"Shoulder impingement. The role of Dynamic ultrasound"

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Authors: M. del Amo, J. Pomes, I. Pomes, L. Fortuny, A. I. Garcia Diez, X. Tomás; Barcelona/ES
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Learning objectives

Ultrasound has proven effective in diagnosing tendon pathology in the shoulder. The baseline ultrasound examination of the shoulder is well described and widely used in daily practice. In this work we offer some tools that may be added to the baseline for a better assessment of subacromial impingement.

Our objectives are:

. To demonstrate the importance of adding a dynamic study to routine ultrasound examination of the shoulder.

. To describe and show the dynamic maneuvers for evaluating impingement with images and video of ultrasound findings.

Background

Shoulder pathology and especially the shoulder impingement is one of the most frequently asked questions in musculoskeletal pathology.

Impingement syndrome is characterized by painful functional limitation, produced by dynamic changes or compression. The supraspinatus tendon and subacromial-deltoid bursa are "impinged" between the humeral head, the acromion and the coracoacromial ligament (CAL). (Fig. 1 on page 3)

Ultrasound examination of the shoulder with radiography should be the first choice of imaging and in most cases of tendon pathology it will not be necessary to perform additional imaging examinations.

Several authors report ultrasound as a diagnostic option with high yield result - economical and safe for studying the pathology of the shoulder. But we cannot forget that this is a joint with a wide range of motion, and static assessment can only lead us to ignore findings that a dynamic study brings us.
It is therefore important to add to the baseline study a dynamic exploration of CAL, the humeral head, the supraspinatus tendon, the subacromial space and even the acromioclavicular joint.

**Images for this section:**

![Anatomical structures diagram](image_url)

**Fig. 1:** Anatomical structures that may contribute to impingement of the supraspinatus tendon and the subacromial-deltoid bursa.

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Findings and procedure details

The ultrasound examination is performed using a high frequency linear-array transducers (10-13 MHz). The patient must be seated in front of the explorer and should be well positioned avoiding slouched or upright postures.

In our study of shoulder pain we always start with the baseline assessment of the tendons of the long head of the biceps (Fig. 2 on page 6), the subscapular (Fig. 3 on page 7), the supraspinatus (Fig. 4 on page 8), the infraspinatus (Fig. 5 on page 8), and the glenohumeral and acromioclavicular joints (Fig. 6 on page 9). We also include the assessment of coracoacromial ligament (also Fig. 6 on page 9), supraspinatus and infraspinatus muscles.

After the baseline ultrasound exam, we include a dynamic assessment of the shoulder.

DYNAMIC STUDY OF THE SHOULDER

The dynamic study of the shoulder in impingement will focus on assessing:

1. The acromioclavicular joint
2. The coracoacromial ligament (CAL)
3. The subacromial space
4. Abnormalities within the supraspinatus and the subacromial bursa

1. The acromioclavicular joint

Degenerative changes and instability in the acromioclavicular joint can cause subacromial impingement with involvement of the bursa and the supraspinatus tendon.

Ultrasound examination does not allow a good view of the underside of the joint but with the evaluation of the upper surface of the joint and the dynamic study, we can have a good idea of its characteristics.

This joint is studied in the coronal plane in neutral position and then with the adduction of the arm (Fig. 7 on page 9). Repeated movement between these two positions offers a good dynamic assessment and allows the diagnosis of joint instability (Fig. 8 on page 10).

2. The coracoacromial ligament (CAL)
CAL thickening and degeneration cause loss of elasticity and subsequent impingement of the supraspinatus tendon and therefore should not be forgotten in the assessment of shoulder pain.

To explore the CAL, the patient relaxes the upper extremity next to the body. The probe is placed in axial plane to see the anterior part of acromion and the medial side of the transducer is moved downwards to see coracoid process and between them there is the ligament (Fig. 9 on page 11).

The CAL is a thin, convex, fibrillar and hyperechoic band which can be a focal cause of stenosis in subacromial impingement. (Fig. 10 on page 13).

The dynamic assessment which is performed while the supraspinatus. The patient will place his hand on the iliac crest and repeated movements forward and backward (Fig. 11 on page 13), allowing us to assess the movement of supraspinatus tendon and its relationship with CAL.

In the dynamic study we can assess the movement of the supraspinatus tendon below the ligament and the repercussion of thickening of CAL in the tendon (Fig. 12 on page 15) and also observe dynamic changes in the ligament secondary to supraspinatus tendon lesion (Fig. 13 on page 15).

3. The subacromial space

The subacromial space is the distance between the acromion and the humeral head. The techniques for measuring the subacromial space with ultrasound are different and vary according to different authors. We use a perpendicular line between the tip of the acromion and the humeral head, because it is more reproducible (Fig. 14 on page 16).

Placing the transducer on the lateral surface of the shoulder along the longitudinal axis of the humerus, we perform the first measurement of the subacromial space with the shoulder in neutral position, at 45 degrees and 60 degrees of abduction with the elbow flexed at 90 degrees. After performing static measures, we can record videos during the abduction and check the impact on the bursa and the supraspinatus tendon. This movement reproduces the clinical symptoms and will often be enough to do an abduction at 45 degrees. (Fig. 15 on page 17).

The increase or decrease in the thickness of the supraspinatus tendon can be the cause or the effect of subacromial impingement, as might be tendinopathy, presence of
calcifications or partial or complete tear (Fig. 16 on page 19) (Fig. 17 on page 19) (Fig. 18 on page 20).

