Ultrasound imaging for the rheumatologist XLI. Sonographic assessment of the hip in OA patients

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ABSTRACT

Objectives. *To investigate the prevalence of ultrasound (US) detectable abnormalities in the hip joints of patients with osteoarthritis (OA) and correlate them with clinical findings and measures of disease severity.*

Methods. *Consecutive patients with hip OA were investigated by clinical and US examinations. Bilateral US of the hip joints was performed by using a Logiq9 machine, equipped with a multifrequency linear probe, operating at 9 MHz; in addition, power Doppler (PD) was applied (frequency 7.5 MHz; PRF 750 Hz). Clinical evaluation included the registration of demographic data, disease duration, current and previous joint pain and Lequesne index. US study included the assessment of both inflammatory and structural abnormalities at the level of hip joint (joint effusion, synovial hypertrophy, local pathologic vascularisation at PD, osteophytes) and periarticular soft tissues (ilio-psoas bursitis, trochanteric bursitis, iliopsoas tendinopathy, gluteus medius tendinopathy and gluteus minimus tendinopathy).*

Results. *One hundred and fifty hips of 75 patients were studied. Clinical examination demonstrated the presence of current hip pain in 80% of patients and previous hip pain in 85.7% of cases. The mean Lequesne Index was 11.9±4.9. US detected effusion in 50% of the joints, synovial hypertrophy in 41.3%, PD signal in 0.7%, osteophytes in 77.3%; at periarticular level, trochanteric bursitis was found in 24.7% of patients, gluteus tendinopathy in 22.7%, iliopsoas tendinopathy in 7.3% and finally iliopsoas bursitis in 1.3%. The presence of current and previous hip pain significantly correlated with the presence of effusion (p=0.01); age and disease duration significantly correlated with the presence of osteophytes (p=0.01). Various US-detected abnormalities were found also in asymptomatic patients. Statistically significant differences between the 2 subgroups of symptomatic and asymptomatic patients were registered for effusion (p=0.003).*

Conclusions. *In hip OA, US is a useful imaging tool for analysing both inflammatory and structural damage lesions as well as for differentiating the involvement of joint structures and periarticular soft tissues. In addition, US was able to detect a wide set of abnormalities even in asymptomatic patients, confirming that it is more sensitive than clinical examination in detecting musculoskeletal involvement.*

Introduction

Osteoarthritis (OA) is the most common rheumatic disease, affecting most synovial joints. It represents a complex pathologic process involving all joint tissues with an imbalance of local turnover and repair and consequent global joint failure (1-4). Predominant involvement of the hyaline cartilage is present and is associated with bone and joint capsule abnormalities. In addition, episodic synovitis with characteristic non-destructive and non-aggressive features frequently occurs and often contributes to the appearance and worsening of symptoms (2, 3). Usually, OA appears and progressively worsens with the advance of old age, even though it may sometimes occur earlier in life. Clinically, it is characterised by use-related pain, stiffness, deformity and reduced joint motion that result in disability and work impairment (2, 4). The hip joint is frequently involved in OA, with very different disease patterns and variable natural history. Hip OA is

traditionally imaged using conventional radiographs that demonstrate the presence of characteristic structural lesions but have clear limitations in visualising soft tissue abnormalities (1, 2). Contrast-enhanced MRI might be a useful technique for diagnosis and staging of hip OA since early disease (5). However its routine use is burdened by high costs and limited equipment availability. Ultrasound (US) is a sensitive and bedside imaging tool for the assessment of most joint abnormalities in rheumatic diseases and its emerging role has been highlighted also in recently published classification criteria for specific disorders (6-12). In the last few years there has been an increasing interest on the part of investigators in the application of US in OA and a more widespread use of this tool for assessing different changes in the osteoarthritic joints has been registered (2). In addition to its emerging applications in clinical practice, many recently published studies demonstrate a new interest also of research in this field. In OA, US is able to detect a wide set of abnormalities both at joint level and in the periarticular soft tissues. However, its role in assessing hip OA is still to be defined and the majority of reports present in the literature in the field have been mainly focused on the use of US for guiding hip joint injections (13, 14).

