Ultrasound imaging for the rheumatologist XLVII. Ultrasound of the shoulder in patients with gout and calcium pyrophosphate deposition disease

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Received on September 15, 2013; accepted on September 16, 2013.

Clin Exp Rheumatol 2013; 31: 659-664.

Key words: shoulder, rotator cuff, ultrasound, gout, calcium pyrophosphate deposition disease, crystal deposits

Competing interests: none declared.

ABSTRACT

Objectives. *This study was aimed at determining the prevalence of ultrasound (US) morpho-structural changes in the shoulders of patients with crystal-related arthropathies, and at investigating the relationship between them and the clinical findings.*

Methods. *Eighty-eight patients with a crystal proven diagnosis of gout or calcium pyrophosphate dihydrate (CPPD) disease attending the in-patient and the out-patient clinics of four Italian Rheumatology Departments were consecutively enrolled in this multi-centre study. All patients were clinically examined by an expert rheumatologist who recorded clinical and laboratory data in addition to the presence/absence of spontaneous shoulder pain and performed the Hawkins, Jobe, Patte, Gerber, and Speed tests. In each centre, US examinations were carried out by a rheumatologist expert in musculoskeletal US blinded to clinical data, using a MyLab TWICE XVG machine (Esaote SpA, Genoa, Italy) equipped with a linear probe operating at 4–13 MHz, and a Logiq 9 machine (General Electrics Medical Systems, Milwaukee, WI, USA) with a linear probe operating at 9–14 MHz. Shoulders were scanned to detect peri-articular inflammation, rotator cuff pathology and joint involvement, and to reveal US signs indicative of crystal deposits.*

Results. *A total of 88 patients, 39 with gout, 46 with CPPD disease, and 3 with both gout and CPPD disease, were enrolled. In total, 176 shoulders were clinically assessed, of which 54/176 (30%) were painful and 74/176 (42%) were clinically normal shoulders. All US findings indicative of peri-articular synovial inflammation were more frequently detected in patients with CPPD disease than in gouty patients. In 50 out of 176 (28.4%) shoulders, US allowed the detection of at least one finding indicative of synovial inflammation. Chronic tendinopathy was a frequent US finding both in gout patients and in patients with CPPD disease and the supraspinatus tendon was the most frequently involved one. In CPPD disease the supraspinatus tendon was found ruptured in a number of shoulders seven times higher than in gouty patients. The osteophytes were found at acromion-clavicular joint in nearly 80% of the shoulders in CPPD disease and in 60% in the gouty patients.*

Conclusion. *The results of this study confirm the high specificity of US findings indicative of crystal deposits at hyaline cartilage level and indicate that the supraspinatus tendon and the fibrocartilage of the acromion-clavicular joint are the most frequently affected structures of the shoulders in patients with crystal-related arthropathies.*

Introduction

Painful shoulder is a frequent complaint in the general population (with a prevalence ranging between 17 and 20%) and it is the commonest soft-tissue disorder for referral to the general practitioner (1-4). Nevertheless, until now the evaluation of this anatomic site has been relatively neglected in patients affected by gout and calcium pyrophosphate dihydrate (CPPD) disease, because its involvement does not immediately evocate the clinical suspicion of these crystalline arthropathies.

At present, there is solid body of evidence supporting the use of ultrasound (US) in the daily practice, as an imaging tool allowing for a rapid and ac-

curate detection of several abnormalities involving joint and peri-articular shoulder structures (5-9).

In general, US findings supplement the clinical picture revealing subclinical soft tissue involvement (10-12). In patients with painful shoulder, US provides a detailed description of even minimal morphological and echotextural changes usually affecting multiple anatomic structures of the shoulder (13-15). In patients with crystal-related arthropathies, US can identify crystal deposits, especially at cartilage level, and US findings ha shown a high degree of specificity and sensitivity (16-21).

This study was aimed at determining the prevalence of US morpho-structural changes in the shoulders of patients with definite diagnosis of gout and CPPD disease, and at investigating the relationship between US and the clinical findings.

