Coracoplasty: Indications, Techniques, and Outcomes

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Abstract: Coracoplasty has become a more commonly performed surgical procedure, as coracoid impingement has become increasingly recognized as a cause of persistent anterior shoulder pain. Open and arthroscopic techniques have shown satisfactory results. This article will provide a current review about the indications and techniques for coracoplasy, including both arthroscopic and open techniques and the expected outcomes.

Key Words: coracoplasty, coracoid impingement, subcoracoid impingement

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In 1909, Goldthwait[1] was first to describe rotator cuff impingement by the coracoid process. Since then several anatomic, clinical, and biomechanical studies have addressed the topic to understand more about its etiology, diagnosis, and treatment. Hence, today coracoid impingement (CI) is a relatively well-known cause of anterior shoulder pain. It is defined as compression of the anterior soft tissues of the shoulder (subscapularis tendon, long head biceps tendon, and biceps reflection pulley) between the coracoid process and the lesser tuberosity.[2–4] More recent studies have shown the association between subcoracoid stenosis, defined as a narrowed coracohumeral distance (CHD), and anterior shoulder pathologies to be relatively common, although probably often unrecognized and underreported.[5–8] Suenaga et al[9] found subcoracoid impingement syndromes in 11 of 216 (5.1%) cases after rotator cuff surgery because of ongoing pain and tenderness over the coracoid process.

Potential causes of CI may be classified as idiopathic, iatrogenic, or traumatic.[2] Idiopathic causes are because of "individual variations" in the length and projection of the coracoid process,[2] calcification within or ossification of the subscapularis tendon,[10,11] and ganglion cysts.[12,13] Idiopathic causes have been described by Gerber et al[2] and include surgical procedures like coracoid transfer, posterior glenoid neck osteotomy, or acromionectomy. CI might also occur after previous humeral head or neck fractures, fractures of the coracoid process, the glenoid or the scapula neck, and posterior sternoclavicular dislocations.[2,14] A narrowing of the coracohumeral interval, because of an idiopathic or posttraumatic anterior instability is also a potential cause and has been discussed in literature.[15,16]

Correct diagnosis of CI can be challenging. As there are no validated clinical or radiologic examinations for diagnosis of CI, diagnosis has to be established by a synopsis of medical history, clinical examination, and appropriate imaging.[17]

The patients typically present with anterior shoulder pain that worsens during abduction or flexion and internal rotation, as the lesser tuberosity approaches to the coracoid process. Furthermore, patients may complain about tenderness to palpation around the coracoid process.[2] A thorough history must include prior shoulder injuries or surgeries, the duration of pain, and the point in time when it occurred first. Furthermore, the evaluation of possible iatrogenic, idiopathic, and traumatic causes is mandatory.

Clinical examination should include a careful evaluation of both shoulders. Particular attention needs to be paid to positive rotator cuff or biceps-tendon tests and signs for instability, as these pathologies are reported to be associated with a narrowed CHD.[7,15,17–19] The coracoid process and the surrounding space are palpated to detect any tenderness. During passive examination of the shoulder, attention has to be paid to pain aggravation during flexion or abduction and internal rotation.[2] The CI test according to Dines et al[20] is performed by passive internal rotation with the arm in cross-body adduction and forward elevation. However, as discussed, these clinical tests have not been shown to be specific and have yet to be validated in literature. In addition, a subcoracoid lidocaine injection may sometimes be a helpful diagnostic consideration to exclude other sources of pain such as the acromioclavicular joint or the glenohumeral joint.[2,3,21]

Standard radiographs should be obtained and may reveal anatomic variations, such as a far laterally projecting coracoid process in anteroposterior view or a chevron-shaped coracoid process in the supraspinatus outlet view,[22,23] however, there is no evidence-based correlation of these morphologic variations to CI syndrome in literature. Therefore magnetic resonance imaging (MRI) or computed tomography (CT) examinations seem to be more useful in this context, and several studies have shown a narrowing of the CHD in patients with CI.[24–26] The CHD is measured on the axial CT or MRI image, with the greatest amount of narrowing from the cortical margin of the coracoid process to the cortical margin of the humeral head.[7,24,25,27] The normal CHD has been shown in anatomic and imaging studies to be between 8.4 and 11 mm.[5,26,28] A CHD of <6 mm has a high specificity for CI and is defined as subcoracoid stenosis.[6,11] Furthermore, an increased coracoid index might be a predictive value for CI.[3,20] The coracoid index is defined as the projection of the coracoid process beyond the line of the glenoid in axial planes (Fig. 1). Dines et al[20] found the average value in 67 normal shoulders to be

