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Shoulder Impingement Syndrome: Correlations Between Clinical Tests and Ultrasonographic Findings

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SUMMARY

Objectives. To compare the diagnosis of shoulder impingement syndrome (SIS) established by clinical and ultrasonographic examination and to evaluate the value of clinical tests for SIS as well as for rotator cuff pathology.

Methods. One hundred patients with periathrophatia scapulohumeralis entered the study, including 64 females and 36 males aged between 20-84 years (mean 56.8 and 57.5, respectively). Clinical and ultrasonographic examinations were carried out by independent observers, a rheumatologist and a musculoskeletal-trained sonographer. Clinical tests for SIS and for each of the tendons of the rotator cuff, as well as static and dynamic ultrasonographic examinations were performed for both shoulders. Findings were compared and statistically analyzed.

Results. The Hawkins test (72.2%) proved to be the most sensitive clinical test for the identification of SIS and the Neer test (95.3%) was the most specific one. When four tests were simultaneously positive, the specificity for the diagnosis was 98.5%, but the sensitivity decreased to 40.3%. Jobe's test indicated supraspinatus involvement with a specificity of 90%, but it was not able to disclose the type of lesions. The sensitivity and specificity of the tests aiming to elicit infraspinatus tendon pathology were of low value whereas those addressing subscapularis tendon involvement were rather of moderate value. SIS was clinically correctly diagnosed in 80.5% of cases, but its characteristic stages were poorly recognized (stage I 50%, stage II 70%, and stage III 30.7%).

Conclusions. 1. Although clinical tests are insufficient for clinical diagnosis, the examination of the patient still plays an important role in rotator cuff disorders. 2. Ultrasonography should be used for all patients suffering from painful shoulder in order to improve the diagnosis.

Key words: shoulder impingement syndrome, clinical examination, ultrasonography

BACKGROUND

Periarthropathia scapulohumeralis represents a complex and non-homogeneous syndrome characterized by pain and reduced range of motion of the shoulder due to periarticular disorders. This concept, as stated by Duplay and the French Rheumatologic School of de Seze, along with the older classification in four clinical presentations (simple painful shoulder, acute painful shoulder, frozen shoulder and pseudo-paralytic shoulder), is only a descriptive classification without any reference to anatomopathological lesions [1].

In 1972 Neer introduced the concept of shoulder impingement syndrome (SIS) to explain this pathology [2]. According to Neer, the syndrome results form mechanical impingement of the rotator cuff tendons beneath the anteroinferior portion of the acromion, especially when the shoulder is placed in the forward-flexed and internally rotated position. Although Neer described three stages of the SIS (I – edema and hemorrhage, II- fibrosis and tendinitis, III – rotator cuff tears, biceps rupture, and bony changes), the process is considered to be continuous [2,3,4]. This classification can be superimposed on the classic French classification [5,6] (Table 1).

Several tests or maneuvers are used in daily clinical practice to demonstrate the presence of SIS and to localize the periarticular lesions [7,8,9], but their accuracy is still questionable. Owing to improvements in musculoskeletal ultrasonography (US) and the high availability of this method in rheumatologic and orthopedic servicies, US can be used to evaluate the accuracy of clinical diagnosis in patients with painful shoulder [10,11].

The aim of this study was to compare the findings of clinical and US-based diagnosis in painful shoulder and to verify, by comparison with dynamic US, the validity of tests for SIS in order to optimise the clinical examination and therapeutic aproach.

MATERIAL AND METHODS

The study was performed on 100 consecutive patients (64 women of a mean age of 56.8 years, 35 men of a mean age of 57.5 years, age range for the whole group 20-84 years), a total of 200 shoulders, referred to the Rheumatology Clinic with shoulder pain (unilateral or bilateral) interpreted as periarticular disorders. We excluded from the study patients with previous trauma, shoulder surgery, inflammatory arthritis or chronic renal disease. Each patient had a clinical examination and a US examination in the same day. The study was approved by the ethical committee of our institution and a signed informed consent was obtained from each patient.

