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Original Research Article

Clinical and radiological outcomes of arthroscopic subcoracoid decompression for idiopathic coracoid impingement, a stepped approach

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ABSTRACT

Background: Idiopathic subcoracoid impingement is considered now as a well-established cause of anterior shoulder pain. There are multiple techniques reported for management of subcoracoid impingement. Open decompression and reattachment of conjoint tendon as well as arthroscopic resection of coracoid tip. The aim of this study was to evaluate the results of arthroscopic stepwise approach for management of idiopathic coracoid impingment.

Methods: This prospective therapeutic case series study included 26 consecutive patients suffering from anterior shoulder pain and were diagnosed as subcoracoid impingement. All cases were evaluated preoperatively and followed up for 12 months after surgery both clinically and radiologically. Arthroscopic subcoracoid decompression, coracoplasty and arthroscopic repair of partial subscapularis tear if present were done for all cases.

Results: The mean age at the time of surgery was 45.3±5.4years. At the final follow up, the mean VAS score improved significantly to 0.8±0.8points postoperatively ($p<0.01$). The mean Constant score improved significantly to 87.8±7.8 at the final follow-up ($p<0.001$). The mean UCLA score improved significantly to 32.1±2.4 at the end of follow-up ($p<0.001$)

Conclusions: Coracoid impingement should be in mind when evaluating any patient with anterior shoulder pain. The arthroscopic management in form of bone, bursal and tendon procedures (triple attack) is a good treatment to relieve clinical symptoms with excellent patient reported outcomes.

Keywords: Coracoid, Subcoracoid decompresion, Arthroscopy, Subscapularis tear, Subscapularis repair

INTRODUCTION

Subcoracoid impingement occurs as a result of compression of subscapularis muscle between lesser tuberosity and coracoid process.[1] This concept was first report by Goldthwait in 1909.[2] He described a variation in the coracoid shape as a cause for this impingement. Gerber et al expanded this concept to include impingement of the long head of biceps and the medial biceps pulley along with subscapularis between the coracoid and lesser tuberosity.[3,4]

Idiopathic subcoracoid impingement is considered now as a well-established cause of anterior shoulder pain. It is a dynamic phenomenon that mainly evokes by forward flexion, internal rotation and adduction of the arm.[5]

Goldthwait was the first to describe the subcoracoid impingement of the shoulder in 1909. To that the coracoid was a main contributor to anterosuperior cuff pathology. They were the first to describe treatment of subcoracoid impingement.

Multiple causes of subcoracoid impingement have been described. It may be either primary idiopathic impingement due to elongated coracoid tip or secondary.[6] Secondary causes may be due to ganglion cyst, malunited fractures of glenoid, head or coracoid, scapular dyskinesia or posterior glenoid osteotomy.[7]

Multiple studies have discussed the coracoid morphology and the coracohumeral distance and their contribution in coracoid impingement.[8-12] Type I (round bracket configuration) appears to be more predisposed to coraco-humeral impingement than type II (square bracket) and type III (fish hook).[9]

There are multiple techniques reported for management of subcoracoid impingement.[13] Open decompression and reattachment of conjoint tendon was described (via deltopectoral approach) as well as arthroscopic resection of coracoid tip.[4,5,13-15]

Arthroscopic approach can be done using either the rotator interval approach via direct anterior portal or extra-articular bursal approach via accessory anterolateral portal.[6,16]

This study was done to evaluate the results of arthroscopic stepwise approach for management of idiopathic coracoid impingement over one year follow up.

METHODS

This prospective therapeutic case series study between January 2018 and July 2019 included 26 consecutive patients suffering from anterior shoulder pain and were diagnosed as subcoracoid impingement. All cases were evaluated preoperatively and followed up for 12 months after surgery both clinically and radiologically. All cases were operated at El-Hadara University Hospital, Alexandria, Egypt. The study was approved from local ethical committee of Alexandria University. An informed detailed consent was taken from each patient participated in the study.

