Imaging of sternocostoclavicular joint in spondyloarthropaties and other rheumatic conditions

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Abstract

Objective

To retrospectively evaluate the role of the various imaging techniques in the study of the sternocostoclavicular joint, in patients with spondyloarthropathies and other rheumatic conditions and to assess potential pitfalls in the radiological diagnosis.

Subjects and methods

Thirty patients, 11 male and 19 female, mean age 45 years, with involvement of the sternocostoclavicular joint as part of rheumatologic disorders (psoriatic arthritis, ankylosing spondylitis, Tietze syndrome, SAPHO syndrome, and condensing osteitis of the clavicle) were studied. Conventional radiography, CT, MRI and bone scintigraphy were performed. The following imaging findings were evaluated: soft tissue swelling, bone sclerosis, cortical bone erosions, joint space narrowing, subchondral sclerosis, periosteal new bone formation, synovial reaction and intrarticular effusion. All the images were independently reviewed by two musculoskeletal radiologists.

Results

Conventional radiography demonstrated only sclerosis of the clavicula in 8 pts (26%) and the sternum in 3 pts (10%), cortical bone erosions in 7 pts (23%), joint space narrowing in 6 pts (23%) and periosteal bone formation in 2 pts (10%). At the CT examination sclerosis of the clavicula and the sternum was observed in 13 pts (44%), cortical bone erosions in 22 pts (76%), joint space narrowing in 10 pts (34%), ligament ossification in 12 pts (41%), subchondral sclerosis in 9 pts (34%) and periosteal bone formation in 10 pts (34%). The MRI was the most sensitive technique in the evaluation of the soft tissue swelling in 9 pts (56%), intrarticular effusion in 13 pts (81%) and synovial reaction in 13 pts (81%). Finally, bone scintigraphy showed an increased uptake at the sterno-costoclavicular joint in all patients who underwent the examination.

Conclusions

The radiological evaluation of the anterior chest wall in patients with different rheumatic disorders represents a problem of difficult diagnostic evaluation both for the anatomic region complexity and for the variability of the radiographic findings. The integrated use of X-ray, CT, MRI and nuclear medicine is suggested to avoid misdiagnosis.

Key words

Sternocostoclavicular joint, seronegative spondyloarthropaties, X-ray, CT, MRI, bone scintigraphy.

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Received on June 9, 2008; accepted in revised form on November 27, 2008.

Competing interests: none declared.

Introduction

The sternocostoclavicular joint represents the anterior part of the chest wall; it consists of the sternum, the adjacent articulating first to seventh costal cartilages, the sternoclavicular joint, the medial part of the clavicles and the surrounding soft tissue. The sternoclavicular joints are a typical site of involvement in the spondyloarthritis (such as ankylosing spondylitis and psoriatic arthritis), in SAPHO syndrome (synovitis, acne, pustulosis, hyperostosis and osteitis) (1) in chronic recurrent multifocal osteomyelitis (CRMO), in Tietze syndrome, in the osteitis condensans of the clavicle, in sternocostoclavicular hyperostosis and in various forms of pustulotic arthro-osteitis. There is a lot of variation in terminology, probably reflecting our lack of understanding of these conditions. This is understandable in view of the wide variation in clinical presentation and the occurrence of associated conditions, such as palmoplantar pustulosis, psoriasis and acne (2, 3). The different patterns of joint and bone involvement on imaging introduce yet another dimension of variability. For example, Chamot *et al*. (4) suggest that multiple non-infectious osteitis, sternoclavicular hyperostosis, palmoplantar pustulosis and severe acne represent different but overlapping clinical presentations of the same condition. Others also regard osteitis condensans and Tietze syndrome as part of the condition (5, 6). Anterior chest wall involvement can break out insidiously or suddenly with localized or diffuse joint pain and radiologically with features referred to degenerative arthropathy, sclerosis, osteitis and hyperostosis. The preferred sites are generally the sternoclavicular, manubriosternal or sternocostal joints, often clinically associated with skin lesions; involvement of the anterior chest wall is rarely diagnosed in these patients and may cause diagnostic difficulties for both radiologists and clinicians. In fact, they share common clinical and laboratory features and have the propensity to affect the synovial joints with inflammation at the bony insertion of ligaments and tendons (7). The radiographic changes are also essentially similar and can sometimes be demonstrated on a plain radiograph only in clear cases but most often are more difficult to diagnose and can cause problems of differential diagnosis with other diseases such as osteomielitis, Paget's disease, bone metastasis, bony tumours. Consequently, different cross-sectional images are usually needed to detect subtle changes (8, 9) and other radiological techniques such as musculoskeletal ultrasound (10), CT, MRI and bone scintigraphy are necessary to make the correct diagnosis. The aim of this study is to retrospectively evaluate the role of the various imaging techniques (X-ray, CT, MRI and bone scintigraphy) in the study of sternocostoclavicular joint in patients with seronegative spondyloarthropathies (SpA) and to assess potential pitfalls in the radiological diagnosis.