The aims of the present study were to investigate the prevalence of US-detectable abnormalities in the hip joints of patients with OA and to correlate them with clinical findings and measures of disease severity.

Patients and methods

Consecutive patients with hip OA were included in the present multicentre study that was conducted in four Italian units of rheumatology (Sapienza Università di Roma, Università Politecnica delle Marche, Università di Pisa and Università di Pavia). All the patients met the American College of Rheumatology criteria for hip OA and were enrolled independently of disease duration and severity of clinical signs of hip involvement (15). In all subjects clinical assessment and US examination were performed for both hips.

Prior to US evaluation, an expert rheumatologist registered demographic data and disease duration. In addition, the presence/absence of previous and/or current hip joint pain was recorded. Moreover, in all cases the Lequesne index was used to assess the severity for OA of the hip (16).

The presence of any other rheumatic disease and history of either severe trauma or surgery of the hip were the criteria for exclusion from the study.

The study was conducted according to the Declaration of Helsinki and local regulations, and informed consent was obtained from all the patients.

US scanning technique

Prior to patient enrolment, the US examination methodology was clarified among sonographers and a consensus was obtained on scanning protocol and image interpretation. In the 4 units participating in the study, US examination was separately and independently performed by a single ultrasonographer who was a rheumatologist experienced in musculoskeletal US and was blinded to the clinical findings.

Bilateral US of the hip joints was performed on the same day as the clinical evaluation by using a Logiq9 machine (General Electrics Medical Systems, Milwaukee, WI), equipped with a multi-frequency linear probe, operating at 9 MHz. At the beginning of each scanning session, the focus was positioned at the level of the region of interest. In addition, power Doppler (PD) was applied (frequency 7.5 MHz; PRF 750 Hz). The colour box was positioned at the level of the joint area to be examined, enlarging the box to the upper part of the image. Colour gain was adjusted just below the degree that caused the appearance of noise artefacts (17).

The patients were examined while lying supine, with the hips in neutral position and the heels together (18-20). A standardised anterior longitudinal scan (oblique sagittal plane along the axis of the femoral neck) was performed in order to visualise the bony profile of the femoral head and neck, the joint capsule as well as the iliopsoas tendon and bursa (18). The trochanteric area for the study of gluteus tendons and bursa was assessed by performing longitudinal and transverse scans with the patients on the opposite lateral position. US examinations were carried out after an abundant amount of gel was applied to the skin to provide an appropriate acoustic interface; particularly for the trochanteric area, attention was made to avoid applying probe pressure on the anatomical structures under examination. During the same scanning session, US was initially performed in B-mode modality with the aim of detecting morphological changes and immediately afterwards by using PD technique searching for local abnormal vascularisation. According to commonly used international definitions of pathological findings and including the assessment of both inflammatory and structural abnormalities, the following changes were registered (18, 20-22):

a) Hip joint abnormalities: joint effusion (JE), joint synovial hypertrophy (SH), local pathologic vascularisation at PD, osteophytes;
b) Periarticular soft tissues abnormalities: ilio-psoas bursitis, trochanteric bursitis, iliopsoas tendinopathy, gluteus medius tendinopathy and gluteus minimus tendinopathy.

Each pathological US finding was confirmed in two perpendicular planes. All US-detected lesions were registered according to a dichotomous (presence/absence) score.

Statistical analysis

The statistical calculations were made using Statistical Package for Social Sciences 13.0 (SPSS, Chicago, IL, USA) and GraphPad 5.0 (La Jolla, CA, USA).

Normally distributed variables were summarised using the mean±SD, and non-normally distributed variables by the median and range. Percentages were used for the prevalence of the alterations. Wilcoxon's matched pairs test and paired *t*-test were performed. Univariate comparisons between nominal variables were calculated using chi-square (χ^2) test or Fisher's exact test. Two-tailed *p*-values were reported; *p*-values less than or equal to 0.05 were considered significant.

Results

Seventy-five patients (29 males and 46 females) were studied. A total of 150 hip joints were examined both by clinical examination and US assessment.

Patients' demographic and clinical characteristics are reported in Table I.