Methods

Clinical assessment

A total of 88 consecutive patients with either gout or CPPD disease attending the in-patient and the out-patient clinics of four Italian Rheumatology Departments were enrolled in this multicentre study. The diagnoses were made according to the international criteria of the American Rheumatism Association guidelines for gout and to McCarty criteria for CPPD disease (22, 23).

Patients with a history of shoulder surgery or severe trauma were excluded from this study. All patients were clinically examined by an expert rheumatologist who recorded clinical and laboratory data in addition to the presence/absence of spontaneous shoulder pain and performed the Hawkins, Jobe, Patte, Gerber, and Speed tests (24).

The present study was carried out according to local regulations and the Declaration of Helsinki. All patients gave their informed consent before participating in the study.

US assessment

Before starting the study, all the sonographers participating in this multi-centre investigation, one per each Rheumatology Department, reached an agreement on both the scanning technique and the method to use to assess the US findings.

The scanning technique was defined according to international indications provided by both rheumatologists and radiologists experts in musculoskeletal US (25-28). In each centre, US examinations were carried out by a rheumatologist expert in musculoskeletal US, blinded to clinical data, using a MyLab

Table I. Demographic and clinical characteristics. Three patients had both gout and CPPD disease and their data were reported together with the results obtained from the gouty patients.

	Gout	CPPD disease	Total
Number of patients	42	46	88
Gender M/F	40/2	17/29	57/31
Mean ± SD age (min-max) (years)	62.5±10.8 (39–80)	73.6±7.7 (53–89)	68.3±10.8 (39–89)
Mean ± SD disease duration (min-max) (months)	85.2±115.7 (1–564)	58.7±69.3 (1–288)	71.2±94.4 (1–564)
Disease duration (months)	no. of patients	no. of patients	no. of patients
<12	6	11	17
12–24	9	7	16
25–60	11	14	25
>60	16	14	30

Table II. Prevalence of spontaneous shoulder pain and results of the provocative clinical tests. In this table, the data acquired for the 3 patients with diagnosis of both gout and CPPD disease were reported together with the results obtained in the gouty patients.

	Right shoulder (n=88)		Left shoulder (n=88)		Total (n=176)	
	Gout (n=42)	CPPD disease (n=46)	Gout (n=42)	CPPD disease disease (n=46)	Gout (n=84)	CPPD disease (n=92)
Spontaneous shoulder pain (n/%)	10/23.8	20/43.5	9/21.4	15/32.6	19/22.6	35/38
Hawkins test (n/%)	6/14.3	13/28.3	7/16.7	11/23.9	13/15.5	24/26.1
Patte test (n/%)	5/11.9	10/21.7	5/11.9	9/19.6	10/11.9	19/20.7
Jobe test (n/%)	5/11.9	15/32.6	6/14.3	8/17.4	11/13.1	23/25
Gerber test (n/%)	4/9.5	9/19.6	3/7.1	7/15.2	7/8.3	16/17.4
Speed test (n/%)	6/14.3	13/28.3	2/4.7	7/15.2	8/9.5	20/21.7
Palpation at acromion-clavicular joint (n/%)	9/21.4	11/23.9	10/23.8	12/26.1	19/22.6	23/25

Table III. Prevalence of US findings indicative of peri-articular soft-tissue inflammation. In this table, the data acquired for the 3 patients with diagnosis of both gout and CPPD disease were reported together with the results obtained in the gouty patients.