Patients and methods

Thirty patients, 11 male and 19 female, aged 14 to 77 years (mean age 45 years), composed of in- and out-patients at our hospital, with seronegative spondyloarthropathies and other rheumatic conditions involving sternocostoclavicular joint and with a clinical pattern of soft tissue swelling in this region, with or without pain, were studied. The anatomic sites studied were the manubrium sterni, the sternoclavicular joint and the first sternocostal joint; the morfological changes analyzed were joint space narrowing, bone sclerosis or hyperostosis, bone erosions, ligaments ossification, subchondral sclerosis, periosteal bone formation, osteitis, soft tissue swelling, synovial reaction and intrarticular effusion. Table I shows the data base of the patients studied, the performed radiological examinations, the main symptoms and the formulated diagnosis. In our study population, 12 patients were affected by psoriatic arthritis, 9 patients by ankylosing spondilitys, 4 patients by Tietze syndrome, 3 patients by SAPHO syndrome and 2 patients by condensing osteitis of the clavicle. Plain X-ray examination includes: posterior-anterior, lateral and oblique projections of the sterno-costoclavicular joint.

The computed tomography study (TCT 900S Toshiba, Japan) was performed only in basal conditions. The serial

scans were obtained through the sternocostoclavicular area of pain, swelling or tenderness; slice thickness was 2 mm and contiguous scans were obtained at 2 mm intervals with high resolution technique. Using CT, we recognised the three stages of involvement of the sternocostoclavicular joint, according to Earwaker *et al*. (7) Stage I is localized in the region of the costoclavicular ligament and may be a primary enthesopathy. It can be demonstrated on CT as a soft tissue mass with evidence of new bone. Stage II evolves with the development of an arthropathy in the sternoclavicular joint and sclerosis involving the medial end of the clavicle, the first rib and adjacent sternum with sclerotic hypertrophy of the costal cartilage. Stage III is a continuum with osteosclerosis, hyperostosis and bone hypertrophy affecting the medial ends of the clavicles, the sternum and upper ribs with arthritis in the adjacent joints (7). MRI images were obtained in axial, sagittal, coronal and coronal/oblique plains along the main axis of the manubrium sterni, with a circular (12.7 cm) receive surface coil and with patient lying in prone decubitus. On MRI (Signa General Electric 1,5 T, USA) the sequences performed were: T1-weighted (SE T1-w; TR/TE 500/20; Thickness 3mm; Intersection gap 1mm; Nex 2; Matrix 256x224; FOV 18cm; Time 3'52''; Slices 6-8), T2 (FSE T2-w) and STIR-FSE (TR/TE/ETL 3000/90/8; Matrix 256x256; TI 150msec; Time 3'24''; Slices 6-8 FSE e 6 STIR-FSE) in basal conditions, and SE-CHESS T1-w (TR/TE500/20; Matrix 256x224; Time 3'52''; Slices 6-8) after Gadolinium-DTPA ev. (Magnevist, Bayer, Berlin, Germany) administration.