Clinical examination

The clinical examination (history and physical examination) was performed by an experienced rheumatologist and finally a clinical diagnosis was established. The clinician used the classic tests for SIS (Neer, Hawkins, Yocum and painful arc) and for rotator cuff tendon pathology (Jobe test for supraspinatus, Patte test and external rotation strength test for infraspinatus and teres minor, Gerber lift test and internal rotation strength test for subscapularis) [2,5, 8,9,10,11,12,13,14,15].

For the Neer maneuver, the examiner stands behind the seated patient and uses one hand to prevent rotation of the scapula while passively raising the patient's arm with the other hand to produce both forward elevation and abduction. In the Hawkins test, the examiner stands facing the patient and, after raising the patient's arm to 90° of strict forward elevation with the elbow in 90° flexion, rotates the arm medially by lowering the forearm. For the Yocum test, the patient is asked to place the hand on his or her other shoulder and to raise the elbow without elevating the shoulder. These tests are positive when patients experience pain during the maneuvers. The painful arc was considered positive for SIS when the patient had pain between 45-90° of arm abduction.

In the Jobe maneuver, the patient places both arms in 90° abduction and 30° horizontal adduction, in the plane of the scapula; the examiner then pushes the patient's arms downward while asking the patient to

Tab. 1. Correspondence between clinical aspects of periarthropathia scapulohumeralis and the stages of shoulder impingement syndrome

Anatomopathologic aspects	Classification	
	Periarthropathia scapulohumeralis	Shoulder impingement syndrome
Tendinitis (supraspinatus, biceps)	Simple painful shoulder	Stage I
Tendons degeneration Partial tears		Stage II
Calcific tendinitis Bursitis	Acute painful shoulder	
Adhesive capsulitis	Frozen shoulder	
Total tears of rotator cuff and/or biceps tendon	Pseudo-paralytic shoulder	Stage III

resist the pressure. For the Patte maneuver, the examiner supports the patient's elbow in 90° flexion while the patient is asked to rotate the arm laterally. In the external/internal rotation strength test, the patient's arms are held at their sides with the elbows flexed to 90°. The patient actively externally/internally rotates the arms against resistance. In the Gerber lift-off test, the patient is asked to place the hand against the back at the level of the waist with the elbow in 90° flexion. The examiner pulls the hand to about 5-10 cm from the back while maintaining the 90° flexion of the elbow.

Clinical diagnosis of SIS was made in the presence of pain or catch sensation at arm abduction, and at least one positive impingement test. The stages of SIS were clinically established by the following criteria: stage I – at least one positive impingement test, possible positive Jobe test, and catch sensation at arm abduction; stage II – at least two positive impingement tests, more than one positive test for rotator cuff tendons, possible muscular hypotrophy; stage III – stage II and muscular hypotrophy or atrophy, superior subluxation of the shoulder, loss of some/all active range of motions.

US examination

The US examination was performed by a rheumatologist with experience in shoulder ultrasonography who was blinded to the clinical tests, on the same day as the clinical examination. A linear array 7.5-10 MHz transducer (EsaoteBiomedica AU3) was used. The standard protocol for static and dynamic transverse and longitudinal evaluation of supraspinatus, infraspinatus, teres minor and subscapualaris tendons was used [11,16-19] and a US diagnosis was established (Table 2). Figures 1-4 illustrate the normal and the torn supraspinatus tendon.

