

Shoulder Ultrasonography in the Diagnosis of Polymyalgia Rheumatica: A Case-Control Study

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ABSTRACT. Objective. Magnetic resonance imaging (MRI) showed that subacromial/subdeltoid bursitis is the most frequent shoulder lesion in polymyalgia rheumatica (PMR). We evaluated whether shoulder ultrasonography (US) was as effective as MRI in the detection of this lesion and assessed the sensitivity and specificity of bilateral subacromial/subdeltoid bursitis in the diagnosis of PMR.

Methods. A case-control study of 57 consecutive case patients with untreated PMR and 114 controls seen over a 6 month period in 3 secondary referral rheumatology centers. Control patients consisted of the next 2 consecutive patients with bilateral shoulder aching and stiffness observed after the case patient. In all case and control patients the glenohumeral joint space, bursae, and long head biceps tendon were assessed by bilateral shoulder US. The first 24 case patients were also examined by bilateral shoulder MRI.

Results. US showed subacromial/subdeltoid bursitis in 55/57 (96%) patients with PMR and in 25/114 (22%) controls ($p < 0.001$). The lesion was bilateral in 53/55 (96%) case patients and in 1/25 (4%) controls ($p < 0.001$). The frequency of glenohumeral joint synovitis and biceps tenosynovitis did not differ significantly between case patients and controls. In 100% of case patients MRI showed subacromial/subdeltoid bursitis confirming US findings. The sonographic evidence of bilateral bursitis had a sensitivity of 92.9%, specificity of 99.1%, and positive predictive value of 98.1% for the diagnosis of PMR.

Conclusion. US and MRI were equally effective in confirming bilateral subacromial and subdeltoid bursitis in PMR. This finding, in view of its high sensitivity and specificity, could be used as a new diagnostic criterion for PMR. (J Rheumatol 2001;28:1049–55)

Key Indexing Terms:

POLYMYALGIA RHEUMATICA
MAGNETIC RESONANCE IMAGING

PROXIMAL BURSITIS

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Polymyalgia rheumatica (PMR) is a common disease of the elderly, characterized by aching and stiffness in the neck, shoulder, and pelvic girdles, sometimes associated with giant cell arteritis (GCA)^{1–3}. The typical proximal symptoms are the hallmark for the diagnosis of PMR. However, the occurrence of distal musculoskeletal manifestations in PMR could create some diagnostic difficulties with rheumatoid arthritis (RA) and other inflammatory and noninflammatory rheumatic disorders⁴. Further, nonrheumatological condi-

tions such as infections or neoplasms may sometimes mimic proximal PMR symptoms⁵. Therefore, development of a simple diagnostic test for PMR to reinforce the clinical findings of the diagnosis would be useful in clinical practice.

In a recent magnetic resonance imaging (MRI) case-control study we found subacromial/subdeltoid bursitis in 100% of PMR cases, while this lesion was observed in only 22% of controls with RA⁶. The radiological evidence of prominent inflammatory involvement of extraarticular synovial structures of shoulders and hips in PMR has recently been emphasized^{7–9}. Parallel to resolution of the clinical symptoms and normalization of acute phase reactants, these radiological findings rapidly improve after one week of corticosteroid treatment¹⁰.

MRI is considered the gold standard imaging method for depicting both articular and extraarticular inflammatory lesions of arthritic shoulders¹¹. However, ultrasonography (US) may represent a valid, less expensive alternative method for the detection of shoulder soft tissue inflammatory changes¹².

We conducted a case-control study to assess the usefulness of US in comparison to MRI for the detection of shoulder lesions in patients with active PMR. Further, we

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evaluated whether sonographic evidence of bilateral proximal bursitis in the shoulders would be a useful marker for the diagnosis of PMR.

MATERIALS AND METHODS

All consecutive new patients with PMR diagnosed according to the Healey criteria¹³ in the outpatient clinic of 3 secondary rheumatology centers (hospitals of Prato, Reggio Emilia, and Potenza, Italy) over a 6 month period were included in the study. All patients had persistent pain (for at least one month) in the neck and shoulder girdle, with or without pelvic girdle involvement, morning stiffness for more than 1 hour, erythrocyte sedimentation rate > 40 mm/h. All were over 50 years of age and had no other disease capable of causing the musculoskeletal symptoms.

