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Is There a Need for Arthroscopic Subacromial Decompression in Treating Outlet Impingement Syndrome? Sizing Classification of the Subacromial Space Narrowing and Treatment Guidelines

Basim Fleega*, Ahmed Kandil, Said Karim, Moataz Eldeeb

Abstract

Background: The arthroscopic acromioplasty procedure for treating outlet impingement aims to remove the subacromial bursa, (which can serve as a pain generator) and any osteophytes on the undersurface of the acromion, which can lead to impingement as well as decompress the subacromial narrowing causing the impingement by removing bone from the lower surface of the anterior acromion. Controversies were lately present in the literature about whether there is a need for anterior acromioplasty in treating outlet impingement [1].

The control of bleeding and the determination of the appropriate amount of bone resection are two common technical difficulties in performing the arthroscopic subacromial decompression. This paper describes a technique to classify the subacromial narrowing and simplifies the procedure while providing more precise bone resection and contouring in cases of outlet Impingement. This technique is based on the arthroscopic sizing classification of the sub-anterior acromion tendon space (SAT space) described by the first author through using a special measuring needle device for measuring the space in standard sitting position under anesthesia and monitoring the decompression. It also presents the relation between subacromial pathology and the size of the narrowing.

Material and Methods: The arthroscopy was done in general anesthesia with the patient in a standard sitting position with the arm hanging. Between 2015 and 2020, 410 cases had an arthroscopic measurement for the space between the anterior acromion and the cuff (SAT space) in which 280 out of 410, were cases of more than 6 months therapy resistant outlet impingement syndrome stage II (without cuff tear) and impingement stage III with cuff tear. The other 130 cases were instability and calcific tendonitis. The SAT space is classified to 4 sizes grades, called Sizing Classification. A standard arthroscopic anterior acromioplasty was made depending on the grade of SAT space. An arthroscopic trans-periosteal - muscular suture reconstruction of the origin of the anterior deltoid muscle was done if there was a gap after bone removal.

Results: In the study all cases of outlet impingement were only present with SAT space grade 2 -4 , there was no outlet impingement stage II (chronic impingement) or III (impingement with supraspinatus tear) found with a SAT space grade 1, thus the bone removal was only of the amount of bone needed to get a SAT space grade 1 (more than 12 mm). The postoperative results were very promising, no complications were found, and the Neer Score was rated excellent in all 228 out of the 280 impingement cases reexamined with an average follow up period of 6 years and 3 months.

Affiliation:
GOC Shoulder Services Al Nada Zayed Hospital Cairo Egypt

***Corresponding Author:**
Basim Fleega, GOC Shoulder Services Al Nada Zayed Hospital Cairo Egypt

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Conclusion: The sizing classification is a guide to determine whether there is a need for decompression, and if so, the amount of bone to be removed based on the measuring guide. Thus, it gives more clarity to the controversy presented now in literature. The subacromial decompression based on the sizing classification using the measuring needles eases the operation and standardizes the technique. Closing the defect at the deltoid origin if present, leads to regaining the normal anterior deltoid anatomical origin.

Keywords: Arthroscopy; Outlet Impingement; Rotator cuff; Shoulder Impingement Syndrome; Anterior Acromioplasty.

Level of evidence: Level III

Introduction

The procedure of arthroscopic subacromial decompression (anterior acromioplasty) is indicated for refractory subacromial bursitis and subacromial outlet impingement. It is also a routine portion of rotator cuff repair exposure. The determination of the appropriate amount of bone resection is a common technical difficulty in performing arthroscopic subacromial decompression. Classification of impingement syndrome in the literature is based either on pathological changes such as staging classification by Neer [2] and arthroscopic soft tissue changes classification by Levy et al. [3] or the classification based on the relation of impingement to shoulder instability as described by Jobe and Kvitne [4]. Other classifications based on investigations were reported as Milgrom et al classification [5] based on the ultrasound examination and Bigliani and Levine [6] radiological grading of the shape of the acromion and its relation to impingement (Figure 1). In some cases, impingement occurs due to increase thickness of the supraspinatus tendon as in body building athletes causing outlet impingement due to narrowing of the space between the anterior acromion and the supraspinatus, although the x-ray shows a wide space. Lately studies suggest that there is no need for decompression as the result of cases treated with conservative means and that treated with arthroscopic decompression are similar. Presented in this paper will be the sizing classification of the impingement syndrome, and an arthroscopic technique of measuring needle standard subacromial decompression based on the SAT measurement sizing classification that simplifies and standardize the procedure providing precise anterior acromion bone resection. Also demonstrated will be a technique to close the gap at the origin of the anterior deltoid, if present after the decompression.

