5 mm, the effect of coracoplasty

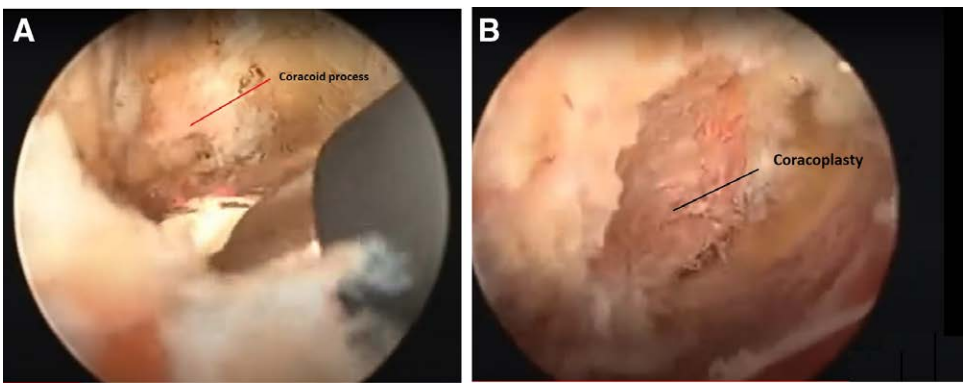

Figure 2. (A) Arthroscopic view from the lateral portal of the right shoulder of a patient before coracoplasty. (B) Arthroscopic view of coracoid process after coracoplasty.

Table 1

Preoperative and postoperative Mean Hawkins test pain score, strength scores for bear hug test (BH), belly press test (BP), lift-off test (LO), American Shoulder and Elbow Surgeons shoulder (ASES) score, degree of internal rotation, transverse coracohumeral distance (tCHD), sagittal oblique coracohumeral distance (sCHD) and coracoid overlap (CO) of the patients.

Patients (n:16)	Preop mean+/− SD (median)	Two-year post-op mean+/−SD (median)	*P* value
Hawkins pain (0–5)	3+/−1 (4)	0.6+/−0.7 (0.5)	.002
BH strength (0–5)	3+/−0.9 (4)	4 +/−0.5 (5)	.001
BP strenght (0–5)	4+/−1 (4)	4+/−0.5 (5)	.02
LO test (0–5)	3+/−1 (4)	4+/−0.5 (5)	.02
ASES score	39+/−21 (28)	82+/−16 (84)	.001
Internal Rotation°	64+/−20 (65)	83+/−14 (90)	.003
tCHD (mm)	9 +/−1 (10)	11+/−2 (11)	.01
sCHD (mm)	10+/−1 (10)	11+/−1 (10)	.04
CO (mm)	15+/−4 (15)	13+/−4 (12)	.005

Table 2

A synoptic table for Mean Hawkins test pain score, strength scores for bear hug test (BH), belly press test (BP), lift-off test (LO), American Shoulder and Elbow Surgeons shoulder score (ASES), degree of internal rotation, transverse coracohumeral distance (tCHD), sagittal oblique coracohumeral distance (sCHD) and coracoid overlap (CO), degree of rotator tendon retraction, fatty infiltration and acromion type of the patients.

BH strength (0–5)	Significant
BP strength (0–5)	Significant
LO test (0–5)	Significant
ASES score	Significant
Internal rotation°	Significant
tCHD (mm)	Significant
sCHD (mm)	Significant
CO (mm)	Significant
Degree of tendon retraction	Not significant
Degree of fatty infiltration	Not significant
Acromion type	Not significant

on functional results or re-rupture of the subscapularis tendon repair could not be shown.[11] Çetinkaya et al reported a minor difference between the tear and control groups for tCHD (8.6 mm, 8.2 mm, *P* = .04); however, the major difference was in CO (24 mm vs 21 mm).[23] Conversely, Leite et al reported that lower CHD and higher CO values were progressively related to subscapularis injuries. The mean CHD and CO were 5.7, 19.7 in the tear group vs control (10.3 mm, 14.3 mm).[24] Reichel et al reported that a threshold value of 9.5 mm CHD had a sensitivity and specificity of 83 % for predicting subscapularis tears.[25] Most recently, Hodax et al reported a CHD distance of 13.7 mm as the lower limit of normal, which was measured in 714 healthy asymptomatic patients.[26] Both postoperative and preoperative measurements were below the normal range reported by Reichel et al[25]

Unlike the clinical studies mentioned above, this study is the first to report a negative relationship between gain in belly press strength and postoperative CHD. This may partially explain the absence of the beneficial effect of concomitant coracoplasty reported in the literature in cases where subscapularis tendon repair is required.[11] Secondly, the most important finding of this study was that the coracoid length on the tendon is necessary and effective for increasing subscapularis muscle tendon strength.