The presence of current hip pain was registered in the majority of patients (80%) and was principally localised at the left hip (66.6%) with respect to the contralateral side (61.2%). A history of hip pain during previous years was referred by 85.7% of patients and was localised at the level of the right hip in 69.4% of cases and at the left hip in 67.3% of joints.

The mean Lequesne Index was 11.9±4.9.

The results of US-detected abnormalities at the level of joint structures and periarticular soft tissues are reported in Table II.

JE was the most frequent finding, and was detected in 46/75 patients (61.3%) corresponding to 50% of evaluated hip joints (Fig. 1a-b). The right and left hips were similarly affected (50.7% *vs*. 49.3%).

Interestingly, SH was identified in 31/75 subjects (41.3%) and 34.6% of joints. Also in this case, the right and left hips were similarly involved (36% *vs*. 33.3%).

PD signal was detected only in 1 joint (0.7%) of 1 patient (1.3%).

Osteophytes were imaged in the majority of cases (81% of patients; 77.3% of joints; right *vs*. left hip 80% *vs*. 74.6%) (Fig. 1b-c).

US assessment of periarticular soft tissues demonstrated that trochanteric bursitis was the most frequent finding (45.3% of patients; 24.7% of sites), followed by gluteus medius/minimus tendinopathy (28% of subjects; 22.7% of sites) (Fig. 1d), iliopsoas tendinopathy (10.6% of patients; 7.3% of sites) and, finally, iliopsoas bursitis (2.6% of subjects; 1.3% of sites).

The analysis of the correlations between clinical features and US findings at the level of the hip joint demonstrated that the presence of current hip pain as well as a history of hip pain significantly correlated with the presence of JE (p=0.01) (Table III). In addition, both mean age and mean disease duration significantly correlated with the presence of osteophytes (p=0.01) (Table III). On the contrary, no differences were found between subjects with or without US synovial hypertrophy in terms of age, disease duration, previous or present hip pain and, finally, the Lequesne index from patients with normal US findings.

Concerning the relationships between clinical findings and US abnormalities detected at the level of periarticular soft tissues, patients with US changes did not differ significantly in terms of all clinical variables examined (Table IV).

Patients were then divided into 2 subgroups, according to the presence or absence of symptoms. US-detected features in asymptomatic patients as well as in symptomatic subjects and the differences between the 2 subgroups are reported in Table V. Fifteen subjects did not refer any pain in both hips at the time of enrolment. However, 20% of them had JE. Similarly, in 20% of asymptomatic cases US detected SH. In addition, 26.6% of them had signs of trochanteric bursitis. Finally, gluteus medius or minimus tendinopathy was demonstrated in 9.3% of asymptomatic cases. All symptomatic patients had one or more signs of pathological involvement at US assessment, being osteophytes the most frequent finding (76.6%), followed by JE (71.6%), trochanteric bursitis (50%), SH (46.6%), gluteus medius or minimus tendinopathy (23.3%); finally, iliopsoas tendinopathy and PD signal were rarely found (13.3% and 1.6%, respectively).

Statistically significant differences between the 2 subgroups of patients were registered in terms of JE which was present in 3 asymptomatic patients *vs*. 43 subjects with symptoms (p=0.003).

No significant differences were found in the 2 subgroups, concerning the values of the Lequesne Index (subgroup 1= 0–10; subgroup 2 = 1–20).

Table I. Patients demographic and clinical characteristics.

	Patients (n=75)	Joints (n=150)	
		Right hip (n=75)	Left hip (n=75)
M/F	29/46	–	–
Mean age±SD (years)	71.7 ± 7.5	–	–
Mean disease duration±SD (months)	70.8 ± 72.2	–	–
Clinical evaluation			
Previous hip pain (n/%)	64 (85.7)	52 (69.4)	50 (67.3)
Current hip pain (n/%)	60 (80)	46 (61.2)	50 (66.6)
Lequesne index (mean±SD)	11.9 ± 4.9	–	–

Table II. US-detected abnormalities at the level of the hip joint and periarticular soft tissues.