The arthroscopic impingement sizing classification [7,8] of the space between the lower surface of the anterior acromion and the Supraspinatus tendon (Sub-anterior Acromion Tendon space; SAT space) (Figure 2) is the only classification addressing the cause of the outlet impingement pathology which is the narrowing of the SAT space causing the compression on the bursa and tendon leading to outlet impingement pathology. It classifies the SAT space narrowing into four grades (Figure 3). The relation of the subacromial pathology to each grade was based on the reviewing of 410 subacromial arthroscopies done for subacromial pathologies (Table 1).

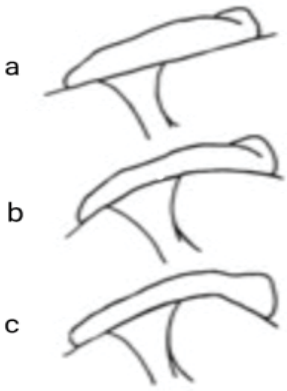

Figure 1: Classification of the shape of the acromion as described by Bigliani: a- type I, flat acromion, b-type II curved acromion and c-type III hooked acromion.

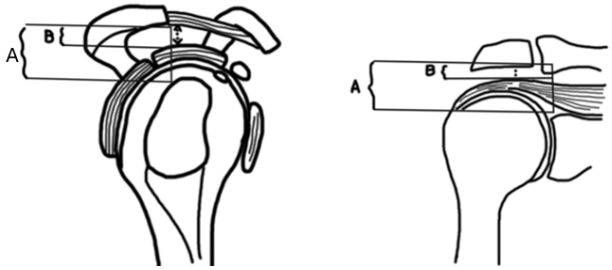

Figure 2: A- Supraspinatus outlet: The space between the upper border of the glenoid and the acromion. B- the SAT space: between the anterior acromion and the tendon. The space between the head and anterior acromion, which is usually measured on x-ray view, does not give information about the SAT space which its narrowing is responsible for the outlet impingement.

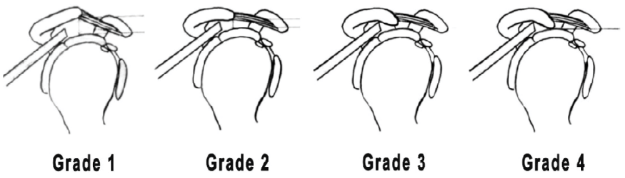

Figure 3: Arthroscopic sizing classification of the sub-anterior acromion tendon space (SAT space) is:- Grade 1: SAT space more than 12mm, Grade 2: between 6 and 12mm, Grade 3: between 1 and 5mm, Grade 4: no detectable space.

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Table 1: Relation of the SAT space to the subacromial pathology after reviewing 410 cases shows no SAT space Grade 1 in cases of impingement syndrome with or without rotator cuff tear. While in cases of instability and calcium there was no SAT Grade 3.

PATHOLOGY	CASES	GRADE I	GRADE II	GRADE III	GRADE IV
Outlet Impingement II (also, Partial cuff tear)	(147)	-	20%	40%	40%
Outlet Impingement III (complete RC Tear)	(133)	-	3%	22%	75%
Calcium (space after removal)	(97)	5%	55%	40%	-
Instability Impingement	(33)	80%	20%	-	-

Technique

Preoperative Imaging:

Preoperative evaluation with anteroposterior, scapular-Y, and axillary radiographs is obtained and reviewed. Also, the MRI gives information about the SAT space.

Anesthesia and Patient Positioning:

Anesthesia is a combination of general endotracheal anesthesia and interscalene block for postoperative pain control. The arthroscopy is done with the patient in a sitting position with the arms hanging (Figure 4). This position is mandatory for this technique as a standard for measurements used in the surgery.

Figure 4: Patient in a sitting position with the arm hanging. Is the standard for the measurement of SAT space.

A standard 30°arthroscope is used and introduced in the subacromial space through the lateral posterior portal. A motorized shaver is introduced in the lateral anterior portal and the water inflow cannula in the standard posterior medial portal which also helps to push the supraspinatus muscle downwards for better visualization. The standard posterior portal is also used for intraarticular examination (Figure 5).