The whole body bone scintigraphy with planar images was performed 2-4 hours after injection of 99mTC- methylene-diphosphonate (MDP). Tracer uptake was interpreted to be significant if the entire sternocostoclavicular region showed a higher activity than the thoracic spine.

All the studies were independently reviewed by two musculoskeletal radiologists (G.G and A.C., one with more than 15 years of experience, while the other was a fellow in radiology) who were blinded to the results. Questionable cases were discussed by the two radiologists to obtain a consensus. Ethics committee approval and informed patient consent were not required for this retrospective study.

Table I. Characteristics of the study population.

Patient	Age	Sex	Duration (months)	Imaging	Chest pain	Fever	Soft tissue swelling	Diagnosis
1	43	F	6	x-ray/CT	Y	Y	N	Osteitis condensans
2	57	M	36	x-ray/CT	Y	Y	Y	Psoriatic arthritis
3	24	F	12	x-ray/CT	Y	Y	N	Ankylosing spondylitis
4	72	F	120	x-ray/CT	Y	N	N	Psoriatic arthritis
5	68	F	12	x-ray/CT/NM	Y	Y	N	SAPHO syndrome
6	45	M	5	x-ray/CT	Y	N	N	Psoriatic arthritis
7	72	M	24	x-ray/CT/NM	N	Y	Y	Ankylosing spondylitis
8	68	F	72	x-ray/CT/MR/NM	Y	Y	Y	Tietze syndrome
9	14	F	4	x-ray/CT/MR/NM	Y	Y	N	Psoriatic arthritis
10	56	F	18	x-ray/MR	Y	Y	N	Osteitis condensans
11	54	M	24	x-ray/CT	N	N	Y	Psoriatic arthritis
12	37	M	3	x-ray/CT/MR/NM	Y	Y	Y	Psoriatic arthritis
13	62	F	240	x-ray/MR	Y	Y	Y	Ankylosing spondylitis
14	53	M	24	x-ray/CT/MR/NM	Y	Y	N	Tietze syndrome
15	73	F	72	x-ray/CT/MR/NM	Y	N	N	Psoriatic arthritis
16	55	F	12	x-ray/CT	Y	Y	N	SAPHO syndrome
17	35	F	4	x-ray/CT	Y	Y	Y	Ankylosing spondylitis
18	66	F	18	x-ray/CT	Y	Y	N	Psoriatic arthritis
19	44	F	24	x-ray/CT/NM	Y	Y	N	Tietze syndrome
20	53	F	60	x-ray/CT/MR/NM	Y	Y	N	Ankylosing spondylitis
21	22	F	8	x-ray/CT/MR/NM	Y	Y	N	Psoriatic arthritis
22	20	F	3	x-ray/CT/MR/NM	Y	Y	N	Ankylosing spondylitis
23	77	M	240	x-ray/CT/NM	Y	N	N	Tietze syndrome
24	60	M	120	x-ray/CT/MR/NM	Y	N	Y	Psoriatic arthritis
25	47	F	24	x-ray/CT/NM	Y	Y	N	SAPHO syndrome
26	57	F	36	x-ray/CT/MR/NM	Y	Y	Y	Ankylosing spondylitis
27	31	M	12	x-ray/CT/MR/NM	Y	Y	Y	Psoriatic arthritis
28	58	F	6	x-ray/CT/MR/NM	Y	N	N	Ankylosing spondylitis
29	64	F	72	x-ray/CT/MR/NM	Y	N	N	Psoriatic arthritis
30	57	F	12	x-ray/CT/MR/NM	Y	Y	N	Ankylosing spondylitis

Table II. Radiologic features with different imaging techniques.