All patients were rheumatoid factor negative (Rose-Waaler titer $\leq 1:40$ or nephelometric determination ≤ 20 IU/ml on 2 or more occasions). Patients treated with corticosteroids prior to clinical evaluation were excluded from the study. All patients were clinically assessed and prospectively followed by the same rheumatologists (FC, CS, IO, LN), who recorded medical information on a standardized data collection form at every visit. Temporal artery biopsies were performed only in patients with cranial signs and/or symptoms suggestive of GCA. At diagnosis and throughout followup, all patients were evaluated as to whether they met the American College of Rheumatology (ACR; formerly, the American Rheumatism Association) 1987 revised criteria for RA¹⁴.

Before starting corticosteroid therapy, bilateral shoulder US was performed in all patients and controls. Bilateral shoulder MRI was also performed on the first consecutive 24 patients with PMR, with a median interval from US evaluation of 5 days (range 1–8).

As a control group we used the 2 consecutive outpatients, older than 50, who complained of bilateral shoulder aching and stiffness and who were observed after the patient with PMR. The equipment used for US was the Toshiba SSA 340A (Tokyo, Japan) with high resolution 7.5 MHz linear transducer.

All US examinations were performed jointly by 2 radiologists (MM, FR) with special training in musculoskeletal sonography. They were blind to the clinical diagnosis and agreed on the US findings. Shoulder sonograms were obtained according to standardized techniques^{15–17}.

MRI scans were also evaluated by 2 radiologists (AB, GZ). To compare the findings in 24 patients with PMR, the radiologists evaluated the US and MRI scans on an independent basis and blind to clinical diagnosis to reciprocal results. MRI scans were performed with a 0.5 T superconductive magnet system (Philips Gyroscan T5 II, 0.5 Tesla, Eindhoven, The Netherlands) and a 17 cm extremity bore transmit-receive coil. Pulse sequences included coronal T1 weighted sequences (240 ms repetition time, 25 ms echo time, 2 excitations) and T2 weighted sequences (2000 ms repetition time, 90 ms echo time, 2 excitations). The coronal section was 5 mm thick and the axial section was 7 mm thick; both had an intersection gap of 1 mm. The field of view was 20 cm; the matrix size was 160 × 224 cm or 128 × 192 cm.

US and MRI were used to evaluate the glenohumeral joint space, subacromial and subdeltoid bursae, and synovial sheath of the long head of biceps.

The inflammatory involvement of these structures was defined by the presence of fluid collection. Since in normal shoulder the 2 opposite sides of subacromial/subdeltoid bursa are separated no more than 1 mm¹⁸, at US examination the diagnosis of bursitis was accepted when the sonoluent fluid distended the bursa more than 1 mm. At US, glenohumeral joint synovitis was defined by the presence of intraarticular effusion sufficient to cause a gap > 3 mm between the humeral head and the joint capsule (scans obtained with the transducer placed in the axilla and the arm in 90° abduction). Biceps tenosynovitis was diagnosed in presence of fluid surrounding the bicipital groove giving a target image on axial sonogram or when the distance between the biceps tendon sheath and the tendon groove was > 5 mm on longitudinal sonogram¹⁵.

As reported⁶, both for US and MRI scans, measurement of fluid accumulation was graded by using a semiquantitative scale (0 = no accumulation; 1 = sufficient accumulation to allow visualization of the articular shoulder structure, periarticular shoulder structure, or both; 2 = moderate accumulation; 3 = sufficient quantity to stretch the walls of the structures).

The study protocol was reviewed and approved by ethics committees of the participating centers. Written informed consent was obtained from all participating patients.

Statistical analysis was done using the SPSS statistical package (SPSS Inc., Chicago, IL, USA). Chi-square test was used to compare the results.

RESULTS

We studied 57 patients with PMR and 114 controls. The demographic and clinical characteristics of the 57 case patients and 114 controls are summarized in Tables 1 and 2. Rapid improvement of symptoms was observed in all patients with PMR after corticosteroid therapy and none of them met the 1987 ACR criteria for RA or developed articular erosions during the followup period.