Two special measuring needles are passed through the skin from above one at the anterior lateral corner of the anterior acromion and the other one at the medial corner of the anterior acromion near the AC-joint and push in them to

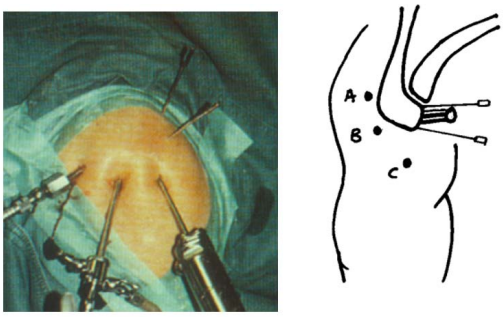

Figure 5: Portals used for for the subacromial decompression; A-posterior medial portal for water inflow, B-lateral posterior portal for the scope, C- lateral anterior portal immedialty above the supraspinatus as detected with the spinal needle. The measuring needles are placed at the medial and lateral corners of the anterior acromion.

the supraspinatus tendon to measure the space between the anterior acromion and the tendon (Figure 6 and 7).

The technique of placing the lateral measuring needle is by feeling the lateral edge of the acromion with the thumb and placing the needle were the edge ends anteriorly, by feeling the lateral corner of the anterior acromion with the needle.

The medial measuring needle is placed by feeling the acromioclavicular joint with the finger and then placing the needle immediately lateral to it by using the needle to feel the medial corner of the anterior acromion then pushing it down. In case the AC joint cannot be felt, a spinal needle is used to localize it.

The role of the measuring needles is to localize the medial corner of the anterior acromion in order not to injure the AC joint and to protect the anterior deltoid while using instruments for decompression. It helps to localize the acromial insertion of the coraco-acromial ligament for resection as it lies immediately below the medial measuring needle. They are used to measure the SAT space and monitor the decompression to reach grade 1 SAT space.

The SAT space is measured and classified accordingly and if the space is not grade 1 a decompression is made to reach SAT space Grade 1 (more than 12 mm).

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The decompression starts first by releasing the coracoacromial ligament at its acromial attachment by cutting it with a sharp scissor to minimize bleeding.

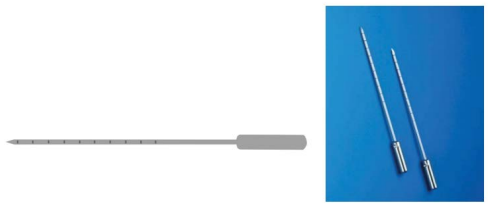

Figure 6: The meassuring needles are marked every 5 mm to measure the subacromial space arthroscopicaly

Figure 7: Placement of the measuring needles at the corners of the anterior acromion

The motorized shaver is brought through the instrumentation portal and rested against the acromion(Figure 8a) to remove the periosteum of the under surface of the anterior acromion in order to visualize the bone and the anterior inferior rim of the acromion (Figure 8b).The shaver is removed and with the acromionizer the Bone resection of the lower surface of the anterior acromion is done by sweeping the acromionizer from posterior to anterior progressively till the marking of 12 mm or more is visualized on the measuring needle scale (Figure 8c).

If a bony protrusion at the anterior acromion is passing the line laying in continuation with the anterior border of the lateral clavicle and the AC-joint is present; it must be resected to have the anterior border of the acromion in continuation with the anterior border of the acromioclavicular joint (Figure 9). Preoperative diagnosis can be done with axial x-ray.

Finally, the appropriate amount of bone is resected, resulting in a flat acromion which is tapered anteriorly and has a smooth transition to normal bone posteriorly (Figure 10).

The subacromial decompression and widening the SAT space to be more than 12 mm has usually no effect on the anterior acromion expect in case of narrowing with a flat acromion, as the bone resection can lead to thinning of the anterior acromion affecting the anterior deltoid muscle insertion (Figure 11). In this case we recommend the arthroscopic suturing of the anterior deltoid to the periosteum of the anterior acromion using the Giant needle [9] (Figure 12).

Postoperative:

After surgery the arm is placed in a sling and in cases of anterior deltoid repair an arm sling with abduction pillow is used.