This study had some limitations. First, the number of patients was limited and patients with concomitant rotator tears were included in the study without a control group. We included rotator cuff tears without subscapularis tears in this retrospective study because we did not have any cases of coracoplasty due to subcoracoid impingement in the absence of rotator cuff tears. All the patients underwent coracoplasty in conjunction with supraspinatus repair. Therefore, it is difficult to determine whether the improvement after surgery is the result of coracoplasty or the overall improvement after rotator cuff repair. However, clinical case series exist where patients treated with arthroscopic subcoracoid decompression most have subscapularis tears in addition to posterior cuff tears, unlike the present study.[1,4,7,13,27,28] Additionally, accompanying lesions such as biceps tendon pathologies, capsular and labral lesions were excluded from the study.[29–31] It was also a limitation and potentially related to limited number of the patients. Finally, our MR protocol stated that the arm was in a neutral position, and variation in positioning may be a limitation but has been reported to be valid.[26]

5. Conclusion

Similar to the outcomes reported in the literature,[4,13] coracoplasty is an effective and safe procedure for subcoracoid impingement to reduce anterior shoulder pain and to increase the strength of the subscapularis muscle with a noticeable increase in internal rotation at the 2-year follow-up.

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Supervision: Onur Hapa.
Software: Onur Gürsan.
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Writing – review & editing: Ahmet Emrah Açan.

References

[1] Lo IK, Burkhart SS. The etiology and assessment of subscapularis tendon tears: a case for subcoracoid impingement, the roller-wringer effect, and TUFF lesions of the subscapularis. Arthroscopy. 2003;19:1142–50.
[2] van der Windt DA, Koes BW, de Jong BA, et al. Shoulder disorders in general practice: incidence, patient characteristics, and management. Ann Rheum Dis. 1995;54:959–64.
[3] McKernan MJ, Schickendantz MS, Frangiamore SJ. Diagnosis and management of subcoracoid impingement. J Am Acad Orthop Surg. 2021;29:100–7.
[4] Garofalo R, Conti M, Massazza G, et al. Subcoracoid impingement syndrome: a painful shoulder condition related to different pathologic factors. Musculoskelet Surg. 2011;95(Suppl 1):S25–9.
[5] Karnaugh RD, Sperling JW, Warren RF. Arthroscopic treatment of coracoid impingement. Arthroscopy. 2001;17:784–7.
[6] Kragh JF, Jr., Doukas WC, Basamania CJ. Primary coracoid impingement syndrome. Am J Orthop. 2004;33:229–32; discussion 232.
[7] Lo IK, Parten PM, Burkhart SS. Combined subcoracoid and subacromial impingement in association with anterosuperior rotator cuff tears: an arthroscopic approach. Arthroscopy. 2003;19:1068–78.
[8] Russo R, Togo F. The subcoracoid impingement syndrome: clinical, semeiologic and therapeutic considerations. Italian J Orthop Traumatol. 1991;17:351–8.