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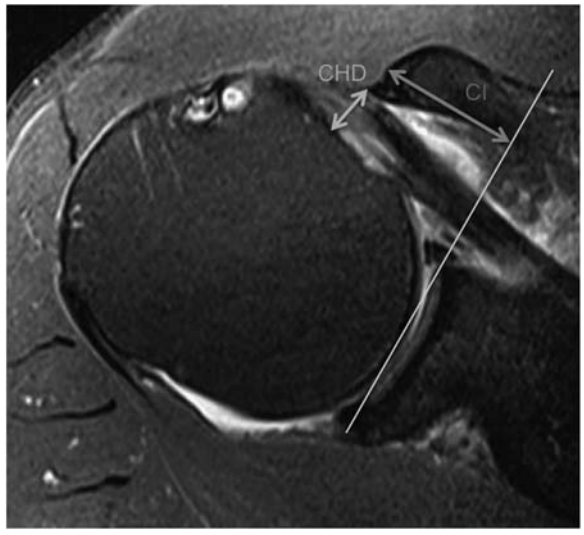

FIGURE 1. Magnetic resonance imaging of a male left shoulder showing narrowed coracohumeral distance (7 mm, small arrow) and increased coracoid index (CI, 20 mm, large arrow) in patient with partial subscapularis tendon tear, biceps-tendon rupture, and a cyst within the lesser tuberosity.

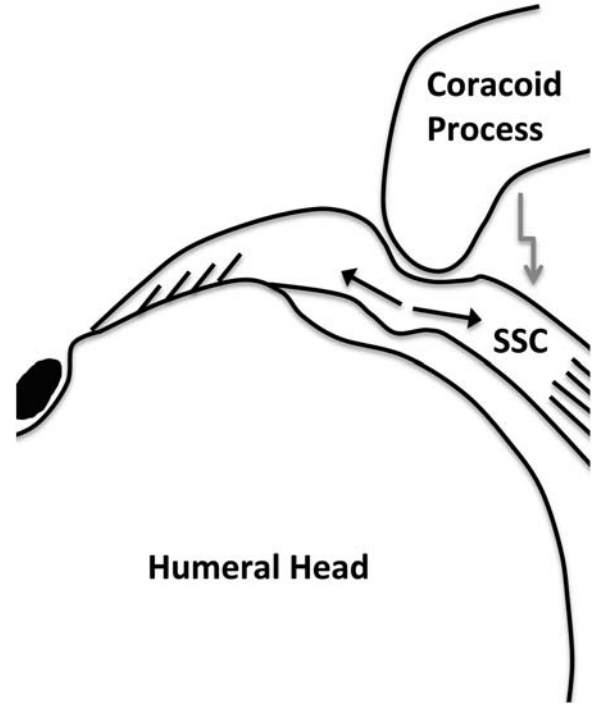

FIGURE 2. Schematic drawing of the "roller-wringer effect" as described by Lo et al.[36] In patients with coracoid impingement, the prominent coracoid process indents the superficial surface of the subscapularis tendon, creating tensile forces. This might lead to failure of the subscapularis fibers [black arrows indicating the tension forces on the articular surface of the subscapularis tendon (SSC)].

8.2 mm. Nevertheless, a validated pathologic value for the coracoid index in patients with CI is lacking in literature.

In addition, Giaroli et al[24] showed that the CHD as measured on routine MRI was found to be only 5.3% sensitive yet 97% specific for CI. Hence, they concluded CI primarily to be a clinical diagnosis that may be supported, but not established, by MRI findings alone.

Once diagnosis of CI is established, initial treatment is nonoperative including activity modification with avoidance of provocative positions and physiotherapy for rotator cuff strengthening and scapula stabilization, followed by injection therapies.[2,17,29,30] We have shown in our lab that postural changes can affect the coracohumeral interval and therefore recommend a program that focuses on scapular protraction to widen the interval and hopefully alleviate symptoms.[31] However, to date there are no well-designed prospective studies in literature reporting on specific nonoperative treatment programs and their outcomes for CI.

On the basis of the information in the literature and our experience, we define CI as a clinical syndrome of anterior shoulder pain, with tenderness over the lesser tuberosity, bicipital groove, and coracoid, and MRI and arthroscopic findings of a narrowed CHD.

Surgical treatment can be helpful in cases of persistent discomfort or pain or, more commonly, in association with other procedures that address anterior shoulder pathology.