	Right shoulder (n=88)		Left shoulder (n=88)		Total (n=176)	
	Gout (n=42)	CPPD disease (n=46)	Gout (n=42)	CPPD disease (n=46)	Gout (n=84)	CPPD disease (n=92)
Long head of biceps tendon						
Synovial effusion (n/%)	10/23.8	15/32.6	6/14.3	3/6.5	16/19	18/19.6
Synovial hypertrophy (n/%)	1/2.4	4/8.7	1/2.4	2/4.3	2/2.4	6/6.5
Power Doppler signal (n/%)	1/2.4	4/8.7	1/2.4	1/ 2.2	2/2.4	5/5.4
Subdeltoid bursa						
Synovial effusion (n/%)	5/11.9	14/30.4	3/7.1	10/21.7	8/9.5	24/26.1
Synovial hypertrophy (n/%)	–	6/13	–	3/6.5	–	9/9.8
Power Doppler signal (n/%)	–	2/4.3	–	–	–	2/2.2
Subscapularis bursa						
Synovial effusion (n/%)	–	3/6.5	–	2/4.3	–	5/5.4
Synovial hypertrophy (n/%)	–	–	–	–	–	–
Power Doppler signal (n/%)	–	–	–	–	–	–

TWICE XVG machine (Esaote SpA, Genoa, Italy) equipped with a multi-frequency linear probe operating at 4–13 MHz, and a Logiq 9 machine (General Electrics Medical Systems, Milwaukee, WI, USA) with a linear probe operating at 9–14 MHz. Particular attention was paid on using all the technical aspects necessary to simplify the detection of US signs indicative of crystal deposits and to avoid their overestimation related to misinterpretation and pitfalls (29).

Shoulders were scanned to detect peri-articular inflammation, rotator cuff pathology and joint involvement (28, 30). Moreover, the following US signs indicative of crystal deposits were investigated: the hyperechoic enhancement of the chondro-synovial interface and the hyperechoic spots within both the fibrocartilage (*i.e.* the fibrocartilage of the acromion-clavicular joint and the fibrocartilage labrum within the gleno-humeral joint) and the hyaline cartilage of the humeral head (31).

Results

Clinical findings

A total of 88 patients, 39 with gout, 46 with CPPD disease, and 3 with both gout and CPPD disease, were enrolled. The demographic and clinical features of this cohort of patients are reported in Table I.

In total, 176 shoulders were clinically assessed, of which 54/176 (30%) were painful and 74/176 (42%) were completely asymptomatic and clinically normal shoulders (*i.e.* no spontaneous pain, no tenderness, and no swelling).

Spontaneous shoulder pain was more frequently found in the dominant side in both gouty and CPPD patients and in twice the number of shoulders in patients with CPPD disease compared with those with gout.

US findings

US findings indicative of peri-articular synovial inflammation, rotator cuff pathology and joint involvement are reported in Tables III, IV and V, respectively.

All US findings indicative of peri-articular synovial inflammation were more frequently detected in patients with CPPD disease than in gouty patients. Synovial effusion within the subdeltoid bursa was the most frequent pathologic finding in patients with CPPD disease and was found in 24/92 of shoulders (26%).

In 50 out of 176 (28.4%) shoulders, US enabled the detection of at least one finding indicative of synovial inflammation. Of these 50 shoulders, only two were asymptomatic and clinically normally shoulders.

In 126 out of 176 (71.6) shoulders, no US findings indicative of inflamed synovial tissue were found in the peri-articular structures. Of these 126 shoulders, 6 were positive for spontaneous pain and US could find evidence of synovitis at gleno-humeral joint level in 4 of them.

Table IV. Prevalence of US findings indicative of rotator cuff pathology. In this table, the data acquired for the 3 patients with diagnosis of both gout and CPPD disease were reported together with the results obtained in the gouty patients.