The diagnosis of subcoracoid impingement was mainly a clinical one based on three main clinical signs. First is tender coracoid proceeding on palpation. Second is positive Bear hug test of De Beer and Burkhart. Lastly, positive Napoleon belly off test. These criteria were present in all patients preoperatively.[17]

All patients had a dull aching dynamic anterior shoulder pain that was exacerbated by forward flexion, adduction and internal rotation. Clinically, all of them had coracoid pain and bicipital grove tenderness. Gerber's test was positive. Pain was elicited in adduction and internal rotation and was eliminated with abduction and external rotation.[3]

Bilateral active and passive glenohumeral range of motion (ROM) using a goniometer were measured. Subscapularis weakness was assessed by Napoleon's test, Belly press test, Lift off test and Bear hug test.

All patients had unsuccessful conservative management for a minimum of three months in form of medical treatment, subcoracoid diagnostic injection in clinic, physical therapy, activity modification and local pain-relieving measures.

MRI was used to calculate coracohumeral interval (CHI) of Gerber et al and the coracoid overlap. CHI is the minimal distance between the lateral tip of the coracoid and the subchondral bone of the humeral head. The normal distance described by Gerber was an average value of 8.7 mm. Coracoid overlap is the distance between a line drawn perpendicular to the most prominent tip of the coracoid and a line drawn tangentially in the plane of the glenoid was measured in all patients. Other radiological signs were found in MRI like bone marrow edema of lesser tuberosity, cyst formation at subcoracoid area, partial-thickness tears of the subscapularis, biceps tenosynovitis (Figure 1).[4]

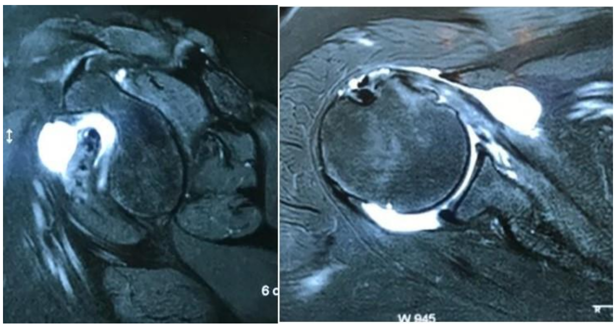

Figure 1: MRI images showing coracoid impingement.

Patients were assessed using the Constant rating score, University of California at Los Angeles (UCLA) score, and Simple Shoulder Test (SST).[18,19] Pain was recorded using a visual analogue scale (VAS); a score of 0 points indicated no pain, and a score of 10 points indicated the worse possible pain.[19]

Only patients with idiopathic coracoid impingement were included in the study. Patients with cuff tears except for isolated partial subscapularis tears were excluded from the study. Moreover, patients with complete subscapularis tears, underlying glenohumeral instability, or space-occupying lesions eg; ganglion or calcific tendinitis of the subscapularis tendon were also excluded from the study.

Surgical technique

The procedure was performed under general with interscalene block anesthesia. Maintenance of a mean arterial pressure of 60-70 mm Hg allowed maximal visualization and minimizes bleeding. A thorough examination of both shoulders under anesthesia was performed on every patient after induction of anesthesia.

All the surgeries were performed with the patient in a beach chair position. The possible subcoracoid impingement between the coracoid process and the humeral head was then examined in different arm positions, especially in adduction, flexion and internal rotation.

Signs of inflammation of the rotator interval, capsular tissue, tendinitis or lesions of the biceps tendon or its pulley or the rotator cuff were carefully searched for (Figure 2).