INDICATIONS

In cases of idiopathic or primary CI that fail nonoperative treatment, the indication for open or arthroscopic coracoplasty needs to be discussed with the patient, as surgical treatment can provide good and reliable clinical results in terms of pain relief and functional improvement.[2,4,5,9–11,32] Furthermore, there is evidence in literature suggesting that coracoplasty should be performed as an associated procedure in patients undergoing surgery for rotator cuff repair who also have symptoms of CI.[9] Coracoplasty may also be performed in some patients who have persistent anterior shoulder pain after prior rotator cuff repair to prevent ongoing postoperative pain.[9] Some authors perform a coracoplasty in patients with rotator cuff tears, once CI is confirmed during arthroscopic examination.[33,34] Others recommend performing a coracoplasty systematically as part of subscapularis repair to avoid any pathologic mechanical process between the coracoid and the subscapularis repair.[35] Lo and Burkhart[36] have described a possible mechanism for upper third subscapularis tears which they called the "roller-wringer effect," suggesting a prominent coracoid process might lead to failure of subscapularis tendon fibers in patients with CI (Fig. 2).

Indeed, a correlation between a narrowed CHD and anterior shoulder pathologies is reported in several recent studies, whereas none of the studies could clarify whether a narrowed CHD is cause of the lesion or its effect.[5,7,8,18]

Regarding the current literature, there is no hard evidence concerning the indication for coracoplasty. Therefore, the authors are now describing a possible approach to decision making.

We recommend performing a coracoplasty in patients with symptomatic and arthroscopically confirmed CI. Our preference is to examine the coracohumeral interval in all patients with anterior shoulder pain and in all patients with anterior shoulder pathology (anterosuperior labral tears, subscapularis tears, biceps-tendon pathology, and leading edge supraspinatus tears) and then to perform coracoplasties on patients with narrowed coracohumeral intervals (< 8 mm in women and < 10 mm in men, from preoperative axial imaging or intraoperative measurements). Impingement of the coracoid

against the subscapularis and the lesser tuberosity is considered an indication for a coracoplasty. This is determined by dynamic, intraopaerative arthroscopic evaluation. The arm is manipulated in a combination of forward flexion, abduction, and internal rotation.[11] Furthermore, coracoplasty is recommended in patients with a combination of anterior shoulder lesions and narrowed CHD.

SURGICAL TECHNIQUES

To perform a decompression of the coracohumeral space, several arthroscopic[10,11,17] and open surgical techniques have been described in the literature. No significant advantage in clinical outcome is confirmed in the literature for either treatment. Dines et al[20] and Ferrick[3] described an open technique, using a standard deltopectoral approach, with dissection of the conjoined tendon from the coracoid process, resection (10 to 15 mm) of the coracoid tip and reattachment of the conjoined tendon to the remaining base of the coracoid process. A different way of performing open coracoplasty is to divide the conjoined tendon for 2 cm and continuing the incision for 2 cm into the coracohumeral ligament. After removal of the lateral portion of the coracoid process the conjoined tendon is repaired side to side.[22,23] In addition, the coracobrachialis attachment can be elevated close to its origin to allow visualization and osteotomy of the posterior, lateral, and inferior portions of the coracoid.[4,9] Gerber et al[2] believe that isolated CI is rare and advocate additional resection of the coracoacromial ligament and acromioplasty.

The arthroscopic technique can be performed from intra-articular (transarticular), inserting the burr through an anterolateral working portal, or extra-articular from the subacromial space. The authors prefer the transarticular arthroscopic technique in most cases as it avoids extensive dissection of soft tissue, and enables the surgeon to directly look at the coracohumeral interval during resection and while moving the arm in the impingement position afterwards for final inspection. In addition, concomitant intra-articular pathologies can be addressed easily, using this approach.

ARTHROSCOPIC CORACOPLASTY

Positioning and Instruments

A thorough examination of both shoulders under anesthesia is performed on every patient after induction of anesthesia but before positioning. Range of motion and signs of instability are documented. This is important, as for example in case of anterior instability coracoplasty alone might not be successful.[15] We prefer the beach-chair position for arthroscopic coracoplasty, although this can easily be performed in the lateral decubitus position as well. The basic instruments required for isolated arthroscopic coracoplasty include a 30-degree arthroscope, a motorized shaver and burr, and a radiofrequency tissue ablation device. For better fluid management an arthroscopic pump is recommended, as this allows the surgeon to adjust the pressure as needed in any situation. To avoid early swelling of the shoulder the initial pump pressure is set low at 35 to 40 mm Hg.