We initiate passive shoulder exercises immediately after surgery. Patients start passive assisted exercise on the first postoperative day. Active shoulder motion begins 3 to 6

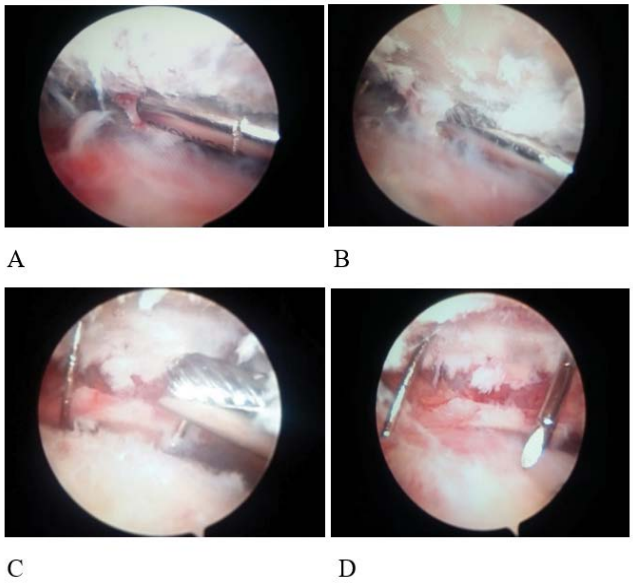

Figure 8: Steps of the subacromial decompression technique based on SAT measuring guideline; A: SAT space Grade 4 with the anterior acromion laying on the supraspinatus with no detectable SAT space, B: after removal of the subacromial periosteum from the lower surface of the anterior acromion showing the bone, C & D: after removing of the bone, the measuring needle is seen and it measures 15 mm,(SAT space , Grade 1).

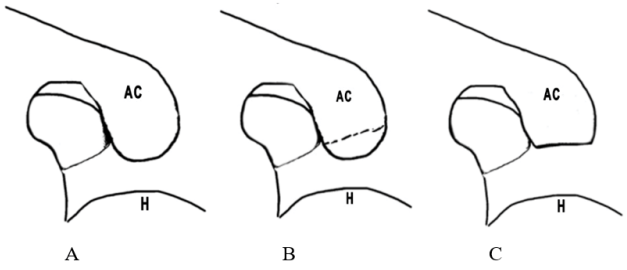

Figure 9: A:anterior acromion protruding over the anterior border of the lateral clavical end and the AC joint, B: a line is drown in cotinuation with the anterior border of the lateral acromion, C: after resection of the acromial protrusion.

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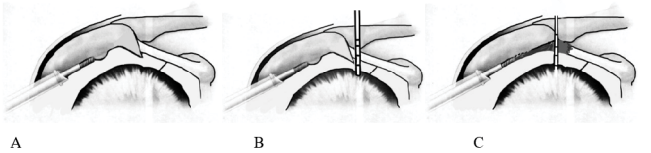

Figure 10: A: The SAT space with bone spur and osteophytes, B: the measuring needle measures a Grade 3 SAT space of 3mm, C: after removal of bone the space is more than 12mm, Grade 1 SAT space with a flat inferior surface of the anterior acromion.

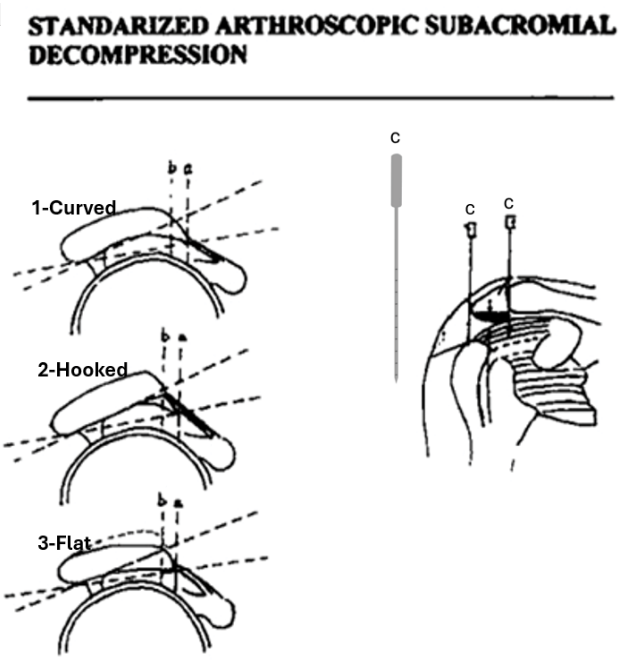

Figure 11: Showing from above down the curved acromion (1), hooked acromion (2) and the flat acromion (3). The narrow SAT space (a) in case of outlet impingement as measured with the measuring needles (c) is irrelevant to the shape of the acromion, and the resection of the bone to achieve Grade 1 SAT space (b) should be done in all types. A thinning of the anterior acromion and an anterior deltoid insertion gap can result in case of a flat acromion after decompression (3).