Statistical analysis

A 2x2 table and the χ^2 test were used for the evaluation of the results. Sensitivity (Se), specificity (Sp),

Tab. 2. Ultrasonographic diagnostic criteria of shoulder abnormalities

Supraspinatus, infraspinatus, subscapularis partial tear	Partial discontinuity of fibers
Supraspinatus, infraspinatus, subscapularis total tear	Non-visualisation of tendon or complete discontinuity of fibers
Rotator cuff tendinitis	Tendon hypoechogenicity or tendon thickening with or without internal hypo- or hyperechoic foci
Subacromial-subdeltoid bursitis	Hypoechoic fluid filled bursa greater than 2 mm thick
Glenohumeral effusion	Distance from the posterior labrum to the posterior infraspinatus tendon greater than 2 mm
Rotator cuff calcifications	Hyperreflective foci or lines with acoustic shadowing
Rotator cuff impingement	A buckling of the cuff as the cuff passes beneath the coracoacromial arch, poor humeral head depression or thickened bursa in front of the acromion while the arm is abducted (stage I with tendinitis, stage II with partial tear, stage III with total tear of the rotator cuff, superior subluxation of humeral head comparative with coracoid process, and fluid in glenohumeral joint)
Adhesive capsulitis	Demonstration of continuous limitation of all sliding movements and continuous visualization of the supraspinatus tendon during abduction

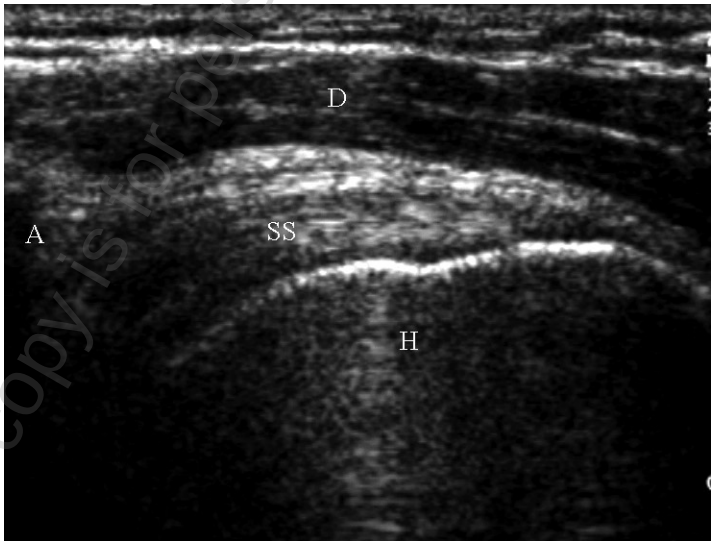

Fig 1. Longitudinal sonogram of a normal supraspinatus tendon (SS). A – acromion, H – humeral head, D-deltoid muscle