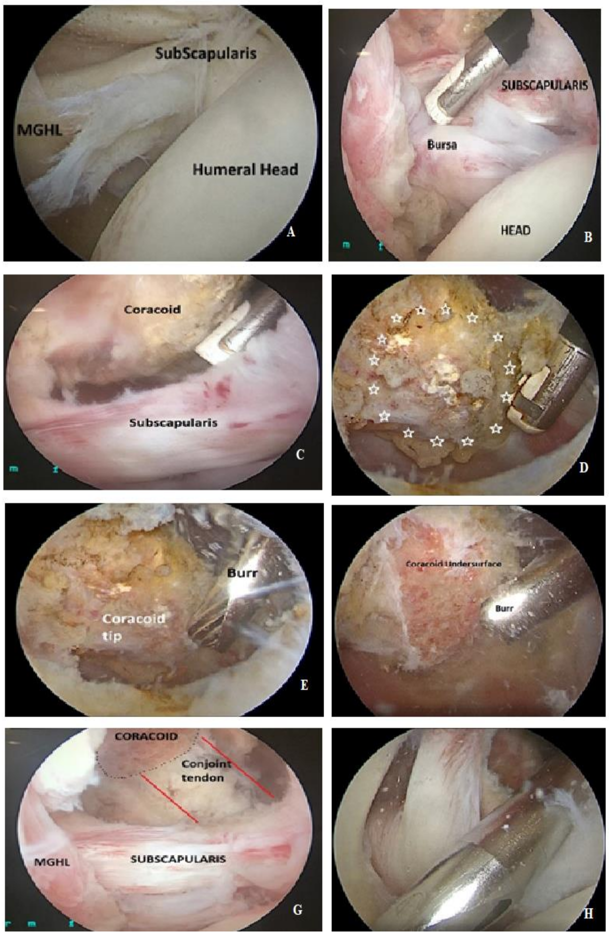

Figure 2: (A) Inflamed rotator interval with frayed upper border of subscapularis tendon (B) Subcoracoid bursectomy using radiofrequency probe; (C) Very prominent coracoid after removal of bursa; (D) Very prominent coracoid after complete debridement of bursa (Stars) (E) starting coracoplasty from anterior portal (F) coracoplasty using 4 mm burr (G) end of coracoplasty at the insertion of the conjoint tendon and (H) after coracoplasty, the coracoid edge at the level of the glenoid.

In all patients, the rotator interval approach was used to reach coracoid process. A traditional anterior portal was first created. Complete rotator interval decompression was done for visualization of subcoracoid space using radiofrequency. In some cases, an anterolateral portal is established approximately 1.5 cm lateral to the anterolateral tip of the acromion for better arthroscopic coracoplasty. After that, three stepped approach; bursal, bone and tendon work were initiated.

Bursal work (Subcoracoid decompression) was done first to clear the thickened inflamed subcoracoid bursa using shaver and radiofrequency devices along with excision of thickened soft-tissue falx (if present) at coracoid tip. The decompression continued till complete subperiosteal exposure of the posteriolateral and inferior surfaces of the coracoid tip. In order to expose the coracoid. The joint capsule between the superior glenohumeral ligament (SGHL) and the middle glenohumeral ligament (MGHL) was opened using radiofrequency probe, preserving the medial sling of the biceps sheath and the MGHL and SGHL. The coracoacromial ligament serves as landmark, safely leading to the lateral coracoid process. Further landmarks are the conjoined tendon inferiorly and the base of the coracoid medially (Figure 2).

Bone work (Coracoplasty) was done to excision of the lateral tip of the coracoid was done by using a 4 mm motorized burr (acrominizer) taking care to maintain the coracobrachialis origin. Approximately 5 mm of the posterolateral tip of the coracoid process was removed. Adequate coracoplasty was ensured when the remaining coracoid surface was at the level of the glenoid (Figure 2).

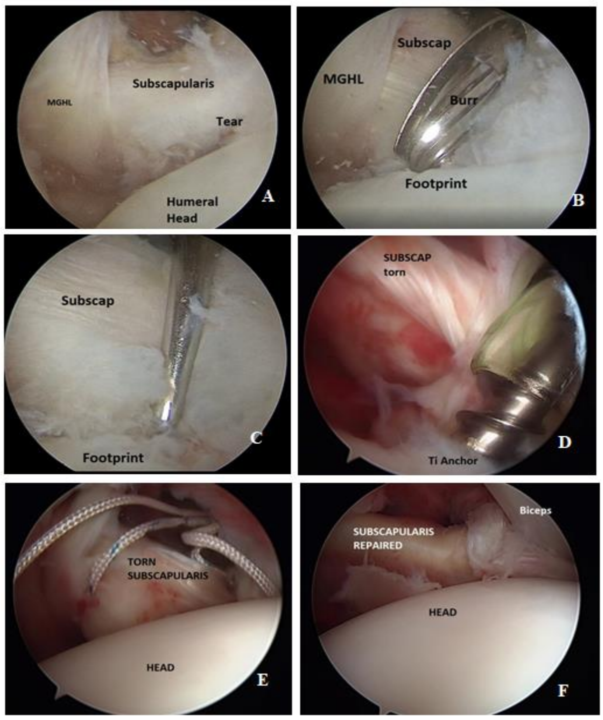

Figure 3: (A) torn upper fibers of the subscapularis tendon; (B) preparation of the footprint of subscapularis tendon; (C) a guide inserted for determining trajectory for anchor insertion perpendicular to footprint; (D) Subscapularis anchor placement; (E) passing sutures through subscapularis and (F) Repaired subscapularis to its footprint.