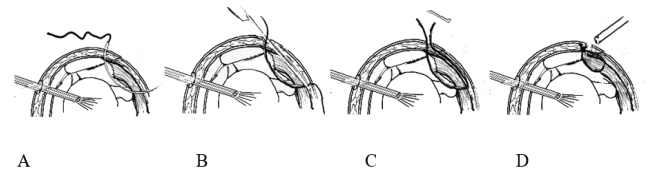

Figure 12: In case of presence of a gap between the anterior acromion and the deltoid muscle after acromioplasty, especially in case of flat acromion, a giant needle is passed through the skin and the periosteum on top of the anterior acromion then through the deltoid muscle from inside and out through the skin (A). The lower end of the suture is then pulled out under the skin through a portal above the anterior acromion (B). Then the upper suture end is pulled through the portal (C). A sliding knot is made to suture the deltoid to the anterior acromion and close the gap (D).

weeks postoperatively depending on the patient's tolerance. Shoulder strengthening exercises are initiated 10 weeks after surgery

Results

All cases with outlet impingement were only SAT space narrowing Grade 2 to 4, there was no outlet impingement II or III found with a SAT space Grade 1, which is more than 12 mm, thus the bone removal was only of the amount of bone needed as determined by the SAT space measurement to reach SAT space Grade 1. The postoperative results were very promising, no complications were found, and the Neer Score was rated excellent in all 228 out of the 280 impingement cases which were re-examined with an average follow up period of 6 years and 3 months.

Discussion

The arthroscopic subacromial decompression surgery is to remove the compression on the supraspinatus tendon through removing bone from the lower surface of the anterior acromion and thus treat the narrowing below the lower part of the anterior acromion and the supraspinatus tendon (SAT space). But there are no regulations or standards in the literature for the amount of bone to be removed and no standard technique based on measurements to ease the surgery and secure the result.

The relation of the outlet impingement pathology to the shape of the acromion is not proven as any type of the acromion shapes can have an impingement pathology with an average percentage between 20% and 40% of the cases as stated by Bigliani and others [6].

Neer [2] stated in his paper that 70% of impingement II are healed with conservative means mostly after six months of treatment, and if failed then the surgeon should go to decompression, on the other hand the studies [1] made comparing conservative treatment with operative treatment found no difference in the result , but these studies are done for patients after only three months of conservative treatment and were operated after that. According to the literature about an average 90% of impingement operations are healed, the conservative treatment causes healing in 50% after 3 months and 70-75% after 6 months [2], so if we operate patients after 3 months from conservative treatment in which 50% of them would heal conservatively and adding both, the 90% improvement of the 50% cases added to them we will have a sum of 20% who are not healed which is approximately equal to the 25% of the cases not healed after 6 months conservative treatment as mentioned in the study [1].

In summary, if outlet impingement syndrome is treated conservatively for 6 months 70-75% of the cases will heal, if an arthroscopic subacromial decompression is done after six months 95-100% of the cases heal On the other hand if the

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surgery is done after 3 months failed conservative treatment you will operate about 20% of cases which would have healed conservatively if the conservative treatment continued for 6 months so as the results of both conservative and operative treatment for these cases operated after 3 months cases will be 75-80% healed cases, which is approximately the same as the results of only conservative treatment for more than 6 months.

The only pathological relation is found between the subacromial narrowing, according to the sizing classification and the outlet impingement. So, the aim of treatment is to increase the space between the anterior acromion and the tendon, if needed, whatever is the shape of the acromion. The radiological measuring of the space between the anterior acromion and the humeral head or the upper end of the glenoid does not reflect the real causality because the tendon width which maybe so thick causing a SAT space grade 3 or 4 narrowing although the x-ray shows a sufficient space. This knowledge led us to use this technique to treat the SAT space narrowing causing outlet impingement to deal with the cause of the disease and use standards to resolve this task.