	X-ray	CT	MRI	Bone scintigraphy
Soft tissue swelling	NO	1 (3%)	9 (56%)	NO
Sclerosis clavicula	8 (26%)	13 (44%)	NO	NO
Sclerosis sternum	3 (10%)	13 (44%)	NO	NO
Bone erosion	7 (23%)	22 (76%)	NO	NO
Joint space narrowing	6 (23%)	10 (34%)	NO	NO
Subchondral sclerosis	NO	9 (34%)	NO	NO
Periosteal bone formation	2 (10%)	10 (34%)	NO	NO
Synovial reaction	NO	NO	13 (81%)	NO
Intrarticular effusion	NO	NO	13 (81%)	NO
Ligament ossification	NO	12 (41%)	NO	NO
Bone scintigraphic uptake	NO	NO	NO	18 (94%)

Results

Table II summarizes the main imaging findings observed with the different imaging techniques. At X-ray we found sclerosis of clavicula in 26% of patients (Fig. 1), periosteal bone formation and sclerosis of sternum (Fig. 2) in 10% and cortical bone erosion with joint space narrowing in 23% of examined patients. The CT study demonstrated better than plain X-ray radiographs the reactive bony lesions at the level of sternoclavicular, manubriosternal and sternocostal joints while it was less available in the analysis of soft tissue involvement. In particular, CT imaging demonstrated a sclerosis of clavicula and sternum in 44% of subjects, bone erosions in 76% (Fig. 4), periosteal bone formation (Fig. 5), subchondral sclerosis and joint space narrowing in 34% of cases (Fig. 6) and

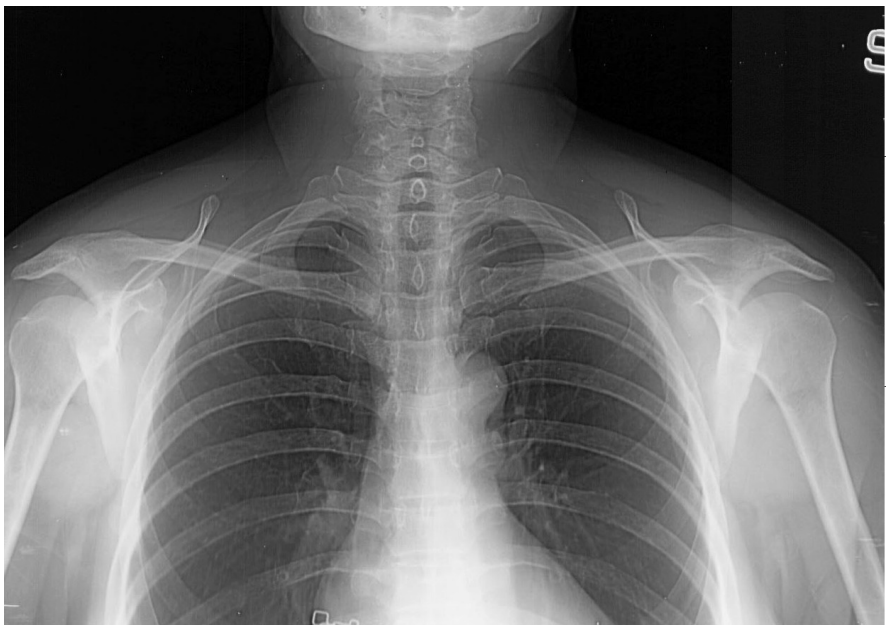

Fig. 1. Postero-anterior radiograph of the upper part of the chest demonstrates an irregularity of the articular surfaces with small erosions of the right sternoclavicular joint.

Fig. 2. X-ray oblique projection that shows the sclerosis (arrows) of the sternoclavicular joints.

ligament ossification in 41% of cases (Fig. 3). According to the classification suggested by Earwaker *et al*., using CT, we classified in our study 3 patients at stage I, 19 patients at stage II and 7 at stage III (7). In our study, CT was superior to X-ray in showing bony lesions with 18% of detected lesions with X-ray *vs*. 86% of assessed lesions by CT.