Tendon work (Subscapularis repair) was done if any partial subscapularis tear was present (Lafosse I-III) using one threaded titanium anchor (5.5 mm, Corckscrew, Arthrex) inserted at footprint of subscapularis tendon at lesser tuberosity after refreshment of the footprint. The tendon was sutured using Lafosse lasso loop technique for optimal tissue grip and tendon fixation (Figure 3).[20] Biceps tendon tenodesis was done in some cases using the same anchor of subscapularis repair.

Postoperative protocol

Postoperatively, the rehabilitation program depended on the presence or absence of subscapularis repair.

Patients with subscaularis repair were protected with immobilization in a broad arm sling with no external rotation for 6 weeks.

However, patients with isolated coracoplasty and no subscapularis repair, immediately started focusing on scapular stabilization and rotator cuff strengthening. Repetitive crossbody movement or adduction was avoided for 6 weeks. After one week, gentle supervised physical therapy consisting of passive pendulum and gradual passive range of motion (PROM), trunk, and scapular exercises was begun. After 6–8 weeks, scapular stabilizer strengthening exercises, using isometric contractions and resistance bands, were started, and at the same time, the PROM recovery was gently performed with dry and water therapy.

In all cases, the combined flexion adduction and internal rotation was avoided until 6 weeks after surgery. Full force exercise was allowed after 4 months.

Data analysis

Statistical analysis was done using SPSS version 25. The preoperative and final postoperative outcome score on the VAS, UCLA, SST and constant score were compared with use of wilcoxon signed rank test. Preoperative and postoperative range of motion was also compared with non-parametric tests. A comparison between subscapularis tear group and no subscapularis tear group was done using Mann Whitney test. Nominal data were compared using chi square test. A difference of results was considered to be significant when the corresponding P value was below the standard threshold of 0.05.

RESULTS

Between January 2018 and July 2019, a total of 26 patients were included in the study with idiopathic subcoracoid impingement. The study included 9 males (34.6%) and 17 females (65.4%). The mean age of the patients at the time of surgery was 45.3±5.4 years (range, 33-57 years). All patients were followed up for a minimum of 12 months. No patient lost follow up.

The anterior shoulder pain at the level of coracoid region was improved in all patients very early at the first postoperative month. At the final follow-up, clinical findings of subcoracoid impingement were negative in all patients.

The average CHI in this study was 6.4±0.7 mm with range from 5 mm to 7.9 mm. The mean coracoid overlap was 15.5±2 ranging from 12 to 19 mm (Table 1).

Table 1: Patients' demographic data.

Variable	Data	
Age (years)	Mean±SD	45.3±5.4
	Range	33-57
Gender	9 males (34.6%)	
	17 females (65.4%)	
MRI findings	7 Bone marrow edema in lesser tuberosity (26.9%)	
	11 Subcoracoid cyst (42.3%)	
	25 Biceps tendinitis (96.2%)	
	13 Subscapularis tears (50%)	
Subscapularis tears	13 No tear (50%)	
	7 Lafosse 1 (26.7%)	
	6 Lafosse 2 (23.3%)	
Coracoid overlap	Mean±SD	15.5±2
	Range	12-19
Coracohumeral Interval	Mean±SD	6.4±0.7
	Range	5-8

Regarding MRI findings, seven patients had bone marrow edema in lesser tuberosity (26.9%), 11 had subcoracoid cyst (42.3%), 25 had biceps tendinitis (96.2%) and 13 patients had Subscapularis tears (50%). Subscapularis tears were Lafosse 1 in seven patients (26.7%), Lafosse 2 in six patients (23.3%) (Table 1).

Table 2: Improvement of ROM from preoperative till the end of follow up.