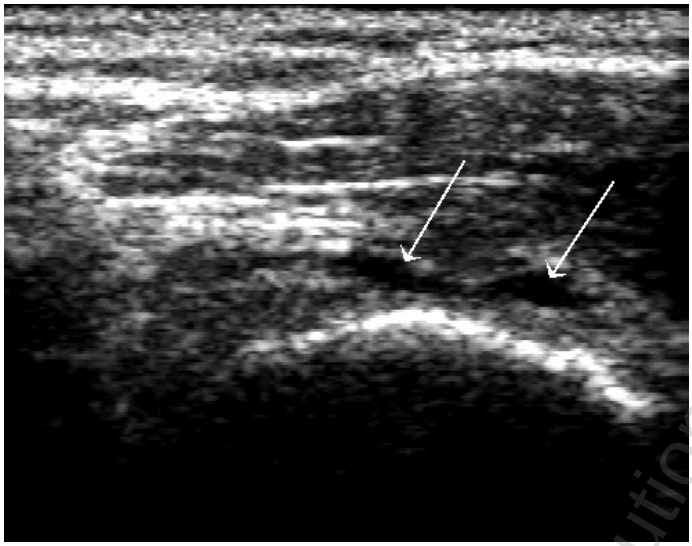

Fig. 2. Partial tear of the supraspinatus tendon (arrows), longitudinal sonogram

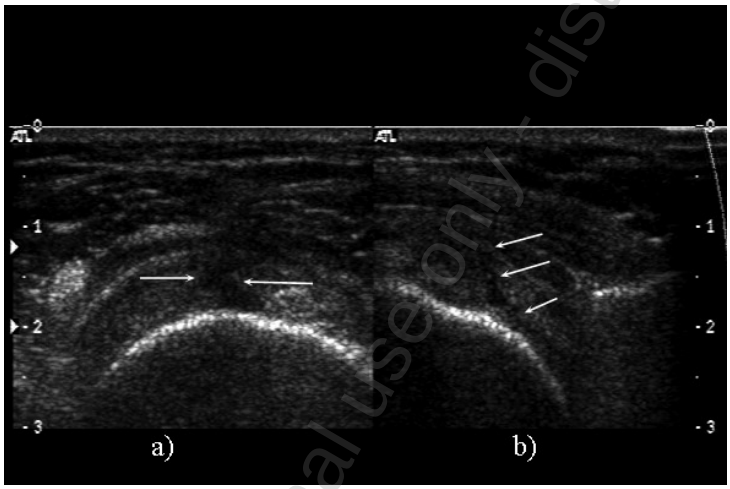

Fig. 3. Total tear of the supraspinatus tendon (arrows), a) transverse scan, b) longitudinal scan

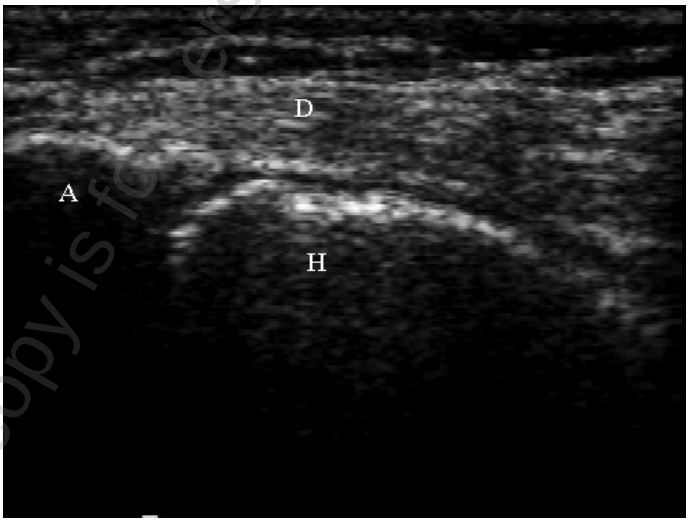

Fig. 4. Total tear of the supraspinatus tendon with superior subluxation of the humeral head. A- acromion, D- deltoid muscle, H- humeral head

positive and negative predictive values were determined (PPV, NPV). The confidence interval was 95%.

RESULTS

There were 130 symptomatic shoulders from 200 shoulders included in study. The diagnosis of SIS was established in 70 shoulders by clinical examination (4 stage I, 55 stage II, and 11 stage III) and in 72 shoulders by US (2 stage I, 57 stage II, and 13 stage IIII). There was a concordance between the clinical examination and US of 80.5%. Of the 72 SIS shoulders found by US, the clinician recognized 58 SIS, but in only 45 shoulders with SIS (62.5%) the stage was correctly indicated (50% stage I, 70% stage II, and 30.7% stage III). Table 3 lists the sensitivity, specificity, positive and negative predictive value of the clinical tests used for detection of SIS. The variation of these parameters depending of the numbers of concomitant positive clinical tests is illustrated in Figure 5.

The association of clinical tests for SIS with supraspinatus tendon tears detected by US was statistically significant, except the Hawkins test (2 = 18.4 for Neer test, 20.5 for Jocum test, 0.73 for Hawkins test, and 11.2 for painful arc). The Jobe test was positive in 38 shoulders, but only 7 of these met the US criteria for tendinitis. The sensibility of the test for diagnosis of supraspinatus tendinitis was 50%, the specificity was 83.3%, PPV was 18.4% and NPV was 95.5%. Of the 38 shoulders with a positive Jobe test, 31 were associated with SIS (Se 43%, Sp 94.5%, PPV 81.5%, and NPV 74.6%). The association with supraspinatus total tears was statistically significant (χ^2=8.7).