Surgical Landmarks, Portals, and Diagnostic Arthroscopy

At the beginning of every case we mark the bone landmarks on the skin. Thereby the acromion, clavicle, acromioclavicular joint, scapular spine, coracoid process, and coracoacromial ligament can easily be identified (Fig. 3). Diagnostic arthroscopy is performed through a standard posterior portal. In patients with diagnosed CI particular attention has to be paid for anterior lesions like anterosuperior rotator cuff tears, rotator interval lesions, or long head biceps-tendon disorders.[5,7,8,18,36] Also signs of anterior shoulder instability such as capsulolabral lesion or elongated capsule-ligament complex must be detected to choose the correct treatment.

FIGURE 3. Right shoulder of patient in beach-chair position, marked bony landmarks and incisions. For coracoplasty the burr is inserted through the anterior portal (1). The standard viewing portal is marked with (2). (3) shows an additional posterolateral portal and (4) the standard posterior viewing portal.

In presence of anterior shoulder instability, stabilization should be performed first, as this might solve the anterior impingement problem.[15,32] After stabilization, the dynamic intraoperative evaluation described above is repeated and a coracoplasty is performed in cases of persistent CI. Once a lesion to the long head biceps tendon and/or its pulley system is detected, tenodesis or tenotomy is indicated to avoid the risk of persistent pain. The authors prefer immediate tenotomy and subsequent subpectoral biceps tenodesis, once arthroscopy is completed. Subpectoral tenodesis reliably relieves pain, improves function,[37] and eliminates any type of sawing mechanism of injury to the subscapularis tendon.[38] In cases in which a subscapularis tendon tear is accompanied by a narrowed coracohumeral interval (< 8 mm in women and 10 mm in men), we recommend performing a coracoplasty first. By doing so, one can avoid mechanical compression between the coracoid and subscapularis tendon repair. Furthermore, one creates more space within the anterior shoulder compartment, which makes the surgery technically easier for the subsequent subscapularis tendon repair.

For performing a coracoplasty, an anterolateral portal is established approximately 1.5 cm lateral to the anterolateral tip of the acromion. The key to proper portal placement is first verifying the intra-articular position and the expected work angles with a spinal needle. To expose the coracoid, we start opening the joint capsule between the superior glenohumeral ligament and the middle glenohumeral ligament with a shaver or radiofrequency device (Fig. 4A), preserving the medial sling of the biceps sheath and the major capsular ligaments. This window in the rotator interval describes only a very small round defect, not leading to any instability as long as the surrounding capsule tissue and ligaments are preserved. The coracoacromial ligament serves as landmark, safely leading to the lateral coracoid process (Figs. 4D and 5). Further landmarks are the conjoined tendon inferiorly and the base of the