	Preoperative		Postoperative		Z score	P value
	Mean±SD	Range	Mean±SD	Range		
Forward flexion	157±9.7	140-170	172±5.7	160-180	4.116	0.000*
Abduction	128.2±12.4	100-150	166.8±7.2	150-180	4.476	0.000*
External rotation	50±10.8	30-70	75.7±5.7	60-85	4.472	0.000*
Internal rotation	36±6	20-45	71.2±7.8	60-85	4.472	0.000*

*P value<0.001, Z score=Wilcoxon signed rank test

Table 3: Comparison between preoperative and postoperative functional scores.

	Preoperative		Postoperative		Z score	P value
	Mean±SD	Range	Mean±SD	Range		
Constant score	39.8±10.5	15-55	87.8±7.8	70-100	4.474	0.000*
UCLA score	13.5±3.1	7-18	32.1±2.4	28-35	4.461	0.000*
SST	10.1±1.6	8-13	2±1.3	0-4	4.474	0.000*
VAS	7.9±0.8	7-9	0.8±0.8	0-2	4.497	0.000*

*P value<0.001, Z score=Wilcoxon Signed rank test

Table 4: Comparison between no tear group (group 1) and Subscapularis tears (group 2).

	Group 1 (no subscapularis tears)	Group 2 (Subscapularis tears)	Test of significance	P value
Age (years)	44.5385	46.0769	U=75.500	0.642
Gender	6 males, 7 females	3 males, 10 females	X2 FE=1.529	0.205
FF_pre	159.0000	155.1538	U=66.500	0.345
FF_post	171.5385	172.6923	U=74.000	0.534
ABD_pre	129.2308	127.3077	U=72.500	0.526
ABD_post	166.0769	167.6923	U=72.000	0.483
ER_pre	49.6923	50.3846	U=78.500	0.754
ER_Post	76.5385	75.0000	U=77.000	0.668
IR_pre	36.1538	36.1538	U=80.500	0.824
IR_post	71.0000	71.4615	U=80.000	0.811
CO	13.7692	17.2308	U=0.000	0.000*
CHI	7.0846	5.8462	U=0.000	0.000*
CMS_pre	41.1538	38.4615	U=72.500	0.530
CMS_post	86.9231	88.8462	U=75.500	0.639
UCLA_pre	13.7692	13.3077	U=74.000	0.587
UCLA_post	32.1538	32.1538	U=83.500	0.958
SST_pre	9.9231	10.3846	U=70.500	0.463
SST_post	2.2308	1.7692	U=68.500	0.397
VAS_pre	7.8462	8.0769	U=71.500	0.480
VAS_Post	0.4615	1.1538	U=44.500	0.028*
Subcoracoid cyst	1 case	10 cases	X2 FE=12.76	0.000*

*P value<0.001, U=Mann-Whitney test, X^2=Pearson chi square, X^2 FE=Fisher exact test

At the end of follow up the ROM improved significantly in all planes especially internal rotation in all cases (Table 2).

After 12 months of follow-up, VAS score decreased significantly from a mean preoperative value of 7.9 points (range 7-9) to a mean value of 0.8 points (range 0-2) (p<0.001). There was a statistically significant improvement in UCLA score from a mean preoperative value of 13.5 (range 7–18) to a mean postoperative value of 32.1 (range 28-35) (p<0.001). Also, the Constant Murely score improved significantly from preoperative value of 39.8 (range 15-55) to a mean postoperative value of 87.8 (range 70-100) (p<0.001). Moreover, the SST scores improved significantly from preoperative value of 10.1 (range 9-13) to a mean postoperative value of 2 (range 0–4) (p<0.001) (Table 3)

Patients were subdivided into 2 groups. The first group had no subscapularis tears and the other group had subscaularis tears. There was a significant difference between both groups regarding CO, CHI and the presence of subcoracoid cyst (p<0.000) (Table 4).

A bivariate regression model was done to evaluate the correlation between the occurrence of subscapularis tears and value of coracoid overlap and CHI. There was a strong positive correlation between CO and type of subscapularis tears (R=0.84, p=0.000*). Also, there was a strong negative correlation between CHI and type of subscapularis tear (R=-0.884, p=0.000*).

No intraoperative or postoperative complications were recorded in all patients.