4. Abnormalities within the supraspinatus and the subacromial bursa

The pathology of the supraspinatus tendon and subacromial bursa plays a fundamental role as both a cause and result of subacromial impingement.

Supraspinatus tendinopathy whether calcifying or not and the partial or complete tendon tear, will contribute to causing or aggravating the subacromial impingement. Furthermore, the bone components of the subacromial space (humeral head and the acromion) and CAL will condition changes and "suffering" of the tendon and bursa.

To explore the supraspinatus tendon the shoulder must be internally rotated by having the hand palm outward behind the lower back, in the "hand-on-back" position or hanging by the side (Fig. 4 on page 8).

We measure the thickness of supraspinatus tendon 15mm away from the transverse cut of the long biceps tendon. (Fig. 19 on page 21) Its normal thickness is variable but we believe that the range is between 4.5 and 5.5 mm.

The dynamic study is performed in the position described for the study of the supraspinatus tendon and the patient moves the elbow back and forth without removing the hand from the body. (Fig. 11 on page 13)

In our experience, the dynamic study of the supraspinatus and the bursa not only allows us to assess their involvement in the impingement as a result of their relationship to the acromion and the CAL, but is also an aid in the diagnosis of tendon ruptures, especially partial tears. (Fig. 20 on page 22, Fig. 21 on page 23 and Fig. 22 on page 24)

The dynamic study also allows us to evaluate other moving structures and their involvement in the patient's symptoms. Radiograph (Fig. 23 on page 25) shows surgical changes in the proximal humerus and osteosynthesis material. The dynamic ultrasound study (Fig. 24 on page 26) provides a good correlation between the patient's symptoms and radiological and ultrasound images.

Images for this section:
**Fig. 2:** Long head of the biceps tendon: Patient sits with the elbow flexed and kept close to the body while keeping the hand in supination. Transverse and longitudinal images of the tendon must be obtained.

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**Fig. 3:** Subscapular tendon: Patient sits with the elbow flexed and kept close to the body and the glenohumeral joint is placed in external rotation. Transverse and longitudinal images of the tendon must be obtained.
Fig. 4: Supraspinatus tendon and subacromial bursa: Patient sits with his arm in full internal rotation and hyperextension with the dorsum of the hand placed on the small of the back. Transverse and longitudinal images of the tendon must be obtained.

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**Fig. 5:** Infraspinatus tendon: Patient places his hand on the contralateral shoulder and he is rotated 90 degrees. Transverse and longitudinal images of the tendon must be obtained. It also allows the evaluation of the posterior glenoid labrum and the glenohumeral joint.

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**Fig. 6:** The acromioclavicular joint is studied in the coronal plane and the CAL is a thin, hyperechoic structure between the coracoid and the acromion (arrow).

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**Fig. 7:** Acromioclavicular joint in neutral position and with the adduction of the arm.

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Fig. 8: Video: Dynamic study of the acromioclavicular joint showing joint instability.

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**Fig. 9:** Pacient and probe position to explore CAL.

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**Fig. 10:** Normal CAL (arrow) and its relationship with the supraspinatus tendon (asterisk).

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**Fig. 11:** Video: Position and movement for the assessment of CAL and the supraspinatus tendon.

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**Fig. 12:** Video: Supraspinatus tendon and CAL thickening, moving during dynamic maneuvers allowing us to check the involvement of both in the impingement.

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**Fig. 13:** Video: Complete tear of the supraspinatus tendon with the secondary elevation of the humeral head that moves below the CAL.

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Fig. 14: Measuring subacromial space from the end of the acromion to the humeral head (line).

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Fig. 15: Video: Abduction movement of the shoulder to explore the subacromial space.
Fig. 16: Video: Subacromial impingement secondary to thickening of the supraspinatus tendon (tendinopathy).
Fig. 17: Video: Subacromial commitment by the presence of a large calcification in the supraspinatus tendon that bangs against the acromion.

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Fig. 18: Video: Subacromial impingement space caused by complete tear of the supraspinatus tendon. It shows that the humeral head migrates proximally and greater tuberosity passes under the acromion. During the dynamic study we can "hear" the humeral head passing below the acromion.

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**Fig. 19:** The thickness of the supraspinatus tendon (arrow) 15 mm from the long biceps tendon (asterisk).

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Fig. 20: Partial tear of the supraspinatus tendon in the baseline study.

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**Fig. 21:** Video: The same supraspinatus tendon in Fig. 20 now explored in motion, allowing better visualization of the partial tear.

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Fig. 22: Video: Complete tear of the supraspinatus tendon.

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Fig. 23: Radiograph showing osteosynthesis material (screw and anchor) in the proximal humerus.

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Fig. 24: Video: The same shoulder in Fig. 23 during dynamic ultrasound study showing the mobilization of osteosynthesis material.

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Conclusion

Ultrasound is well established as an excellent tool for studying the shoulder and also offers the possibility of improving the study of subacromial impingement by adding the dynamic study of the structures involved in this syndrome.

In our opinion, the radiologist should be able to include the dynamic evaluation of the shoulder in an ordinary ultrasound study and it will only take a few minutes extra to do a good job.

Personal information

First author: Montserrat DEL AMO MD PhD

ESR / SERME Member

Senior specialist. Radiology Dpt (MSK unit)

Hospital Clinic Villarroel 170 Barcelona 08036 (Spain)

University of Barcelona (UB)

Phone+34932275412

Cell : +34630142424

Emails: mdelamo@clinic.ub.es

montdc@gmail.com

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