At the MRI examination, the gold standard examination in the evaluation of soft tissue involvement, we found soft tissue swelling in 56% of patients and intra-articular effusion and synovial reaction in 81% of cases. In 15 patients, MR showed a low to intermediate signal intensity on T1-w pre-contrast images (Fig. 7) and intermediate to high signal intensity on T2-w surrounded by a low signal intensity sclerotic margin (Fig. 9). In the remaining 7 patients, MR imaging demonstrated a large intramedullary area of low signal intensity on T1-w (Fig. 8) and high signal intensity on T2-w and post-contrast images consistent with a bone marrow edema pattern (Fig. 10). Associated soft tissue edema and joint effusion were present in 7 patients (Figs. 10-11). Table III compares the performance of the different techniques between patients with early symptoms with that obtained in patients with longer duration of anterior chest wall symptoms. The earliest changes we found both at X-ray and CT were sclerosis of the clavicula, sclerosis of sternum, bone erosions and subchondral sclerosis, while at MRI we found soft tissue swelling and intrarticular effusion. In advanced stages, the most common findings were periosteal bone formation, joint space narrowing and ligament ossification at X-ray and CT and synovial reaction at MRI. Radionuclide bone scintigraphy was useful in assessing the extent of involvement in the costo-clavicular region and the involvement of other anatomical sites. In this study, bone scans tended to be abnormal in areas where, radiographically, apparent alteration had not yet developed. In particular, bone scintigraphy revealed in 2 out of 19 patients the bullhead sign, which indicates an osteitic involvement both of the sternoclavicular and manubrium-sternal joints (Figs. 12a, b) (11).

Discussion

The sterno-costoclavicular joint may be difficult to visualize by conventional radiography, even if many special projections have been proposed to minimize the effect of overprojecting structures (8). Nevertheless, X-ray is the first step examination in the evaluation of sterno-costoclavicular joint, because it allows the operator to identify the first, even if aspecific, signs, and

Fig. 3. Axial CT scan using a bony window. Note the lytic areas of the manubrium sterni and soft tissue involvement.

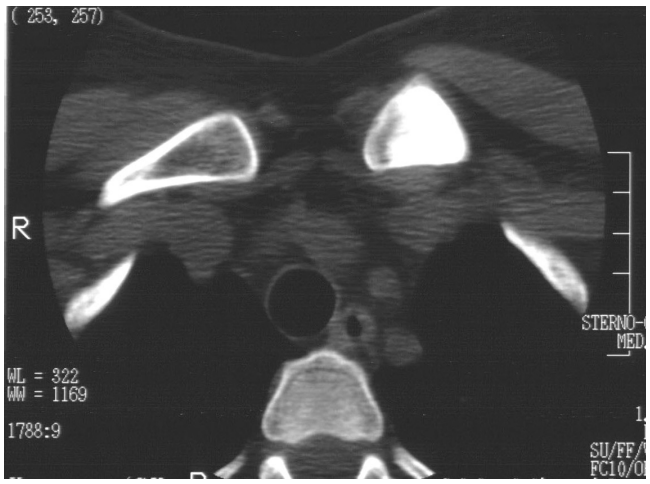

Fig. 4. Axial CT scan showing marked sclerosis with periosteal thickening at the medial end of the left clavicle.

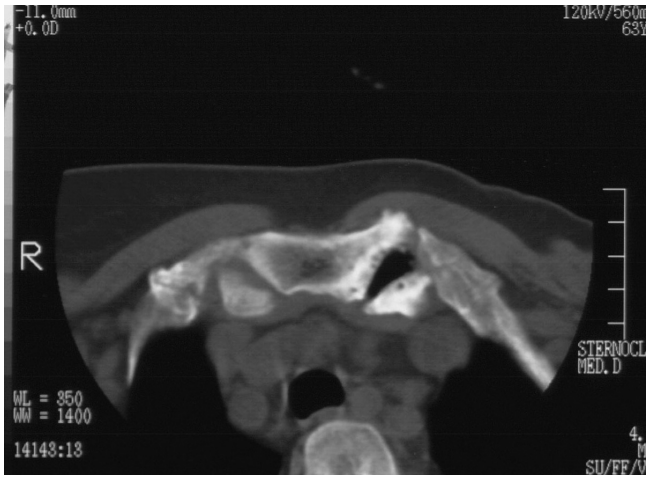

Fig. 5. Axial CT image showing erosions of the sternoclavicular joints at both sides with associated evident vacuum phenomenon at the left side.

