Joint Bone Spine 83 (2016) 669–674

Available online at ScienceDirect www.sciencedirect.com

Elsevier Masson France EM|consulte www.em-consulte.com/en

Original article

Contrast-enhanced ultrasound in coxitis

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ARTICLE INFO

Article history:
Accepted 19 October 2015
Available online 7 April 2016

Keywords:
Hip
Coxitis
Contrast-enhanced ultrasound
Doppler

ABSTRACT

Objectives: Hip involvement is common in rheumatological diseases but can be difficult to diagnose, especially in absence of MRI. B-mode ultrasound (US) detects joint capsule distention while distinguishing effusion from proliferative synovial tissue is strenuous since both appear hypoechoic. Power Doppler ultrasound (PDUS) often fails to detect vascularisation in the hip. We therefore evaluated contrast-enhanced ultrasound (CEUS) in the hip joint.
Methods: We investigated 36 hip joints of patients with known rheumatological joint diseases presenting with hip pain and 5 hips of healthy controls using B-mode US, PDUS and CEUS. We assessed CEUS hypervascularisation semiquantitatively comparing to the periarticular tissue. In B-mode, we measured the distance between femoral neck and joint capsule (DNC) and compared the results to the avascular intraarticular margin (AIM) in CEUS using *t*-tests and crosstables.
Results: PDUS signals were received in only 2/36 cases (5.6%). B-mode US established the diagnosis of coxitis in 64% of all symptomatic hip joints. In 4 cases (11%), the diagnosis was revised after the use of CEUS. In patients with definite coxitis, 14 hips (73.7%) showed CEUS hypervascularisation°2, five°1 (26.3%) and none°0 ($\chi^2 = 3.277$, $P < 0.001$). The difference DNC/AIM was highly significant in patients with hip pain ($P < 0.001$, 95% CI: 2.054–4.684) and those with definite coxitis ($P < 0.001$, 95% CI: 3.268–7.258).
Conclusions: In most cases, clinical parameters together with B-mode US findings are sufficient to diagnose coxitis. However, CEUS is capable of visualizing and quantifying the degree of hypervascularisation and enables the discrimination between effusion and proliferative synovial tissue.

1. Introduction

In inflammatory joint diseases like rheumatoid arthritis (RA), spondyloarthritis (SpA) and others ultrasound (US) is superior to clinical examination in detecting active synovitis [1,2]. However distinguishing collection from inflammatory intraarticular tissue has often proven difficult in B-mode sonography alone. The introduction of color Doppler (CDUS) and power Doppler ultrasound (PDUS) in the assessment of synovial vascularization has greatly improved the differentiation of inflammatory pannus from effusion or avascular tissue like necrosis or fibrosis. However, Doppler based US is limited by the size of the vessels, the blood flow within the vessel and the direction of scanning. The use of contrast-enhanced ultrasound (CEUS) allows a more sensitive visualization of small, low-flow blood vessels compared to B-mode and Doppler based US [3–6] and therefore improves early detection of subclinical synovitis.

The significance of CEUS in RA has been evaluated by many authors [3,7–9]. Although CEUS has not found its way into the EULAR (European league against rheumatism) or ACR (American college of rheumatology) RA classification criteria up to now [10], many reports can be found that CEUS is more sensitive than CDUS/PDUS in early detection of synovitis [11,12] and its accuracy can compete with gadolinium enhanced MRI [13].

Virtually all these studies investigated RA patients and therefore have focused on the evaluation of small and medium-size joints. Very little is known for large joints, especially the hip. In large joints such as knee and hip PDUS signals are rarely received due to the greater distance between the synovia and the transducer head [14,15], which is even more aggravated, by increasing numbers of obese patients [16]. This strongly suggests the use of contrast agents in these cases. Wamser et al. investigated CEUS in shoulder joints of RA patients without showing any benefit in the detection of synovitis compared to MRI [9]. Others investigated knee and sacroiliac joints [4,17]. To the best of our knowledge we are the first group to focus the investigation on CEUS in the hip joint.

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http://dx.doi.org/10.1016/j.jbspin.2015.10.012
1297-319X/

2. Methods

We retrospectively analyzed a total of 23 patients from our joint database. Eighteen presented with uni- or bilateral hip pain to our department of rheumatology, all of which had an underlying inflammatory joint disease at the time of investigation. Five were asymptomatic regarding their hips with no spontaneous pain at hip level and no signs of joint inflammation at physical examination. These patients received CEUS for other reasons than hip pain (e.g. due to a focal liver lesion) and were included as healthy controls. At the time of the investigation none of the control patients had symptoms regarding their hip joints nor did they present with a history of inflammatory or degenerative joint diseases. All patients gave written consent regarding their participation. We obtained the medical history from all patients and every patient underwent a physical examination of the hip joints. The latter included palpation of the greater trochanter and inguinal region, maximum flexion as well as internal and external rotation. In each symptomatic patient both hips were investigated by gray-scale B-mode US, PDUS and CEUS. The relevant patient data is listed in Table 1. We used an Aplio 400 (Toshiba, Minato, Japan) with a curved array multifrequency (3–7 MHz) transducer head. A total of three sonographers performed the investigations for our study. Each case was evaluated by two physicians simultaneously. Uncertain results were debated and consensus was reached. All examiners were trained in joint and contrast-enhanced sonography by the standards provided by the German Society of Ultrasound in Medicine (DEGUM) and had a minimum of three years of experience. Two of the three sonographers were certified DEGUM level 2 and 3 respectively (3 being the highest level of expertise, i.e. ultrasound trainer).