DISCUSSION

Subcoracoid impingement was proved by several studies as a cause of anterior shoulder pain. They also had highlighted that the incidence is much higher than reported. Impingement of the subscapularis tendon in the coracohumeral space often manifests clinically as anterior shoulder and upper arm pain that is worsened by forward flexion, adduction, and internal rotation.[7,21,22]

Cunningham and Lädermann regroup the causes of subcoracoid impingement into 2 main categories.[23] The first is subcoracoid space filling lesion (subscapularis tendon calcification, or ossification, thickening of the subcoracoid bursa and gleno-humeral ligaments, soft-tissue cyst, ganglion and lipomas). The second category is subcoracoid space narrowing or stenosis (anterosuperior migration of the humeral head in cuff deficient shoulders, anatomic variations of the coracoid or lesser tuberosity and bicipital groove, coracoid or proximal humerus malunion, posterior opening glenoid osteotomy "scott glenoplasty" or bony tumors).[23]

The arthroscopic approach to manage the coracoid impingement is better than open approach as it minimizes soft-tissue morbidity and avoids postoperative adhesions. It also allows for the identification and management of concomitant soft-tissue lesions, including rotator cuff tear and biceps pathology. Moreover, it avoids the detachment of coracobrachialis form coracoid tip with better visualization and minimal trauma.[5,7]

Park et al was the only high evidence study (level III study) that has advocated the benefit of arthroscopic coracoplasty over open approach.[24] The safety of arthroscopic subcoracoid decompression as regards musculocutaneous and axillary nerve protection was validated by Kliest et al.8 The arthroscopic intra-articular approach though the rotator interval is preferred over subacromial approach, as it is easier to approach the impinging part of the coracoid. Furthermore, it allows dynamic assessment of coracoid impingement on subscapularis tendon.[25]

Karnaugh et al reported significant postoperative pain relief in all four patients treated with arthroscopic subcoracoid decompression. They emphasis remaining lateral to the coracoid base throughout the procedure to avoid neurovascular injury.[16]

Garofalo et al retrospectively reviewed a group of 13 patients who underwent an arthroscopic surgery for subcoracoid impingement. In 4 patients, the coracoplasty was associated with a subscapularis tendon repair. At the final follow-up, VAS score decreased significantly from a mean preoperative value of 7.7 points to a mean value of 1.2 points. Also, there was a statistically significant improvement in UCLA, Constant, SST scores and also in ROM in all planes measured.[26]

In this study, the VAS score decreased significantly from a mean preoperative value of 7.9 points to a mean value of 0.8 points ($p<0.001$). There was a statistically significant improvement in UCLA score from a mean preoperative value of 13.5 to a mean postoperative value of 32.1 ($p<0.001$). Also, the constant murely score improved significantly from preoperative value of 39.8 to a mean postoperative value of 87.8 ($p<0.001$). Moreover, the SST scores improved significantly from preoperative value of 10.1 to a mean postoperative value of 2 ($p<0.001$).

Lo et al showed that in patients with subcoracoid impingement and subcoracoid stenosis, subscapularis tendon appears “bowstringing” tightly under prominent coracoid process. As the arm is rotating internally with the shoulder in adduction, the tendon is forced between prominent coracoid and proximal humerus like old fashioned clothes roller-wringer. This roller-wringer effect causes tensile loads on the undersurface of the subscapularis tendon and can lead to fiber failure of the articular surface of the subscapularis insertion (TUFF, tensile undersurface fiber failure).[27]

Park et al reported a prevalence of subcoracoid impingement as high as 56% in patients with subscapularis tears.[24]

Blankenship et al found a significant correlation between subscapularis and anterosuperior rotator cuff tears and coracoid overlap, coraco-humeral interval (both axial and sagittal), acromio-humeral interval and coraco-glenoid interval demonstrated P values 0.05.[28] Zhang et al found that the coracohumeral interval (CHI) and coraco-glenoid inclination (CGI) were potential valuable predictors of the types of degenerative subscapularis tendon tears.[29]

Cetinkaya et al found that the coracoid overlap was the most valuable parameter predicting any potential subcoracoid impingement, and the subscapularis tendon slip number (STSN) was inversely correlated with subscapularis tears.[30] However, in predicting a potential subcoracoid impingement, the coracohumeral distance measurements were not significant, as well the coraco-coracoid base angle (CBA), coracoglenoid distance (CGD). They also found in another study that the mean coracoid overlap in the subscapularis isolated tears group was 16.08±5.6 mm, which was larger than mean for supraspinatus tears, 14.65±5.92 mm.[31]