Comparison between US and MRI findings in PMR. Table 3 shows the results of shoulder MRI and US examination in 24 consecutive patients with PMR. MRI showed bursitis in 48/48 (100%) and US in 45/48 (94%) shoulders. MRI and US, respectively, detected grade 3 bursitis in 12/48 (25%) (Figure 1A) and 10/48 (21%) shoulders (Figure 1B), grade 2 in 21/48 (44%) and 22/48 (46%), grade 1 in 15/48 (31%) and 13/48 (27%). In 3/48 (6%) shoulders US failed to detect grade 1 bursitis.

Glenohumeral joint synovitis was observed in 33/48 (69%) shoulders by MRI and in 27/48 (56%) by US. MRI and US showed bilateral fluid collection in the glenohumeral joint in 12/24 (50%) and 8/24 (33%), respectively. Glenohumeral synovitis was absent in 3/24 (12.5%) at MRI and in 6/24 (25%) at US.

Both MRI and US showed long biceps tenosynovitis in 36/48 (75%) shoulders. This finding was bilateral in 15/24 (62.5%) patients. In 3/24 (12.5%) there was no evidence of biceps tenosynovitis.

Assuming MRI as the gold standard method and dividing

Table 1. Demographic and clinical characteristics of the 57 studied patients with polymyalgia rheumatica.

| | |
|--|-----------|
| Female/male, % | 68/32 |
| Age at onset of disease, yrs | 71 ± 10.6 |
| Duration of symptoms before diagnosis, mo | 3 ± 1 |
| Duration of followup, mo | 8 ± 5.2 |
| Systemic symptoms and signs (fever, anorexia and weight loss), % | 44 |
| Distal manifestations (peripheral arthritis, distal extremity swelling with pitting edema) | 36 |
| ESR, at diagnosis, mm/h | 76 ± 19.3 |
| CRP at diagnosis, mg/dl | 5.7 ± 2.6 |
| Biopsy proven GCA, % | 5 |
| Patients with both shoulder and pelvic girdle aching % | 49 |

ESR: erythrocyte sedimentation rate; CRP: C-reactive protein; GCA: giant cell arteritis. Except where otherwise indicated, values are expressed as mean ± SD.

Table 2. Demographic and clinical characteristics of the 114 control-patients.

| | No. | Male/ Female, % | Age yrs | Duration of Disease, mo | ESR, mm/h | CRP, mg/dl |
|---------------------------|-----|-----------------------|------------|-------------------------------|--------------|---------------|
| Diagnosis | | | | | | |
| Rheumatoid arthritis | 46 | 32/68 | 61 ± 8.6 | 32 ± 23 | 42 ± 11.4 | 3.6 ± 4.2 |
| Psoriatic arthritis | 15 | 53/47 | 60 ± 9.2 | 54 ± 33.6 | 45 ± 22.4 | 4.1 ± 2.8 |
| Spondylarthritis | 6 | 67/33 | 58 ± 6.3 | 70 ± 53.2 | 28 ± 8.5 | 1.2 ± 1.8 |
| Osteoarthritis | 35 | 43/57 | 66 ± 10.6 | 42 ± 10.3 | 14 ± 5.9 | 0.5 ± 0.3 |
| Fibromyalgia | 6 | 17/83 | 57 ± 3.5 | 14 ± 6.3 | 16 ± 4.2 | 0.4 ± 0.2 |
| Connective tissue disease | 6 | 17/83 | 53 ± 2.1 | 51 ± 24.7 | 48 ± 20.6 | 0.9 ± 1.1 |

ESR: erythrocyte sedimentation rate; CRP: C-reactive protein. Except where otherwise indicated, values are expressed as mean ± SD.

Table 3. Demographic, clinical, US and MRI shoulder findings in 24 patients with active polymyalgia rheumatica and shoulder girdle involvement.