2.1. B-mode sonography

B-mode US was performed in the ventral longitudinal, ventral transversal and lateral axis. The latter was conducted in maximal flexion of the hip joint with the patient lying on the opposite side [18]. We measured the distance neck-capsule (DNC), which is the maximum extension of the hypoechoic area between the femoral neck and the iliofemoral ligament as proposed by other authors [15,16,19]. To guaranty comparability this measurement was only permitted when the acetabular rim, the femur head with the joint recess and the femoral neck were in axial alignment as shown in Fig. 1.

2.2. Power Doppler ultrasound (PDUS)

In each aspect every hip joint was checked for PDUS signals that were graded into four degrees (0: no signals. 1: ≤ 3 isolated Doppler

Table 1
Overview of patient characteristics.

#	Sex	Age	Dx	Treatment	Side	Hip pain	PDUS vasc.	CEUS vasc.	DNC B-mode [mm]	AIM CEUS [mm]
1	M	55	RA	None	L	No	°0	°0	6.0	6.0
1	M	55	RA	None	R	Yes	°0	°1	8.0	0.0
2	M	82	RA	MTX, GC	L	Yes	°1	°1	9.9	9.5
2	M	82	RA	MTX, GC	R	Yes	°1	°1	4.6	4.5
3	F	40	AOSD	MTX, GC	L	Yes	°0	°2	6.6	6.0
3	F	40	AOSD	MTX, GC	R	Yes	°0	°0	4.0	4.0
4	M	61	RA	MTX, GC	L	Yes	°0	°2	11.0	2.0
4	M	61	RA	MTX, GC	R	Yes	°0	°2	11.0	5.0
5	F	84	RA	Unknown	L	Yes	°0	°2	6.6	11.0
5	F	84	RA	Unknown	R	Yes	°0	°0	5.8	5.8
6	M	54	REA	MTX	L	Yes	°0	°2	7.0	0.0
6	M	54	REA	MTX	R	Yes	°0	°2	10.5	0.0
7	F	34	BD	CsA, GC	L	Yes	°0	°0	4.5	4.5
7	F	34	BD	CsA, GC	R	Yes	°0	°0	4.9	4.9
8	M	73	RA	ETC, GC	L	No	°0	°0	2.0	2.0
8	M	73	RA	ETC, GC	R	Yes	°0	°2	5.2	5.0
9	F	55	SpA	IFX, MTX	L	Yes	°0	°2	8.0	3.0
9	F	55	SpA	IFX, MTX	R	No	°0	°2	12.0	4.0
10	F	48	RA	None	L	Yes	°0	°2	8.0	5.5
10	F	48	RA	None	R	No	°0	°0	2.0	2.0
11	F	63	SpA	Unknown	L	No	°0	°0	2.1	2.1
11	F	63	SpA	Unknown	R	Yes	°0	°2	5.8	0.0
12	M	47	RA	None	L	Yes	°0	°1	8.0	0.0
12	M	47	RA	None	R	Yes	°0	°1	9.0	0.0
13	F	71	MCTD	HCQ	L	Yes	°0	°0	2.0	2.0
13	F	71	MCTD	HCQ	R	Yes	°0	°2	4.7	4.5
14	M	71	RA	None	L	Yes	°0	°0	3.4	3.4
14	M	71	RA	None	R	Yes	°0	°1	3.7	2.2
15	F	26	SpA	SSZ	L	No	°0	°1	3.6	0.0
15	F	26	SpA	SSZ	R	Yes	°0	°1	6.2	0.0
16	M	73	OA	NSAID	L	Yes	°0	°0	2.0	2.0
16	M	73	OA	NSAID	R	Yes	°0	°2	7.4	0.0
17	F	18	SpA	Unknown	L	No	°0	°1	4.9	0.0
17	F	18	SpA	Unknown	R	Yes	°0	°1	7.8	0.0
18	F	66	RA	None	L	Yes	°0	°2	10.0	0.0
18	F	66	RA	None	R	No	°0	°1	5.0	0.0
19	M	73	Co	None	R	No	°0	°0	3.4	3.4
20	F	43	Co	None	R	No	°0	°0	2.8	2.8
21	M	34	Co	None	R	No	°0	°0	3.0	3.0
22	F	65	Co	None	R	No	°0	°0	5.2	5.4
23	F	28	Co	None	R	No	°0	°0	3.2	3.2

#: patient number; F: female; M: male; L: left; R: right; RA: rheumatoid arthritis; SpA: spondyloarthritis/psoriatic arthritis; OA: osteoarthritis; AOSD: adult onset Still's disease; BD: Behçet's disease; MCTD: mixed connective tissue disease; REA: reactive arthritis; Co: control; GC: glucocorticoids; MTX: methotrexate; ETC: etanercept; IFX: infliximab; SSZ: sulfasalazine; HCQ: hydroxychloroquine; CsA: ciclosporin A; NSAID: non-steroidal anti-inflammatory drugs; DNC: distance neck-capsule; AIM: avascular intraarticular margin; PDUS: power Doppler ultrasound; CEUS: contrast-enhanced ultrasound.