Leite et al found that that lower Coracohumeral distance (CHD) and higher coracoid overlap (CO) values were progressively related to more serious injuries of the subscapularis (SS) and long head of biceps (LHB). The CHD was a very strong predictor of SS injury and tear and a good predictor of LHB injuries. A CHD of 7.6 mm had a sensitivity of 84.4% and specificity of 88.6% for SS tears. The CO was also a very strong predictor of SS tears and a good predictor of LHB injury, with a CO of 16.6 mm reaching a sensitivity of 77.8% and specificity of 68.3% for SS tears.[32]

Leite et al also found that the mean CHD for TUFF lesion was 8.9 mm, and for partial SS tear was 6.2 mm and for complete tear SS was 5.0 mm. However, the mean CO for TUFF lesion was 16.2 mm, and for partial SS tears was 19.7 mm and for complete SS tears was 19.9 mm.[32]

In this study, 13 patients out of 26 had subscapularis tears. They were classified as Lafosse 1 in seven patients (26.7%), Lafosse 2 in five patients (19.2%) and only one case had Lafosse 3 (3.8%). Patients with subscapularis tears had a significantly larger CO values (17.3 mm), less CHI values (5.8 mm), more subcoracoid cysts. (p<0.000).

Limitations

This study has multiple limitations. The study sample is small, and there is no control group. Also, it is a case series study with very weak evidence power. However, the condition is not frequent, and this may explain the small sample size. Moreover, there was insufficient data to assess the association between subscapularis tears and preoperative MRI findings and coracoid morphology. Furthermore, the very short follow up (12 months) is another shortcoming in this study. A longer follow up period is needed to assess subscapularis retear and relapse of subcoracoid stenosis after decompression.

CONCLUSION

Coracoid impingement represents a well-established cause of anterior shoulder pain. It may be associated with subscapularis tears. It dictates precise preoperative and intraoperative assessment. The arthroscopic management in form of bone, bursal and tendon procedures (triple attack) is a good treatment to relieve clinical symptoms with excellent patient reported outcomes. The coracoid overlap and CHI are the most preoperative finding that correlate to the presence of the coracoid impingement. Coracoid impingement should be in mind when evaluating