US detected 6 tears of the infraspinatus tendon but the clinical tests for infraspinatus were positive only in one case (Se 16.6%, Sp 82.9%, PPV 2.9%, NPV 98%). On the other hand, there was a better correlation of these tests with stage III of SIS (Se 35.7%, Sp 84.4%, PPV 14.7% and NPV 94.5%) and with total tears of the supraspinatus tendon (χ^2=5.84).

For the subscapularis tendon examination, US detected 7 tendons with tears and 12 tendons with calcifications. The Gerber test and the internal rotation strength test had Se 85.7%, Sp 78.7%, PPV 12.7, and NPV 993% for tears and Se 58%, Sp 75%, PPV 13.2%, and NPV 96.5% for calcifications.

DISCUSSION

Rotator cuff disorders are common in clinical practice and US is being used today more and more frequently to assess periarticular lesions of the shoulder. The first study of shoulder US was published in 1979 [20], but studies about SIS, based on dynamic evaluation of the shoulder, have been published only since 1987 [21]. Only in recent years has there been

Tab. 3. Sensitivity, specificity, positive and negative predictive value of the clinical test used for detection of SIS

Clinical test	Shoulders with positive test	Shoulders with SIS at US	Sensitivity %	Specificity %	PPV %	NPV %
Neer's	44	40	54.1	95.3	86.6	78.7
Jocum's	64	32	70.3	92.1	84.1	86.1
Hawkins's	61	53	72.2	89	78.7	85
Painful arc	70	45	67	80.4	68.7	79.2

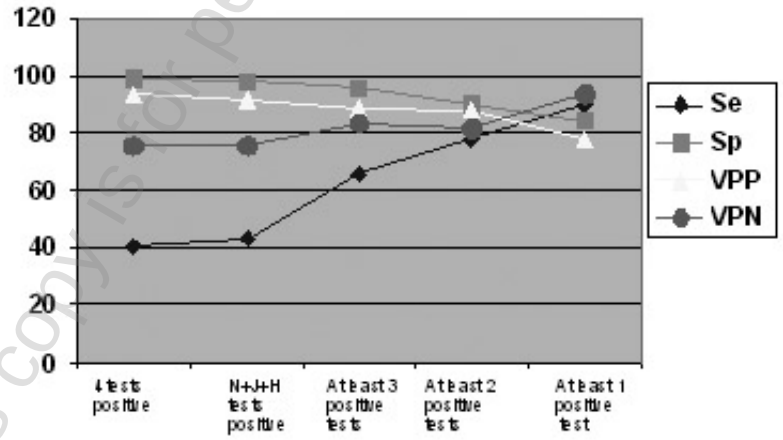

Fig. 5. Variation of sensitivity, specificity, positive and negative predictive value of the clinical tests used for detection of SIS depending of the numbers of concomitant positive clinical tests. N – Neer test, J – Jocum test, H – Hawkins test

interest in comparing the results of clinical examinations with diagnostic imaging (US, magnetic resonance) findings [10,17,22,23,24].

One problem raised in the published papers is the reliability and reproducibility of the clinical tests for SIS and especially interexaminer agreement regarding their significance [7,8,22,24]. Most patients with shoulder pain have multiple periarticular lesions involving different tendons, bursa or impingement syndrome, and this may be one of the reasons for differences in clinical interpretation. A clinical examination is often insufficient for a complete diagnosis. Ure et al [25] found a sensitivity of clinical diagnosis of 73%, by comparing clinical tests with arthroscopic findings, but Silva et al. [26] obtained a sensitivity above 58% for all clinical tests by comparison with MRI findings.