| Patient | Sex/ Age, yrs | Disease Duration at Diagnosis, mo | ESR, mm/h | CRP, mg/dl | Subacromial and Subdeltoid Bursitis* | | Glenohumeral Joint Synovitis* | | Tenosynovitis of Long Biceps Head* | |
|---------|---------------------|---|--------------|---------------|--|-----------|----------------------------------|-----------|--|-----------|
| | | | | | MRI l/r | US l/r | MRI l/r | US l/r | MRI l/r | US l/r |
| 1 | F/76 | 5 | 87 | 8.6 | 3/3 | 2/3 | 1/1 | 1/1 | 0/1 | 0/1 |
| 2 | F/72 | 8 | 78 | 4.6 | 3/2 | 3/2 | 1/2 | 1/1 | 2/2 | 1/1 |
| 3 | F/78 | 3 | 96 | 8.5 | 2/3 | 3/2 | 1/1 | 1/1 | 2/0 | 2/0 |
| 4 | F/67 | 4 | 80 | 4.9 | 1/1 | 2/2 | 0/0 | 0/0 | 1/2 | 1/1 |
| 5 | F/71 | 3 | 106 | 6.7 | 2/2 | 2/2 | 1/1 | 1/1 | 0/0 | 0/0 |
| 6 | M/70 | 2 | 78 | 8.1 | 1/1 | 0/2 | 0/0 | 0/0 | 0/1 | 0/1 |
| 7 | F/69 | 4 | 98 | 9.2 | 3/1 | 3/1 | 1/0 | 1/0 | 1/2 | 2/1 |
| 8 | F/75 | 2 | 72 | 6.3 | 1/2 | 0/2 | 1/1 | 0/1 | 1/1 | 1/1 |
| 9 | F/80 | 3 | 88 | 9.8 | 2/2 | 2/2 | 1/1 | 1/1 | 0/0 | 0/0 |
| 10 | F/70 | 2 | 74 | 6.4 | 3/2 | 3/1 | 1/1 | 1/0 | 2/1 | 1/1 |
| 11 | F/66 | 1 | 67 | 5.8 | 1/2 | 1/3 | 1/1 | 1/1 | 1/1 | 1/1 |
| 12 | F/70 | 4 | 81 | 5.2 | 3/2 | 3/2 | 0/1 | 0/0 | 1/1 | 1/1 |
| 13 | M/69 | 4 | 65 | 4.7 | 2/3 | 3/3 | 1/1 | 1/1 | 2/2 | 1/1 |
| 14 | F/70 | 6 | 42 | 2.6 | 2/1 | 1/1 | 1/1 | 0/0 | 1/0 | 1/0 |
| 15 | F/76 | 3 | 52 | 1.8 | 2/1 | 2/1 | 1/0 | 1/0 | 1/1 | 1/1 |
| 16 | M/70 | 1 | 72 | 5.2 | 2/1 | 1/1 | 1/0 | 1/0 | 2/1 | 1/1 |
| 17 | M/69 | 4 | 80 | 3.1 | 3/2 | 3/2 | 1/0 | 1/0 | 0/0 | 0/0 |
| 18 | M/71 | 4 | 84 | 6.3 | 1/2 | 1/2 | 0/0 | 0/0 | 1/2 | 1/2 |
| 19 | F/64 | 5 | 102 | 5.9 | 1/3 | 1/2 | 1/1 | 0/1 | 1/2 | 1/2 |
| 20 | F/76 | 3 | 96 | 4.9 | 2/2 | 2/1 | 1/1 | 0/1 | 1/0 | 1/0 |
| 21 | F/76 | 5 | 60 | 0.9 | 2/1 | 2/1 | 1/0 | 1/0 | 2/1 | 1/1 |
| 22 | F/64 | 3 | 88 | 8.2 | 2/1 | 2/1 | 1/0 | 2/0 | 0/1 | 0/1 |
| 23 | F/66 | 4 | 84 | 5.4 | 3/1 | 2/0 | 0/1 | 0/0 | 1/1 | 1/1 |
| 24 | F/76 | 3 | 78 | 8.4 | 3/2 | 2/2 | 1/0 | 1/1 | 2/1 | 1/1 |

F: female; M: male; ESR: erythrocyte sedimentation rate; CRP: C-reactive protein; MRI: magnetic resonance imaging; US: ultrasonography; l: left shoulder; r: right shoulder.

*Fluid collection was graded with a semiquantitative scale ranging from 0 to 3 (see Materials and Methods).

the results into presence/absence of the various lesions, the sensitivity and specificity of US for bursitis were respectively 93.7% and 100%, for glenohumeral joint synovitis 78.7% and 93.3%, and for long head biceps tenosynovitis 100% and 100%.

Shoulder US findings in PMR patients and controls.