Fig. 6. Axial CT image showing partial bony ankylosis of the left sterno-costal synchondrosis and erosions of the right sterno-clavicular joints.

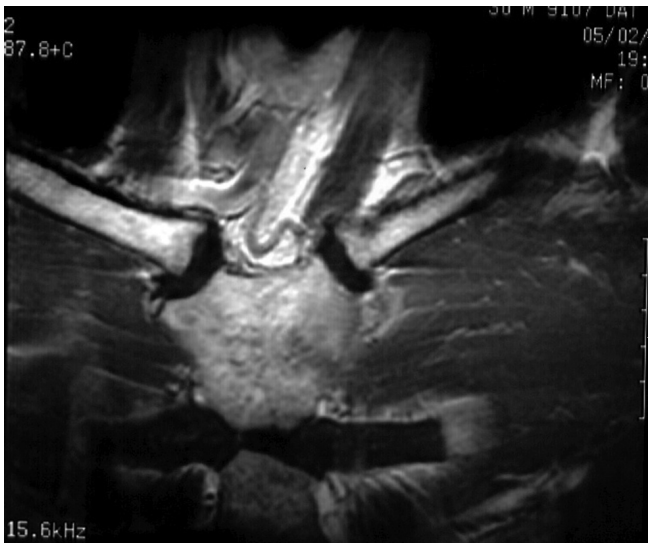

Fig. 7. Coronal T1 weighted image of the sternocostoclavicular region: the bone marrow is relatively dishomogeneous. Note also the capsular thickening.

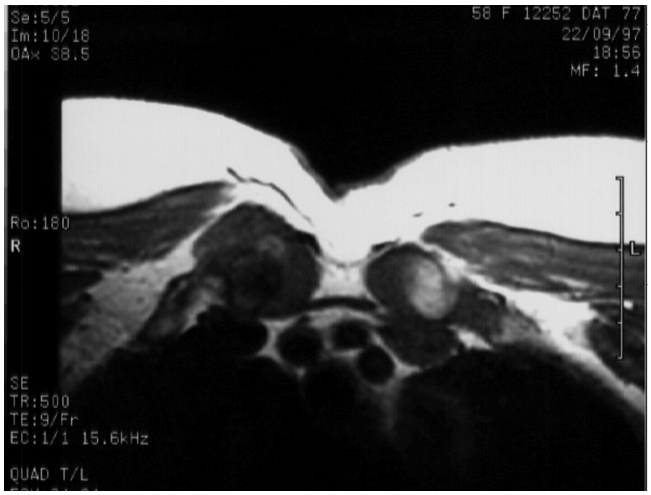

Fig. 8. Axial T1 weighted image shows an ipointense area of altered signal of the right sternoclavicular joint corresponding to capsular thickening and soft tissue involvement.

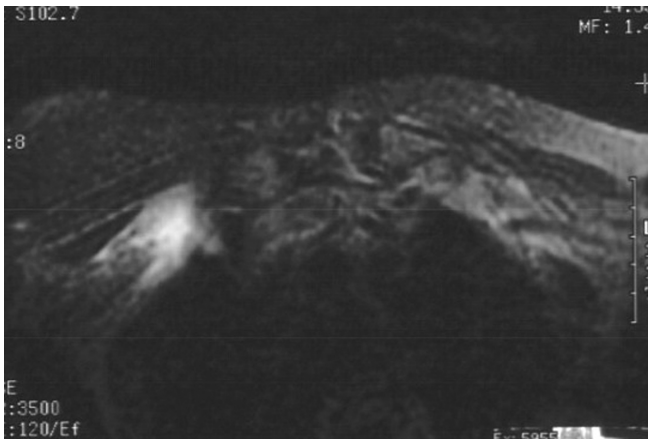

Fig. 9. Axial T2 weighted scan shows an area of increased signal on the right side corresponding to soft tissue edema.