A. *Chronic tendinopathy*

	Right shoulder (n=88)		Left shoulder (n=88)		Total (n=176)	
	Gout (n=42)	CPPD disease (n=46)	Gout (n=42)	CPPD disease (n=46)	Gout (n=84)	CPPD disease (n=92)
Supraspinatus tendon (n/%)	25/59.5	29/63	19/45.2	30/65.2	44/50	59/64.1
Infraspinatus tendon (n/%)	7/16.7	12/26.1	7/16.7	13/28.7	14/16.7	25/27.2
Subscapularis tendon (n/%)	11/26.2	21/45.6	11/26.2	16/34.8	22/26.2	37/40.2

B. *Intra-tendinous hyperechoic spots*

	Right shoulder (n=88)				Left shoulder (n=88)				Total (n=176)			
	Gout (n=42)		CPPD disease (n=46)		Gout (n=42)		CPPD disease (n=46)		Gout (n=84)		CPPD disease (n=92)	
	P/A	Acoustic shadow (n/%)	P/A	Acoustic shadow (n/%)	P/A	Acoustic shadow (n/%)	P/A	Acoustic shadow (n/%)	P/A	Acoustic shadow (n/%)	P/A	Acoustic shadow (n/%)
Supraspinatus tendon	15/35.7	6/40	21/45.7	14/66.7	10/23.8	5/50	21/45.6	7/33.3	25/29.7	11/44	42/45.6	21/50
Infraspinatus tendon	5/11.9	3/60	5/10.9	5/100	3/7.1	3/100	9/19.6	5/55.5	8/9.5	6/75	14/15.2	10/71.4
Subscapularis tendon	3/7.1	2/66.7	10/21.7	6/60	4/9.5	1/25	10/21.7	5/50	7/8.3	3/42.8	20/21.7	11/55

P/A: Presence/Absence.

C. *Rotator cuff ruptures*

	Right shoulder (n=88)				Left shoulder (n=88)				Total joints (n=176)			
	Gout (n=42)		CPPD disease (n=46)		Gout (n=42)		CPPD disease (n=46)		Gout (n=84)		CPPD disease (n=92)	
	Partial tear	Complete rupture	Partial tear	Complete rupture	Partial tear	Complete rupture	Partial tear	Complete rupture	Partial tear	Complete rupture	Partial tear	Complete rupture
Supraspinatus tendon (n/%)	1/2.4	–	10/21.7	4/8.7	1/2.4	1/2.4	4/8.7	3/6.5	2/2.4	1/1.2	14/15.2	7/7.6
Infraspinatus tendon (n/%)	–	–	–	3/6.5	1/2.4	–	2/4.3	2/4.3	1/1.2	–	2/2.2	5/5.4
Subscapularis tendon (n/%)	–	–	5/10.9	2/4.3	–	–	–	2/4.3	–	–	5/5.4	4/4.3

Chronic tendinopathy was a frequent US finding both in gout patients and in patients with CPPD disease, and the supraspinatus tendon was the most frequently involved one. Intra-tendinous hyperechoic spots were also mainly found within the supraspinatus tendon, especially in patients with CPPD disease. Of the 41 rotator cuff ruptures detected by US, 24 were partial tears and 17 were complete ruptures. The supraspinatus tendon was also the most frequent structure showing a tendon rupture, and in patients with CPPD disease this tendon was found ruptured either partially or completely in a number of shoulders seven times higher than in gouty patients (Fig. 1).

The most frequent abnormality at the acromion-clavicular joint was the presence of osteophytes which was found in nearly the 80% of the shoulders in patients with CPPD disease and in 60% of the shoulders in the gouty patients.

As in all peri-articular synovial cavities, also in both acromion-clavicular and gleno-humeral joints, synovial hypertrophy and power Doppler signal at synovial tissue level were rare findings. The fibrocartilage of the acromion-clavicular joint and less frequently the glenoid labrum showed hyperchoic spots especially in patients with CPPD disease (Fig. 1). The double contour sign was found only in three shoulders of two gouty patients while the presence of hyperechoic spots within the hyaline cartilage of the humeral head was detected in three shoulders of three different gouty patients and in 15 shoulders of 12 patients with CPPD disease.

Discussion

In the last five years, a growing number of rheumatologists have been using US to assess patients with crystal-related arthropathies and for guiding interventional procedures in the musculoskeletal system (32, 33). Recent studies have shown the value of US in a core set of target sites in patients with gout and CPPD disease (34, 35), and other reports have suggested the use of US also in anatomic sites not considered characteristic of crystal-related arthropathies (36).