In our study there was a concordance of 80.5% between the clinical examination and US studies in establishing the diagnosis of SIS, which confirms the importance of the clinical examination in diagnosis. A lower concordance (62.5%) was found as regards the correct recognition of stages of the SIS, particularly the 3rd stage (30.7%). A correct framing of the symptoms is very important for the therapeutic approach, especially for surgical treatment. The results of surgical treatment of 3rd stage SIS are disappointing in most cases, due to the need of a decompression procedure before the complete tear of the supraspinatus tendon (27,28).

We found that the Hawkins test was the most sensitive test for detection of SIS (72.2%) but the Neer test was the most specific (95.3%). The Neer test (54.1%) was the least sensitive and the painful arc the least specific (80.4%). In the Çaliş et al study [22], the Hawkins test was also the most specific test but with a higher specificity (92.1%). For clinical examinations, the Hawkins test is considered by Nooregaad et al [24] the test with the best interexaminer agreement but Johansson et al [8] found, for interexaminer reliability, only an almost perfect agreement for the Hawkins test compared with a perfect agreement for the Neer test. Silva et al [26] found that the Yocum test was the most diagnostic for SIS, since it provided the best sensitivity and the best accuracy.

The specificity of impingement tests increased with the number of concomitant positive tests. Thus, for four positive tests the specificity was high, close to 100% (98.5%) but this could be achieved only with a lower specificity (40.3%). We had only one shoulder with all four tests positive but without SIS demonstrable by US. The best alternative seems to be the concomitant positivity of two tests for SIS (any of Neer, Hawkins, Yocum tests or painful arc), with Se 77.7%, Sp 89.8%, PPV 88.6%, and NPV 81.1%. Silva et al [26] demonstrated the same but obtained lower values of sensitivities. Çaliş et al [22] analyzed together the tests for SIS and for biceps tendon. In the papers of Naredo et al [10], Kim et al [23] or de Winter et al [7], all these parameters were not analyzed.

None of these tests was useful for distinguishing between the stages of SIS. For the Hawkins test, there was a statistical association with tears of the supraspinatus tendon (partial or total), and for the Jobe test, with total tears of the supraspinatus tendon. Due to the statistically significant positivism of Jobe's test in tendinitis, tears and SIS (with a specificity over 90%), we can conclude that the test is useful for the detection of a tendon's lesion but does not afford the possibility of precisely determining the type of lesion. Moreover, an NPV over 90% in cases with tendinitis or total tears shows a low probability that these lesions are present in a patient with a negative Jobe test.

The infraspinatus tendon tests were disappointing, the low PPV in all cases being the result of a high number of false positives. When both tests for the infraspinatus tendon are positive, the interpretation should be of a rotator cuff pathology and not of an infraspinatus tendon lesion. Kim at al [23] could not analyze the sensibility of the Patte test because they found no infraspinatus tear despite a positive result of the test. Other types of clinical tests should be considered for infraspinatus tendon lesions.

The Gerber test and the internal rotation strength test had a high sensibility for subscapularis tendon tears (85.7%) and a moderate sensibility for calcification of the tendon. Being the sole tendon of the rotator cuff responsible for internal rotation, it is important to identify its lesions for the maintenance of good balance of shoulder movements. The relation of the subscapularis tendon to the anterior portion of the subacromial-subdeltoid bursa should explain some of the false positive cases: movement of the tendon produces anterior pain from the inflamed bursa and not from a pathologic tendon. Stallenberg et al [29] demonstrated a relation between anteromedial shoulder pain, bursitis, and movement of the shoulder and Silva et al [26] correlated the test with subacromial-subdeltoid bursitis.

One limit of our study is the lack of biceps tendon pathology analysis. It is believed [22] that the biceps tendon becomes thickened by fibrinoid degeneration from the second stage of the impingement syndrome onwards. The possible pain and alteration of the active rage of motion due to this alteration could be the source of some false positive results.

CONCLUSIONS

1. Although clinical tests are insufficient for clinical diagnosis, the examination of the patient still plays an important role in rotator cuff disorders.
2. Ultrasonography should be used for all patients suffering from painful shoulder in order to improve the diagnosis.

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