Subacromial/subdeltoid bursitis was detected in 55/57 (96%) patients with PMR and in 25/114 (22%) controls ($p \leq 0.001$). We also compared frequency of subacromial/subdeltoid bursitis in patients with PMR compared with the subgroup of 67 controls with inflammatory arthropathies. Sonographic findings of bursitis were detected in 19/67

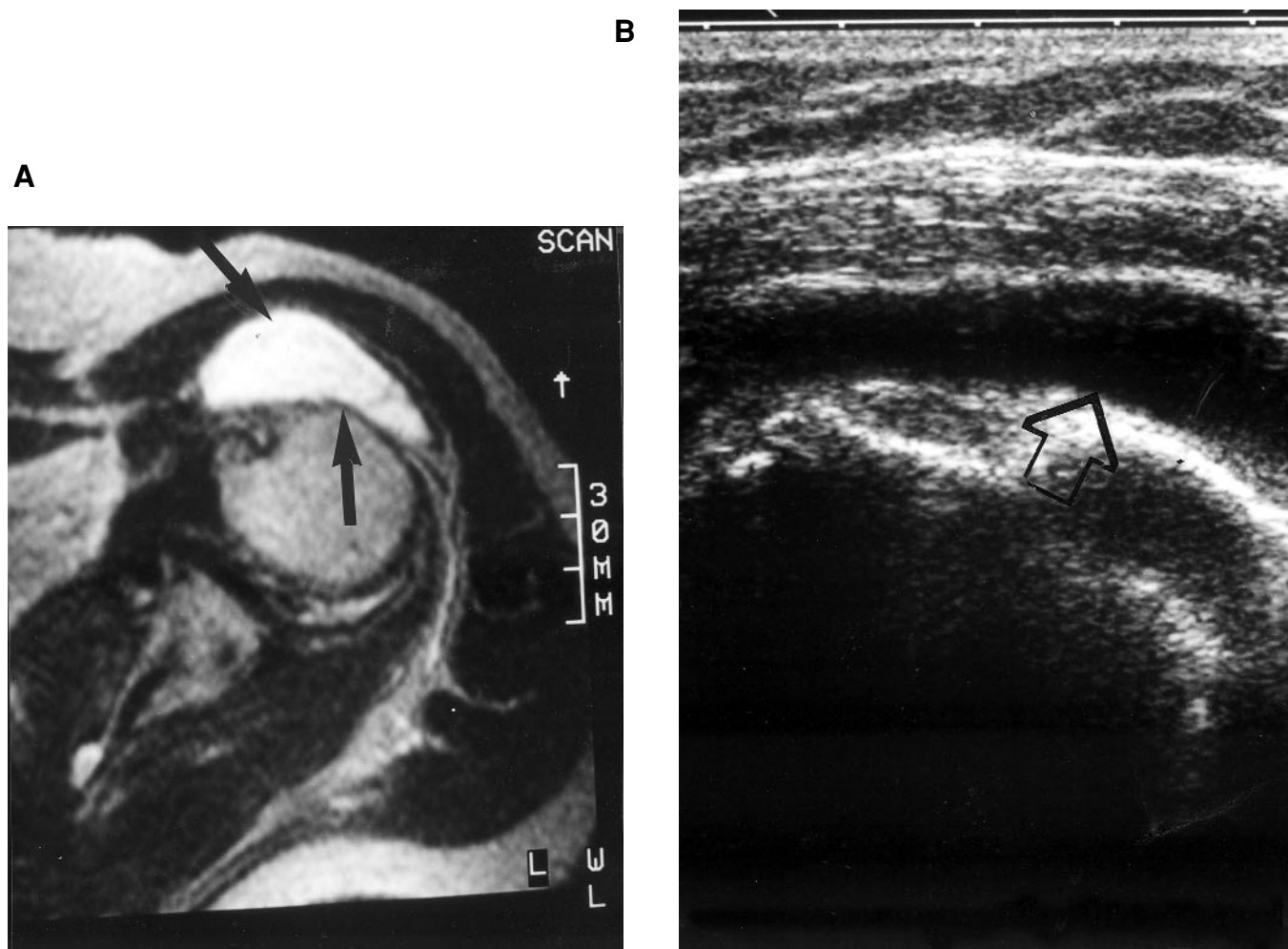


Figure 1. A. MRI of the shoulder. Axial T2 weighted scan shows grade 3 bursitis and a large amount of fluid within the subacromial/subdeltoid bursa (arrows). B. Longitudinal sonogram of the same patient confirming the presence of abundant fluid within the bursa (arrow).