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REFERENCES

1. Friedman RJ, Bonutti PM, Genez B. Cine magnetic resonance imaging of the subcoracoid region. Orthopedics. 1998;21(5):545-8.
2. Goldthwait JE. An anatomic and mechanical study of the shoulder-joint, explaining many of the cases of painful shoulder, many of the recurrent dislocations, and many of the cases of brachial neuralgias or neuritis. J Bone Joint Surg Am. 1909;2(4):579-606.
3. Gerber C, Terrier F, Ganz R. The role of the coracoid process in the chronic impingement syndrome. J Bone Joint Surg Br. 1985;67(5):703-8.
4. Gerber C, Terrier F, Zehnder R, Ganz R. The subcoracoid space. An anatomic study. Clinic Orthop 1987; 215:132-8.
5. Freehill MQ. Coracoid impingement: diagnosis and treatment. J Am Acad Orthop Surg. 2011;19(4):191-7.
6. Lo IK, Parten PM, Burkhart SS. Combined subcoracoid and subacromial impingement in association with anterosuperior rotator cuff tears: an arthroscopic approach. Arthroscopy. 2003;19(10):1068-78.
7. Okoro T, Reddy V, Pimpelnarkar A. Coracoid impingement syndrome: a literature review. Curr Rev Musculoskel Medic. 2009;2(1):51-5.
8. Kleist KD, Freehill MQ, Hamilton L, Buss DD, Fritts H. 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(2):245-50.
9. Gumina S, Postacchini F, Orsina L, Cinotti G. The morphometry of the coracoid process–its aetiologic role in subcoracoid impingement syndrome. Int Orthop1999;23(4):198-201.
10. Ferreira Neto AA, Almeida AMd, Maiorino R, Zoppi Filho A, Benegas E. An anatomical study of the subcoracoid space. Clinics. 2006;61(5):467-72.
11. Bhatia DN, De Beer JF, Du Toit DF. Coracoid process anatomy: implications in radiographic imaging and surgery. Clinic Anat. 2007;20(7):774-84.
12. Dugarte AJ, Davis RJ, Lynch TS, Schickendantz MS, Farrow LD. Anatomic study of subcoracoid morphology in 418 shoulders: potential implications for subcoracoid impingement. Orthop J Sports Med. 2017;5(10):2325967117731996.
13. Martetschläger F, Rios D, Boykin RE, Giphart JE, de Waha A, Millett PJ. Coracoid impingement: current concepts. Knee Surgery, Sports Traumatology, Arthroscopy. 2012;20(11):2148-55.
14. Lo IK, Burkhart SS, Parten PM. Surgery about the coracoid: neurovascular structures at risk. Arthroscopy. 2004;20(6):591-5.
15. Dumontier C, Sautet A, Gagey O, Apoil A. Rotator interval lesions and their relation to coracoid impingement syndrome. J Shoul Elbow Surg. 1999;8(2):130-5.
16. Karnaugh RD, Sperling JW, Warren RF. Arthroscopic treatment of coracoid impingement. Arthroscopy. 2001;17(7):784-7.
17. Barth JR, Burkhart SS, De Beer JF. The bear-hug test: a new and sensitive test for diagnosing a subscapularis tear. Arthroscopy. 2006;22(10):1076-84.
18. Constant C, Murley A. A clinical method of functional assessment of the shoulder. Clinic Orthop. 1987(214):160-4.
19. Romeo AA, Bach JR BR, O'Halloran KL. Scoring systems for shoulder conditions. Am J Sports Med. 1996;24(4):472-6.
20. Lafosse L, Van Raebroeckx A, Brzoska R. A new technique to improve tissue grip:"the lasso-loop stitch". Arthroscopy 2006;22(11):1246e1-3.
21. Mohammed H, Skalski MR, Patel DB, Tomasian A, Schein AJ, White EA, et al. Coracoid process: the lighthouse of the shoulder. Radiographics. 2016;36(7):2084-101.

22. Dines DM, Warren RF, Inglis AE, Pavlov H. The coracoid impingement syndrome. J Bone Joint Surg Br. 1990;72(2):314-6.
23. Cunningham G, Lädermann A. Redefining anterior shoulder impingement: a literature review. Int Orthop. 2018;42(2):359-66.
24. Park J-Y, Lhee S-H, Oh K-S, Kim NR, Hwang J-T. Is arthroscopic coracoplasty necessary in subcoracoid impingement syndrome? Arthroscopy 2012;28(12):1766-75.
25. Osti L, Soldati F, Del Buono A, Massari L. Subcoracoid impingement and subscapularis tendon: is there any truth? Muscl Ligam Tend J. 2013;3(2):101.
26. Garofalo R, Conti M, Massazza G, Cesari E, Vinci E, Castagna A. Subcoracoid impingement syndrome: a painful shoulder condition related to different pathologic factors. Musculoskel Surg. 2011;95(1):25-9.
27. 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(10):1142-50.
28. Giaroli EL, Major NM, Lemley DE, Lee J. Coracohumeral interval imaging in subcoracoid impingement syndrome on MRI. AJR Am J Roentgenol. 2006;186(1):242-6.
29. Zhang H, Zhang Q, Li Z-L. Coracohumeral index and coracoglenoid inclination as predictors for different types of degenerative subscapularis tendon tears. Int Orthopaed. 2019;43(8):1909-16.
30. Cetinkaya M, Ataoglu MB, Ozer M, Ayanoglu T, Kanatli U. 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(4):734-42.
31. Çetinkaya M, Ataoğlu MB, Özer M, Ayanoğlu T, Kaptan AY, Kanatlı U. Korakoid taşma ile subskapularis yırtıklarının ilişkisi. Cukurova Medic J. 2018;43(4):1008-14.
32. Leite MJ, Sá MC, Lopes MJ, Matos RM, Sousa AN, Torres JM. Coracohumeral distance and coracoid overlap as predictors of subscapularis and long head of the biceps injuries. J Should Elb Surg. 2019;28(9):1723-7.

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