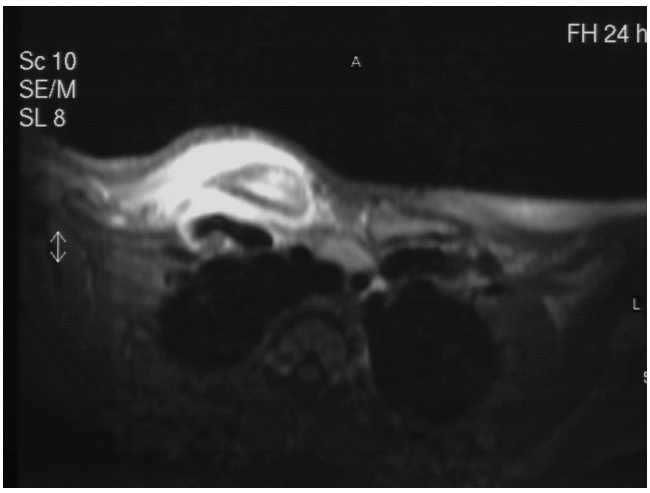

Fig. 10. Axial T1 weighted scan with fat saturation post Gd. Note the marked contrast enhancement corresponding to the soft tissue involvement and to the marrow edema at the right side.

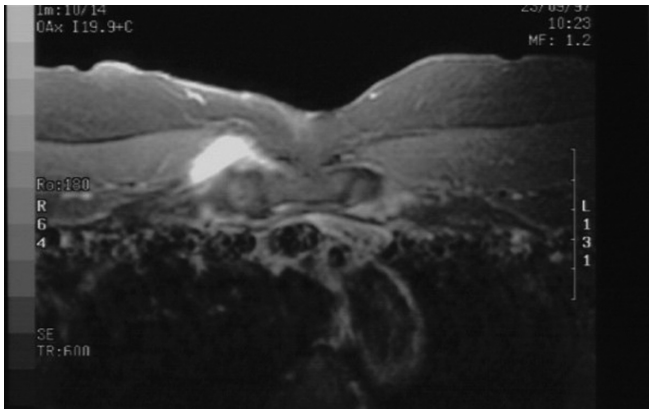

Fig. 11. Axial T1 weighted image with fat saturation, showing an area of hyperintensity corresponding to the intrarticular effusion at the right sternocostal joint.

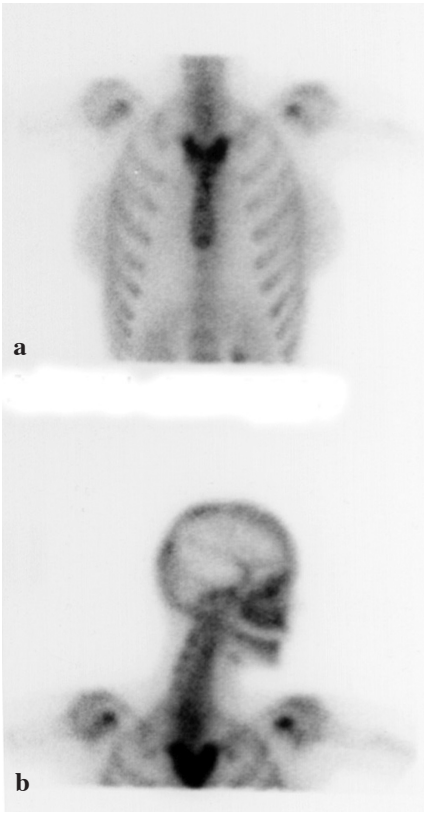

Fig. 12. a) Bone scintigraphy shows the typical symmetric high uptake of the sternocostoclavicular region like a bullhead in SCCH, the manubrium representing the skull of the bull and the horns corresponding to the inflamed sternocostoclavicular joints; **b)** a detail of the same image.

gives a global view of this anatomical region (12).

Musculoskeletal ultrasound (US) has an increasingly important role in the assessment of SpA for its ability not only to detect synovial and tendon involvement but also for the accurate imaging of enthesitis (10). Unfortunately, in our study we have only few data relating to this technique and so we can not make any conclusion about the results we have obtained.