(28%) controls ($p \leq 0.001$). Bursitis was observed in 12/46 (26%) patients with RA and 7/21 (33%) patients with psoriatic arthritis and other spondyloarthropathies. The lesion was bilateral in 53/55 (96%) PMR patients and in 1/25 (4%) controls ($p \leq 0.001$). Glenohumeral joint synovitis was detected in 44 of 57 (77%) patients with PMR and in 66/114 (58%) controls ($p = 0.27$). Joint synovitis was bilateral in 20/44 (45%) PMR patients and in 37/66 (56%) controls ($p = 0.6$). Long head biceps tenosynovitis was present in 46/57 (80%) PMR patients and in 60/114 (53%) controls ($p = 0.12$). Biceps tenosynovitis was bilateral in 33/46 (72%) PMR patients and in 4/60 (7%) controls ($p < 0.001$).

In patients with PMR, grade 3 bursitis was observed in 25/114 (22%) shoulders, grade 2 in 67/114 (59%), and grade 1 in 16/114 (14%). In 6 (5%) shoulders US did not show bursitis. Grade 2 and 1 glenohumeral joint synovitis were present in 3/114 (3%) and 61/114 (53.5%) shoulders, respectively. No patients showed grade 3 joint synovitis.

The grading for long head biceps tenosynovitis was: grade 3 in 4/114 (3.5%), grade 2 in 20/114 (17.5%), and grade 1 in 55/114 (48%) shoulders. The frequency of grade 3 severity score was significantly higher for bursitis compared to the other 2 lesions ($p \leq 0.001$).

Utility of US evidence of bilateral bursitis as criterion for diagnosis of PMR. The US evidence of bilateral bursitis had a sensitivity of 92.9%, specificity 99.1%, and positive predictive value 98.1% for the diagnosis of PMR.

DISCUSSION

The structures involved by the inflammatory process of PMR have been investigated with different techniques. Arthroscopic and radioisotopic studies have revealed the presence of proximal joint synovitis¹⁹⁻²¹. A recent immunohistochemical study showed the presence of mild glenohumeral synovitis with a predominance of CD68+ macrophages and CD4+ T cells in arthroscopic synovial

biopsy samples from shoulders of patients with active PMR²². However, the severe and diffuse musculoskeletal discomfort in shoulder and pelvic girdles may be only partially explained by this mild joint synovitis.

In a recent MRI study we found the presence of pronounced subacromial and subdeltoid bursitis in 100% of patients with active PMR. This lesion was observed in only 22% of control patients with elderly onset RA⁶. We suggested that proximal bursitis in association with synovitis of glenohumeral joints and tenosynovitis of biceps is a likely basis for much of the diffuse aching in the shoulder girdle observed in patients with PMR, and we proposed that PMR could be a primary disorder of extra-articular synovial structures^{8,23}. The relationship between proximal bursitis and the shoulder girdle symptoms was confirmed by the parallel resolution of shoulder MRI lesions and clinical symptoms after a few days of corticosteroid therapy¹⁰.

The structures involved by the inflammatory process in PMR have been also investigated using US. Three different studies reported a low frequency of subacromial/subdeltoid bursitis (16%, 15%, and 16%, respectively), while glenohumeral joint synovitis was the most frequently observed lesion (57%, 61.5%, and 66%, respectively)²⁴⁻²⁶.

In our study, we found US evidence of subacromial/subdeltoid bursitis in 96% of PMR patients. Bursitis was bilateral in 96% of patients. Glenohumeral joint effusion was observed in 77% of the patients, and long head biceps tenosynovitis in 80%.