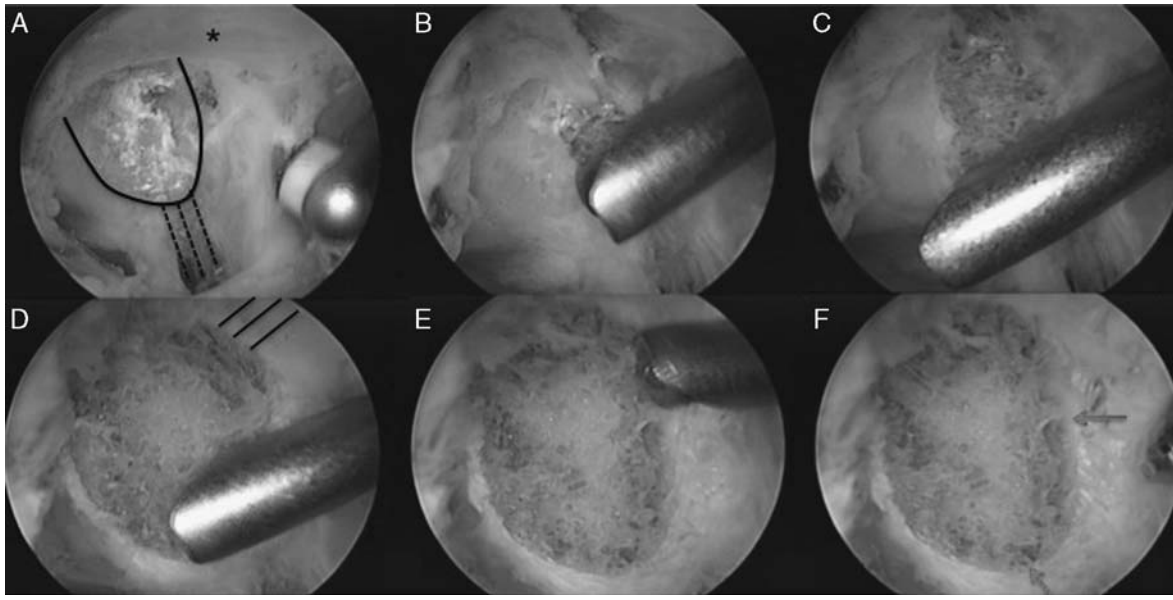

FIGURE 4. Steps of coracoplasty in right shoulder of patient viewing from posterior with patient in modified beach-chair position. A, Preparation of coracoid process (black line) with a radiofrequency device. The conjoined tendon (dotted black lines) and the open joint capsule (*) can be seen. B–D, Stepwise resection of the posterior aspect of the coracoid tip from lateral to medial using a 4-mm burr. The black lines indicate the course of the coracoacromial ligament. E and F, Resection of the lateral aspect of the coracoid tip and completes coracoplasty. The arrows show direction of resection to anteriorize and medialize the coracoid process and create more space for the subscapularis tendon.

coracoid medially. By dissecting on the lateral side of the coracoid, no neurovascular structures will be injured. When reaching the lateral aspect of the coracoid, the radiofrequency device is used to remove the soft tissue from the posterior and lateral aspect of the coracoid. Next, a 4-mm burr is inserted through the anterolateral portal. Coracoplasty is performed from lateral to medial (Figs. 4B–D), removing approximately 5 mm of the posterior tip of the coracoid process and therefore anteriorizing its posterior aspect. Finally, the lateral aspect of the coracoid tip is resected as well, to medialize the coracoid process (Figs. 4E and F). After completion, again a dynamic examination is performed, by moving the arm, which should confirm sufficient resection. The goal should be to create more space between the lesser tuberosity and the posterior and lateral aspect of the coracoid tip, while preserving the major tendinous attachments and preventing an iatrogenic fracture. A schematic drawing, clarifying the expected anatomic changes after coracoplasty is shown in Figure 5.

The postoperative rehabilitation is adapted depending on associated procedures that may be performed concomitantly. After isolated coracoplasty active range of motion is allowed as early as possible. We recommend avoiding impingement (flexion and internal rotation; cross-arm adduction) positions for the first 2 weeks after surgery.

OUTCOMES

The published literature indicates that open and arthroscopic coracoplasty can provide good and reliable results in terms of pain relief and improvement of shoulder function.[2,4,5,9–11,32] However, as CI is a rare finding, present data concerning coracoplasty, its optimal technique and outcome are weak. The available studies report on small case series or patients not treated with isolated coracoplasty. Furthermore, possible associated injuries, missed during open surgery or addressed arthroscopically might have crucial influence on the postoperative outcome.

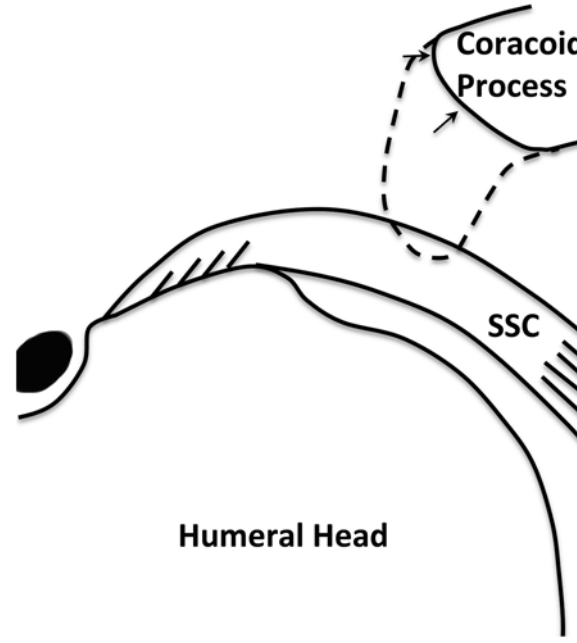

FIGURE 5. Schematic drawing of status after coracoplasty. The red lines indicate the new anatomic conditions. The gained space for the subscapularis tendon (SSC) can be seen. The arrows show the direction of resection to anteriorize and medialize the coracoid process.

SUMMARY

Although regarded as rare condition, CI should be considered as a possible cause of anterior shoulder pain, particularly in patients with associated anterior shoulder pathologies. The authors and others believe that disregarding CI can lead to unsuccessful treatment.[9] Therefore, a thorough diagnostic process is mandatory to gain the correct treatment option. In cases of primary and intractable CI, isolated coracoplasty is satisfactory. Any concomitant pathologies, such as anterior instability, must be evaluated and considered as possible causes for present symptoms.[15,32] The authors prefer the arthroscopic technique to preserve the conjoined tendon, avoid major soft-tissue dissection, and allow early rehabilitation.

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