To the best of our knowledge this is the first study mainly aimed at investigat-

Table V. Prevalence of US findings indicative of joint involvement at shoulder level. In this table, the data acquired in the 3 patients with diagnosis of both gout and CPPD disease were reported together with the results obtained in the gouty patients.

Acromion-clavicular joint

	Right shoulder (n=88)		Left shoulder (n=88)		Total joints (n=176)	
	Gout (n=42)	CPPD disease (n=46)	Gout (n=42)	CPPD disease (n=46)	Gout (n=84)	CPPD disease (n=92)
Synovial effusion (n/%)	11/26.2	15/32.6	9/21.4	14/30.4	20/23.8	29/31.6
Synovial hypertrophy (n/%)	3/7.1	3/6.5	2/4.7	3/6.5	5/5.9	6/6.5
Power Doppler signal (n/%)	2/4.7	–	1/2.4	–	3/3.6	–
Osteophytes (n/%)	27/64.3	38/82.6	24/57.1	35/76.1	51/60.7	73/79.3
Fibrocartilage calcification (n/%)	10/23.8	23/50	5/11.9	16/34.8	15/17.9	39/42.4

Gleno-humeral joint

	Right shoulder (n=88)		Left shoulder (n=88)		Total joints (n=176)	
	Gout (n=42)	CPPD disease (n=46)	Gout (n=42)	CPPD disease (n=46)	Gout (n=84)	CPPD disease (n=92)
Synovial effusion (n/%)	3/7.1*	4/8.7*	3/7.1*	1/2.2*	6/7.1*	5/5.4*
Synovial hypertrophy (n/%)	1/2.4*	1/2.2*	1/2.4*	1/2.2*	2/2.4*	2/2.2*
Power Doppler signal (n/%)	–	–	–	–	–	–
Labrum calcification (n/%)	2/4.7	6/13	3/7.1	6/13	5/5.9	12/13
Humeral head - cartilage calcification (n/%)	2/4.7	7/15.2	1/2.4	8/17.4	3/3.6	15/16.3
Humeral head - double contour sign (n/%)	1/2.4	–	2/4.7	–	3/3.6	–
Bone erosions (n/%)	6/14.3	5/10.9	4/9.5	3/6.5	10/11.9	8/8.7

*posterior recess.