[9] Fama G, Tagliapietra J, Belluzzi E, et al. Mid-Term outcomes after arthroscopic "Tear Completion Repair" of partial thickness rotator cuff tears. Medicina (Kaunas). 2021;57:74.
[10] Cigolotti A, Biz C, Lerjefors E, et al. Medium- to long-term clinical and functional outcomes of isolated and combined subscapularis tears repaired arthroscopically. Arch Med Sci. 2020;17:1351–64.
[11] Kim SJ, Choi YR, Jung M, et al. Concomitant coracoplasty during arthroscopic subscapularis repair does not yield better clinical outcomes and structural integrity. Knee Surg Sports Traumatol Arthrosc. 2018;26:56–62.
[12] Opsomer GJ, Gupta A, Haeni DL, et al. Arthroscopic double-layer lasso loop technique to repair delaminated rotator cuff tears. Arthroscopy. 2018;34:2943–51.
[13] Park JY, Lhee SH, Oh KS, et al. Is arthroscopic coracoplasty necessary in subcoracoid impingement syndrome? Arthroscopy. 2012;28:1766–75.
[14] Davidson JF, Burkhart SS, Richards DP, et al. Use of preoperative magnetic resonance imaging to predict rotator cuff tear pattern and method of repair. Arthroscopy. 2005;21:1428.
[15] Kuptniratsaikul V, Laohathaimongkol T, Umprai V, et al. Pre-operative factors correlated with arthroscopic reparability of large-to-massive rotator cuff tears. BMC Musculoskelet Disord. 2019;20:111.
[16] Fuchs B, Weishaupt D, Zanetti M, et al. Fatty degeneration of the muscles of the rotator cuff: assessment by computed tomography versus magnetic resonance imaging. J Shoulder Elbow Surg. 1999;8:599–605.
[17] Patte D. Classification of rotator cuff lesions. Clin Orthop Relat Res. 1990:81–6.
[18] Bagheri N, Bonnevialle N, Gallinet D, et al. Prospective study of tendon healing and functional gain after arthroscopic repair of isolated supraspinatus tear. Orthop Traumatol Surg Res. 2020;106(8s):S201–6.
[19] Sugaya H, Maeda K, Matsuki K, et al. Functional and structural outcome after arthroscopic full-thickness rotator cuff repair: single-row versus dual-row fixation. Arthroscopy. 2005;21:1307–16.
[20] Kleist KD, Freehill MQ, Hamilton L, et al. Computed tomography analysis of the coracoid process and anatomic structures of the shoulder after arthroscopic coracoid decompression: a cadaveric study. J Shoulder Elbow Surg. 2007;16:245–50.
[21] Tollemar VC, Wang J, Koh JL, et al. Coracoid morphology is not associated with subscapularis tears. J Shoulder Elbow Surg. 2020;29:1162–7.
[22] Ayanoğlu T, Ataoğlu B, Özer M, et al. Is routine coracoplasty necessary in isolated subscapularis tears? Eklem Hastaliklari ve Cerrahisi. 2019;30:112–6.
[23] Cetinkaya M, Ataoglu MB, Ozer M, et al. Subscapularis tendon slip number and coracoid overlap are more related parameters for subcoracoid impingement in subscapularis tears: a magnetic resonance imaging comparison study. Arthroscopy. 2017;33:734–42.
[24] Leite MJ, Sá MC, Lopes MJ, et al. Coracohumeral distance and coracoid overlap as predictors of subscapularis and long head of the biceps injuries. J Shoulder Elbow Surg. 2019;28:1723–7.
[25] Reichel T, Herz S, Tabbakh ME, et al. Less than 95-mm coracohumeral distance on axial magnetic resonance imaging scans predicts for subscapularis tear. JSES Int. 2021;5:424–9.
[26] Hodax JD, Shah KN, Campbell SE, et al. Measurement of the coracohumeral distance on magnetic resonance imaging in a large patient cohort. J Shoulder Elbow Surg. 2021;30:408–12.
[27] Can F, Gültaç E, Şahin G, et al. Subacromial impingement as a predictor of proximal biceps tendon disorders. Joint Dis Related Surg. 2022;33:142–8.
[28] Can F, Gültaç E, Kılınç C, et al. Comparison of the clinical outcomes of chronic rupture, arthroscopic tenotomy and tenodesis of proximal biceps tendon. J Exp Clin Med. 2022;39:728–32.
[29] Biz C, Vinanti GB, Rossato A, et al. Prospective study of three surgical procedures for long head biceps tendinopathy associated with rotator cuff tears. Muscles Ligaments Tendons J. 2012;2:133–6.
[30] Morgan CD, Burkhart SS, Palmeri M, et al. Type II SLAP lesions: three subtypes and their relationships to superior instability and rotator cuff tears. Arthroscopy. 1998;14:553–65.
[31] Adams CR, DeMartino AM, Rego G, et al. The rotator cuff and the superior capsule: why we need both. Arthroscopy. 2016;32:2628–37.