US-detected abnormalities	Patients (n=75)	Joints (n=150)	Right hip (n=75)	Left hip (n=75)
Hip joint				
Joint effusion (n/%)	46 (61.3)	75 (50)	38 (50.7)	37 (49.3)
Synovial hypertrophy (n/%)	31 (41.3)	52 (34.6)	27 (36)	25 (33.3)
Power Doppler signal (n/%)	1 (1.3)	1 (0.7)	1 (1.3)	0
Osteophytes (n/%)	61 (81.3)	116 (77.3)	60 (80)	56 (74.6)
Periarticular soft tissues				
Iliopsoas bursitis (n/%)	2 (2.6)	2 (1.3)	1 (1.3)	1 (1.3)
Trochanteric bursitis (n/%)	34 (45.3)	37 (24.7)	14 (18.7)	23 (30.6)
Iliopsoas tendinopathy (n/%)	8 (10.6)	11 (7.3)	6 (8.0)	3 (4.0)
Gluteus medius / minimus tendinopathy (n/%)	21 (28.0)	34 (22.7)	14 (18.6)	20 (26.6)

Discussion

Hip OA is a common disease that affects a large part of the elderly population. US has demonstrated its ability to play a relevant role in the detection of many alterations at the level of different synovial joints in OA. However, its applications so far, particularly in patients with hip involvement, have been

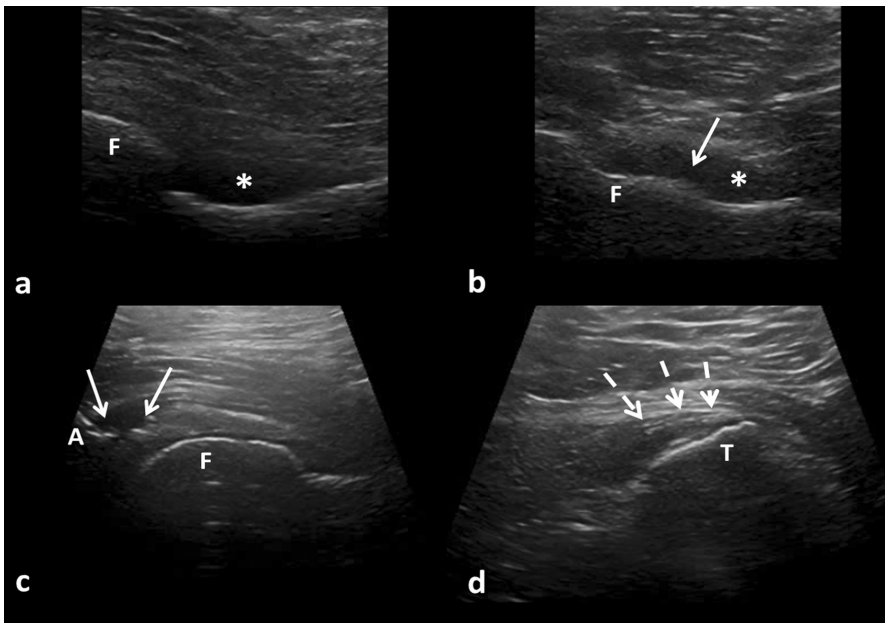

Fig. 1. Ultrasound of the hip in osteoarthritis. **a.** longitudinal anterior scan. Image representative of joint effusion (*). **b.** longitudinal anterior scan. Presence of joint effusion (*) and an osteophyte (↑). **c.** longitudinal anterior scan. Marginal osteophytes (↑) imaged at the level of the femoral and acetabolar aspects of the joint **d.** Longitudinal lateral scan. Gluteus medius and minumus tendinopathy (dotted line) with evidence of loss of the tendon's fibrillar pattern, hypoechogenicity and calcifications. **F**: femur; **A**: acetabulum; **T**: great trochanter.

substantially focused on the execution of US-guided intra-articular injections (13, 14, 23-27). This aspect resembles other diseases, in which very few reports exist in the literature about the US assessment of the hip joint, even though an increasing number of studies have been developed about the evaluation of other synovial joints (28-31).