Several factors may explain the higher frequency of bursitis observed in our patients compared to that reported in other US studies. Different sets of criteria are currently used to identify patients with PMR^{1,13,27,28}. Therefore, a different selection of patients cannot be excluded as a cause²⁹. In addition, the results could be influenced by variability due to the examiner and equipment in US and by different scanning approaches in the assessment of articular and extraarticular shoulder structures³⁰. Further, differences in the treatment of patients when US examination was performed may account for these discrepancies. Corticosteroid therapy dramatically improves MRI evidence of subacromial/subdeltoid bursitis in one week¹⁰. Our patients had active disease and they did not receive corticosteroids at the time of US or MRI examination. In contrast, in one of the previous studies the patients had a mean duration of therapy of 6 months at the time of US examination²⁶, and in the 2 others the authors did not specify when the examination was performed^{24,25}. The 2 radiologists who did US examination were unaware of the patients' diagnoses, therefore an overestimate of bursitis can be excluded in our study.

As reported by other studies that compared shoulder US and MRI¹⁷, US yielded good sensitivity and specificity in the evaluation of bursitis (93.7% and 100%) and long head biceps tenosynovitis (100% and 100%), whereas it was less

sensitive in the evaluation of glenohumeral joint effusion (78.7% and 100%). PMR is a relatively common disorder of the elderly with a prevalence of about one in 150 persons 50 years of age and older³¹. The combination of persistent pain with pronounced morning stiffness in neck, shoulder, and pelvic girdles is pathognomonic and represents the core of diagnostic criteria for this disease. However, distal manifestations, which include peripheral arthritis and distal extremity swelling with pitting edema, may occur in about half the cases⁴. These features were observed in 36% of the patients with PMR in the present series.

When these distal manifestations occur it may be difficult to differentiate PMR from elderly onset RA, systemic lupus erythematosus in the elderly, late onset spondyloarthropathy, psoriatic arthritis, and remitting seronegative symmetrical synovitis with pitting edema (RS3PE) syndrome^{5,32-35}. Further, endocarditis and malignancy may occasionally show proximal musculoskeletal manifestations mimicking PMR symptoms³⁶⁻³⁹. Therefore, the development of a simple diagnostic test for PMR, to reinforce clinical suspicion, would be useful in clinical practice.

Our study showed that US evidence of bilateral subacromial/subdeltoid bursitis may represent a hallmark of PMR. The finding of a sensitivity of 92.9% and specificity of 99.1% for the diagnosis of PMR suggests that US evidence of bilateral proximal bursitis in the shoulders can differentiate patients with PMR from a group of disease control patients. The sensitivity and specificity of this radiological criterion is higher than those of the presence of bilateral shoulder pain and/or stiffness, which is the criterion with the highest sensitivity and specificity (86% and 68%, respectively) in the series of Bird, *et al*²⁷.

The different disease durations in case patients and controls with inflammatory arthropathies could represent a possible bias in the comparison of shoulder US findings. However, all controls had bilateral shoulder aching and stiffness and active disease with elevated acute phase reactants (Table 2). Therefore it seems plausible that shoulder lesions are not different in patients with the same active disease, independent of the disease duration.

Our results might also be influenced by the lower age of controls. The aging process is associated with rotator cuff defects, which may facilitate subacromial/subdeltoid effusions⁴⁰. However, roughly one-third of subjects aged between 50 and 60 have tears across the rotator cuff⁴⁰, thus reducing the possible selection bias.

Other shoulder pathologic processes can produce bursitis, such as tendinosis, tendonitis, and rotator cuff injury⁴¹. However, unlike PMR, these disorders occur unilaterally in the majority of cases⁴¹⁻⁴³. Moreover, the absence of pelvic girdle involvement and systemic inflammatory reaction facilitates the clinical diagnosis.

A limitation of our study may be the absence of control patients with infection and neoplasm. However, the clinical

picture in these patients is usually characterized by myalgias and arthralgia and, unlike PMR, the prolonged morning stiffness and the pronounced pain with movement of shoulder and pelvic girdles do not occur^{36,44,45}. This may suggest a different pathological process sparing the extra-articular synovial structures.

Our study confirms that bilateral subacromial/subdeltoid bursitis, which was observed in 96% of patients, is the most frequent lesion of shoulders observed in untreated PMR. Compared to MRI, US is equally effective in the detection of this lesion and its accuracy, low cost, and easy feasibility may make it the method of choice. Considering the high degree of sensitivity and specificity of US evidence of bilateral shoulder bursitis, this lesion could be used as a new diagnostic criterion for PMR. We would emphasize the need for a large multicenter prospective study that also includes shoulder US to define a new set of criteria for PMR diagnosis.

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