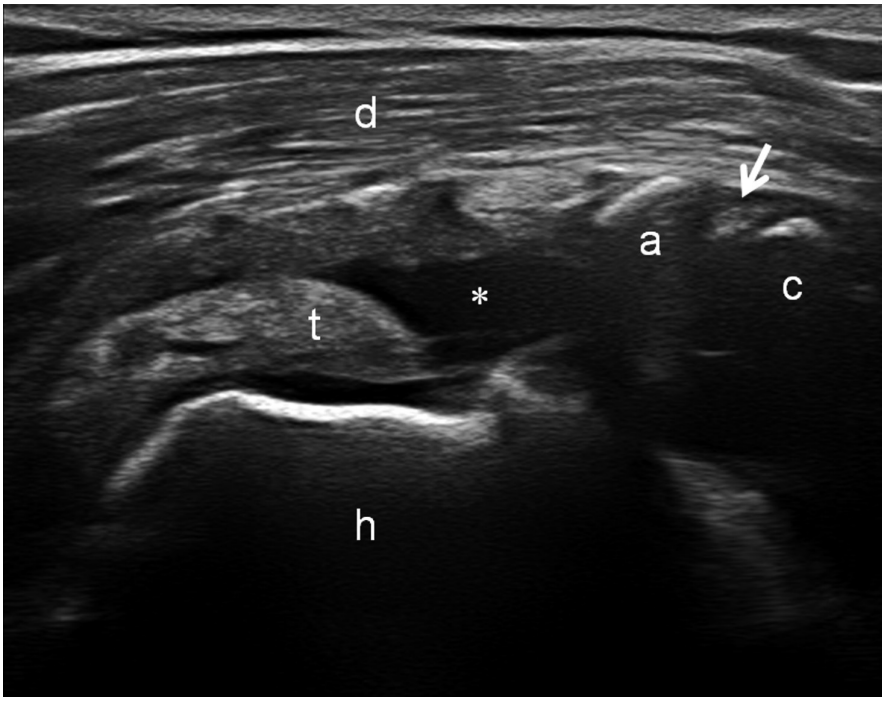

Fig. 1. Calcium pyrophosphate deposition disease. Patient complaining of sudden onset of severe shoulder pain. Ultrasound image acquired on longitudinal lateral view showing a complete rupture of the supraspinatus tendon. The **arrow** indicates a calcification of the fibrocartilage of the acromion-clavicular joint. **h**: humeral head; **a**: acromion; **c**: clavicle; **t**: distal torn of the supraspinatus tendon; *: fluid in the subdeltoid bursa; **d**: deltoid.

ing the prevalence of the US morphostructural changes in the shoulder of patients with definite diagnosis of gout and CPPD disease.

CPPD patients complained more frequently of shoulder pain, spontaneously and during the specific clinical maneuvers, than gouty patients and similarly US detected a higher prevalence of rotator cuff pathology in CPPD disease than in gout. A possible explanation is that the former group is older than the latter with the consequent potential higher prevalence of concomitant rotator cuff abnormalities.

The data obtained in this study confirm the ability of US in detecting, also in the shoulder, sonographic findings universally accepted as characteristic of monosodium urate and CPPD crystal deposits. The limited sensitivity of some of them, especially if compared with the results obtained in studies performed at different anatomic sites, may be partially related to technical aspects, such as the deep localisation of some targets (*i.e.* hyaline cartilage) which are not completely accessible.

If we exclude the osteophytes and the fibrocartilage involvement at the acromion-clavicular joints, the results of this study indicates that the most frequent US pathologic findings were detected at supraspinatus tendon level, especially in patients with CPPD disease. Of note, in patients with CPPD disease nearly half of the scanned supraspinatus tendons was found positive for US findings indicative of calcification, suggesting that the real prevalence of the CPPD crystal deposits within the rotator cuff may be underestimated. Possible explanations could be that CPPD deposits may be misinterpreted as basic calcium phosphate aggregates or that they may be missed because of the well-known limitations of the other imaging techniques (*i.e.* x-ray and MRI) used to assess the shoulder. In the interpretation of these results we cannot neglect the fact that the shoulder is a complex anatomic site, which includes several structures, some superficial and others deeper requiring different acoustic windows to be adequately assessed. The patient's body size can largely influence the US visualisation of the shoulder structures. A thick layer of subcutaneous adipose tissue and/or a hypertrophic deltoid muscle make target tissues, such as the humeral head hyaline cartilage, deeper and more difficult to scan. Moreover, the width of the acoustic windows depends on shoulder movements which can be variably impaired by pain and/or obesity. Conversely, US assessment of the fibrocartilage of the acromion-clavicular joint can be performed with high frequency probes because of its superficial position and does not require any particular shoulder positioning.

The results of this study should be interpreted in the light of the fact that all sonographers involved in this study have several years' experience in musculoskeletal US and the US systems can be considered in the high quality sector. This study has some limitations. First, the US findings were not compared with those of other imaging techniques. Second, the study was performed using a probe with a relatively low frequency, ranging between 4 and 13 MHz, chosen in order to allow the detection of the gleno-humeral joint also in obese subjects, in whom the detection of power Doppler signal is impaired especially at superficial tissue level such as the acromion-clavicular joint.

In conclusion, the results of this study confirm the high specificity of US findings indicative crystal deposits at hyaline cartilage level and indicate that the supraspinatus tendon and the fibrocartilage of the acromion-clavicular joint are the most frequently affected structures of the shoulders in patients with crystal-related arthropathies.

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