As far as we know, for the first time the present study, focused on the investigation of the prevalence of different US-detectable abnormalities in patients with hip OA and on their correlations with clinical findings and measures of disease severity, demonstrated that a wide range of changes may be present at hip level. In addition, the involvement of both joint structures and periarticular soft tissues was shown with findings that were related to inflammation as well as to structural lesions. Particularly, in terms of inflammatory abnormalities, two of the components of synovitis (*i.e.* JE and SH) were frequently detected, since they were present in the most of the joints. Conversely, PD signal was a very rare finding that was shown only in a single hip joint of 1 patient. This last result is in line with the results of other studies assessing the hip joints in patients with different rheumatic diseases and can be interpreted with the reduced sensitivity of US equipment in the assessment of deep areas respect to superficial joint structures (28-30). Even though OA is predominantly characterised by degen-

Table III. Correlations between clinical features and US findings at the level of the hip joint.

	Joint effusion			Synovial hypertrophy			Osteophytes		
	Present	Absent	*p*-value	Present	Absent	*p*-value	Present	Absent	*p*-value
Mean age±SD (years)	71.3 ± 6.1	72.3 ± 9.4	NS	71.5 ± 5.6	71.8 ± 8.6	NS	72.8 ± 7.6	66 ± 3.7	0.01
Mean disease duration±SD (months)	60 ± 46.8	97.8 ± 99.4	NS	67.9 ± 51.2	72.8 ± 84.6	NS	79.2 ± 76.7	36.2 ± 44.8	0.01
Previous hip pain (%)	93.3%	73.7%	0.001	90%	82.7%	NS	82.5%	100%	NS
Current hip pain (%)	93.3%	57.9%	0.001	90%	72.4%	NS	82.5%	100%	NS
Mean Lequesne Index±SD	12.6 ± 5.3	11.1 ± 4.3	NS	12.7 ± 5.6	11.2 ± 4.2	NS	11.2 ± 5.0	10.3 ± 5.2	NS

PD signal was not included because it was present only in 1 joint of a single patient.

Table IV. Correlations between clinical features and US findings at the level of periarticular soft tissues.

	Trochanteric bursitis			Iliopsoas tendinopathy			Gluteus tendinopathy		
	Present	Absent	*p*-value	Present	Absent	*p*-value	Present	Absent	*p*-value
Mean age±SD (years)	71.0 ± 4.9	72.3 ± 9.1	NS	73.2 ± 3.9	71.6 ± 7.8	NS	72.1 ± 9.2	71.6 ± 6.9	NS
Mean disease duration±SD (months)	71.4 ± 65.4	70.3 ± 78.6	NS	43.2 ± 16.1	73.9 ± 75.5	NS	76.3 ± 99.3	68.6 ± 59.8	NS
Previous hip pain (%)	86.4%	85.2%	NS	80%	86.4%	NS	85.7%	85.7%	NS
Current hip pian (%)	86.4%	74.1%	NS	80%	77.2%	NS	64.3%	85.7%	0.01
Mean Lequesne Index±SD	12.5 ± 5.7	11.7 ± 4.1	NS	16.5 ± 1.9	11.3 ± 4.8	NS	12.3 ± 4.2	11.6 ± 5.4	NS

Iliopsoas bursitis was not included because it was present only in 2 cases.

erative findings which involve mostly the hyaline cartilage with associated bone and joint capsule abnormalities, synovitis may occur during the disease course and it has the characteristic non-destructive and non-aggressive features. It has been demonstrated that US is a sensitive tool for imaging synovitis and represents a valuable modality for assessing patients with inflammatory joint involvement. However, at hip joint level the US detection of Doppler signal within the synovial inflamed tissue is very difficult, in the great majority of cases, due to some technical limitations that influence the sensitivity of US (17, 18). On the contrary, JE and SH which represent the other 2 components of synovitis are easily detected at hip joint level where US can, therefore, be considered a useful tool for demonstrating these particular findings. This aspect may have relevant implications, particularly when considering the difficult detection of hip synovitis by physical examination, due to the deep anatomic location of that joint. Thus, the use of US when evaluating patients with hip OA may have a relevant role and can be considered as an integral part of the joint assessment, to be combined with physical examination as a complementary tool.