This technique applies to the standards used in the arthroscopic classification of the SAT space [6], with the patients in a sitting position and the arm hanging. Its aim is to remove enough bone from the lower surface of the anterior acromion to achieve a grade 1 SAT space of more than 12mm where no outlet impingement pathology occurs as found by the sizing study. It is the only technique based on the exact measurement of the SAT space narrowing and the monitoring of the exact amount of bone to be removed by using the measuring needles guide for the decompression.

Summary

In summary the sizing classification is a guide to determine whether there is a need for decompression or not, and if so, determining the amount of bone to be removed based on the measuring guide. Thus, it gives more clarity to the controversy presented now in literature. The standard measuring needle subacromial decompression technique eases the operation and standardizes the technique. Closing the defect at the deltoid origin if present, leads to regaining the normal anterior deltoid anatomical origin (Table 2).

Video Description (Video link: https://youtu.be/IcztrUnBfYg?si=2ox_hdrNiw268QWT)

The position of the patient is a sitting position with the arm hanging. This position is the standard for all measurements and techniques used in the arthroscopic subacromial surgery we use.

This technique cannot be done using the beach chair position.

To place the lateral posterior portal for the scope, the posterior angle of the acromion is palpated with the thumb finger.

A spinal needle is used to test the path of the instruments.

The spinal needle is passed about 1.5 cm below and anterior to the posterior angle of the acromion. It has to move freely in the subacromial space.

The posterior medial standard portal is placed about 2 cm medial to the posterior acromial angle and it is used for the water inflow cannula and the optic for intraarticular diagnosis.

Table 2: Tips and Tricks

	PEARLS	PITFALLS	RISKS
Position	It is essential to have the patient in a sitting position with the arm hanging	Error in measurements	Missing the whole picture
Portals	It is essential to have the portals in the correct places, always use needles	A displaced portal a notable problem	Mishandling the arthroscopic procedure
Posteromedial portal	Water trocar compresses the soft tissue and water inflow allows better vision	longer time in preparation subacromial space	longer time of surgery
Lateral anterior portal	Place needle in extension of the line between the two-measuring needles, immediately above the tendon and parallel to the floor	It is difficult to swing the shaver from posterior to anterior	Missing the whole picture
Deperiost the lower surface of the ant. acromion	Essential to visualize the borders of the anterior acromion	Incomplete decompression	The acromion can fracture
Reposition of the measuring needles	Needle in contact with resected acromion for monitoring	Control bone resection	False measurement
Control acromial lateral narrowing and protrusion	Decompress associated pathology	Avoid remaining pain sores	lateral impingement problems

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Now the first measuring needle is placed at the medial corner of the anterior acromion by feeling the AC joint and placing it immediately lateral to it in contact with the medial corner of the anterior acromion.

The lateral measuring needle is placed by feeling the lateral acromion with the finger and putting the needle at its corner to the anterior border of the anterior acromion.

The lateral anterior portal for instrumentation is localized by passing the spinal needle about 3 to 4cm lateral and 4 mm posterior to the lateral measuring needle. The needle must be parallel to the floor and pushed inside to feel the head then removed and placed upward till it is immediately above the tendon and moves freely in the subacromial space. This portal path will allow the instruments to move in the subacromial space without damaging the anterior deltoid muscle which is protected by the measuring needles.

The motorized shaver is brought through the instrumentation portal, and the bursa and adhesions are removed for visualization. After localizing the measuring needles the subacromial space is measured and classified.

The coraco-acromial ligaments localized lateral to the medial measuring needle and is then cut at its junction to the anterior acromion using a small scissor. If the ligament is not seen it can be felt with the closed scissor immediately lateral to the medial needle.

Then the shaver is brought through the instrumentation portal and is rested against the acromion to remove the periosteum from the under surface of the anterior acromion to visualize the bone and the anterior inferior rim of the acromion.

The borders of the anterior acromion can be clearly identified. The space is now 4 mm after cutting the ligament.

The shaver is removed and the acromionizer is brought into the subacromial space and bone resection is done by sweeping the acromionizer from posterior to anterior progressively under the visualization of the two measuring needles and the lower capsule of the AC joint.

The measuring needles are then removed and placed again in contact with the remainder of the anterior acromion, and the bone resection with the acromionizer will continue till the marking of 12 mm or more is seen on the measuring needle scale.

By pacing the lateral measuring needle, the SAT space measures around 15 mm.

Finally, the subacromial space is cleaned from the remains of bone chips with the shaver.

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