According to Jurik *et al.*, CT is an excellent technique for the visualization of sterno-costoclavicular bones and also for the possibility of multiplanar and 3-D reconstruction, although the spatial resolution regarding bone structures is somewhat lower than that of conventional tomography. An advantage of CT is that it eliminates overlap and, in addition, provides superior soft tissue contrast (13). In fact, in our study, CT was superior to X-ray in showing bony lesions with a higher number of detected lesions by CT.

The role of MR imaging in the diagnosis of sternoclavicular joint diseases has not been defined yet, although a few descriptions of the use of MR imaging in the assessment of disorders of the sternoclavicular joint do exist (14). Our results, which are derived from a close correlation of MR images and anatomic slices, suggest that the anatomy of the sternoclavicular joint and the surrounding tissues can be demonstrated in detail. All the ligaments around the sternoclavicular joint can be delineated with conventional MR imaging sequences. The anterior and posterior sternoclavicular joints can be partially demonstrated on coronal images, can be well demonstrated on transaxial and sagittal images, and can be best

Table III. Different performance of imaging techniques in patients with early and late symptoms.

	Early symptoms	Late symptoms
X-ray	Sclerosis of clavicula 37% Sclerosis of sternum 28% Bone erosions 18%	Periosteal bone formation 58% Joint space narrowing 88%CT
CT	Bone erosions 57% Subchondral sclerosis 63% Sclerosis of clavicula 82% Sclerosis of sternum 79%	Joint space narrowing 85% Periosteal bone formation 77% Ligament ossification 72%
MRI	Soft tissue swelling 65% Intrarticular effusion 53%	Synovial reaction 75%

demonstrated on oblique images. Brossmann *et al*. reported that the interclavicular ligament can be evaluated best on coronal images, although it also can be seen on transaxial and sagittal images. The coronal and sagittal planes appear most favourable for imaging the costoclavicular ligament (15).

The intraarticular disk is best demonstrated in its entirety in the coronal plane. This disk is difficult to differentiate from the fibrocartilaginous articular surfaces on T1-weighted images unless it is calcified but it is well demonstrated on conventional MR images with T2-weighted and proton-density-weighted imaging sequences (16). In our experience, T1-w SE sequences have, more than other sequences, well demonstrated sternocostoclavicular joint involvement and degenerative alterations; while T2-w sequences and fat suppression sequences better showed articular space, articular cartilage, erosions and soft tissue swelling, T1-w with fat suppression sequences after Gd-DTPA administration allowed the detection of inflammation signs like bone marrow edema, soft tissue involvement and intrarticular effusion.

Seronegative spondyloarthropathies involving the sterno-costoclavicular joint may cause difficulties in differential diagnosis with other diseases like Ewing's sarcoma and other primary or secondary neoplasms, even if they may arise uncommonly in this area. Paget's disease of the clavicle is well known but can be excluded by plain radiographs, a high concentration of alkaline phosphatase, and other areas of pagetoid involvement (17, 18).

In our experience, bone scintigraphy is the most useful investigation for assessing the extent and intensity of the disease. CT/MRI may help in the early diagnosis of erosions and differentiation from osteomyelitis and bone tumours. Plain radiographic changes are usually seen relatively late in the course of the disease. We did not see any association with HLA-B27 or specific skin diseases apart from psoriasis and acne conglobata, while we found an association with ankylosing spondylitis, psoriatic arthritis and seronegative spondiloarthropathy in general.

There are some limitations in this research, due to the heterogeneity of the study population but also to the fact that not all the patients underwent all the imaging techniques; we aim to increase the number of the studied patients in order to demonstrate a higher number of lesions. Finally, anterior chest wall seronegative arthropathies represent a problem of difficult diagnostic and clinical organization whether for the complexity of this anatomic region or for heterogeneity of clinical and radiological features. Our study, however, demonstrated either similarities or discrepancies in the anterior chest wall involvement in the different forms of rheumatic conditions and the necessity for an integration between the various radiological techniques.

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