In addition, when synovitis appears in OA, it usually contributes to the appearance and worsening of symptoms. Interestingly, in the present study, the presence of current hip pain as well as a history of previous hip pain correlated with the evidence of JE by US. JE is a fundamental component of joint inflammation in hip OA and is also a relevant indicator of joint burden. This latter finding support the validity of US hip assessment in hip OA, when considering symptoms as the reference method.

As expected, osteophytes were detected in a large part of the assessed joints and, moreover, their presence significantly correlated both with age and disease duration. These findings are in line with the complex pathologic process of OA which is characterised by a wide set of abnormalities that include also bone involvement with osteophyte formation. All these structural lesions appear early during the disease course and progressively worsen with the advance of disease duration as well as with increasing of age.

Table V. US-detected features in asymptomatic patients respect to symptomatic patients.

	Asymptomatic patients (n=15; 20%)	Symptomatic patients (n=60; 80%)	*p*-value
Hip joint			
Joint effusion (n/%)	3 (20.0)	43 (71.6)	0.0003
Synovial hypertrophy (n/%)	3 (20.0)	28 (46.6)	NS
Power Doppler signal (n/%)	0	1 (1.6)	NS
Osteophytes (n/%)	15 (100)	46 (76.6)	NS
Periarticular soft tissues			
Iliopsoas bursitis (n/%)	0	2 (3.3)	NS
Trochanteric bursitis (n/%)	4 (26.6)	30 (50)	NS
Iliopsoas tendinopathy (n/%)	0	8 (13.3)	NS
Gluteus medius / minimus tendinopathy (n/%)	7 (9.3)	14 (23.3)	NS

In our study, periarticular soft tissue abnormalities were a frequent finding, particularly in terms of involvement of the trochanteric area, with US evidence of trochanteric bursitis as well as gluteus medius and minimus tendinopathy. Even though OA is a disease which characteristically affects joint structures, these findings can be explained by the presence of mechanical abnormalities due to the complex joint osteoarthritic pathological process. Mechanical imbalance, indeed, may cause secondary alterations of local periarticular structures, particularly at the level of the lateral hip. Trochanteric involvement is a frequent finding in patients with hip pain and loco-regional pathology, but has never been reported to be related to hip OA. Applied in this clinical setting, the presence of US-detected pathology at the level of trochanteric bursa and gluteus tendons could be either a non-specific picture or a particular finding that might be due to consequences of mechanical abnormalities due to joint disease that lead to difficult or abnormal gait.

This particular aspect can also explain the lack of correlations between US abnormalities detected at the level of periarticular soft tissues and all clinical variables examined, both in terms of patient's characteristic and local symptoms.

Interestingly, when patients were subgrouped according to the presence of current hip pain, pathologic findings were detected also in asymptomatic joints, without any clinical evidence of inflammatory involvement. Except for the presence of JE that resulted to be significantly more frequent in the group of symptomatic with respect to asymptomatic patients, all the other findings were similarly detected in both subgroups. This feature confirms the results obtained by previous studies that have underlined the higher sensitivity of US respect to clinical examination particularly in the detection of joint inflammation, and the capability of US of detecting a wide set of abnormalities, including subclinical synovitis (32-39). Interestingly, in addition to synovial involvement, osteophytes were demonstrated by US in all asymptomatic cases. This finding confirms that structural bony cortex lesions are an integral part of the complex pathology that develop in OA and that they can be present independently of joint pain.

This study carries a relevant limitation represented by the lack of data in terms of cartilage involvement. OA is, indeed, a pathologic process characterised by predominant involvement of the hyaline cartilage. It would be therefore of interest to investigate the prevalence of cartilage abnormalities and its relationship both with clinical features and measures of disease severity. A further linitation of this study is represented by the assesssment of US findings in terms of presence/absence. However, for hip US, the relatively limited acoustic window available to the US beam makes detailed examination of hyaline cartilage impossible, since the sonographic visualisation is limited to a small portion that is, in addition, the most peripheral part of cartilage which is outside

the weight-bearing area, where most of the abnormalities appear in OA.

However, to the best of our knowledge, the present study represents the first report investigating the role of US in the assessment of hip joint in OA, by evaluating both articular and periarticular involvement as well as inflammatory and structural lesions. Further studies on larger populations are warranted to better define the validity of this imaging tool in this common and complex pathology.

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