



## Contrast-enhanced ultrasound in the differentiation between phlegmon and abscess in Crohn's disease and other abdominal conditions



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### ARTICLE INFO

#### Article history:

Received 15 April 2013

Received in revised form 22 May 2013

Accepted 25 May 2013

#### Keywords:

Abdominal abscess

Phlegmon

Contrast-enhanced ultrasound

Crohn's disease

Appendicitis

### ABSTRACT

**Aim:** To evaluate the diagnostic accuracy of the contrast-enhanced ultrasound (CEUS) to differentiate between intra-abdominal phlegmon and abscess.

**Methods:** We retrospectively reviewed all contrast-enhanced ultrasound performed between June 2006 and May 2012 to identify patients with the terms “inflammatory mass”, “phlegmon” or “abscess” on the sonographic report. The initial CEUS report was used for the diagnosis of phlegmon or abscess.

**Results:** 71 inflammatory masses in 50 patients were identified in CEUS examination. 57 masses, 21 phlegmons and 36 abscesses, were confirmed by other imaging techniques, percutaneous drainage or surgery. CEUS specificity for the diagnosis of abscess was 100%. Kappa coefficient between CEUS and other techniques in the diagnosis of phlegmon or abscess was excellent ( $\kappa=0.972$ ). Only in one patient surgery detected a small abscess (<2 cm) within a phlegmon that not was detected by CEUS. Statistically significant differences were found between the size of the abscesses before and after contrast agent injection. The interobserver agreement in the diagnosis of phlegmon or abscess was excellent ( $\kappa=0.953$ ).

**Conclusions:** CEUS is an accurate method for differentiating between intra-abdominal phlegmon and abscess in gastrointestinal conditions, especially in CD. Its use may help to better define the size of the collections and avoid other techniques that use ionizing radiation. CEUS should be used to confirm an inflammatory mass identified at US.

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### 1. Introduction

Sealed-off perforation of the gastrointestinal tract results in the development of an ill-defined inflammatory mass or phlegmon around the perforated site, which can contain discrete fluid collections or abscesses. Both, phlegmon and abscess can be caused by Crohn's disease (CD), as well as other inflammatory conditions of the gastrointestinal tract and peritoneum, such as appendicitis, diverticulitis or the local reaction to a perforated malignant neoplasm [1,2].

The differentiation between phlegmon and abscess has important implications for patient management, since abscesses may sometimes require surgical or percutaneous drainage whereas

phlegmons usually respond to medical treatment. Moreover, in CD newer therapies such as biological agents (anti-tumor necrosis factor antibodies, anti-TNF), excluding an abscess is mandatory before starting a treatment course; the presence of a well-defined abscess can be associated to both a high failure rate and a significant risk of an overwhelming sepsis [2–5].

Cross-sectional images, computed tomography (CT), magnetic resonance (MRI) or ultrasound (US), can be used to differentiate between abscesses or phlegmons. Graded compression sonography has proven to be of significant value in the assessment of patients with possible acute appendicitis or diverticulitis [6,7]. Bowel ultrasound (US) is also an alternative imaging technique for the diagnosis and follow-up of patients with CD, being as accurate as CT and MR for detecting intramural and extramural extension of the disease [8,9]. US has advantages over CT and MRI: it's free of ionizing radiation, non-invasive, well tolerated and easily repeatable in follow-up.

The sensitivity of color Doppler US for the diagnosis of abscesses in patients with CD ranges from 81% to 100%, with specificities in the range of 92–94% [10–14]. A comparison of US and CT for the

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identification of abscesses in the study by Maconi et al. [12] showed that abscesses were correctly detected in a high and similar proportion of cases by means of US (90.9%) and CT (86.4%), although accuracy was higher for CT (92%) than for US (87%) because of a higher number of false positive results in US.

On US and color Doppler examination a phlegmon appears as a hypoechoic mass with poor margination within the inflamed echogenic perienteric fat, without internal color Doppler signals [15]. On the other hand, abscesses are present as hypoechoic fluid collections with an irregular wall and peripheral flow on color Doppler [16]. However, we agree with other authors, that in clinical practice it may be difficult to distinguish a phlegmonic infiltrate from an abscess if gas, fluid or clear signals of color Doppler in their interior are missing [12,15,17,18].

Contrast-enhanced ultrasound (CEUS) is a new technique that involves intravenous administration of an ultrasound contrast agent in a real-time examination, providing an accurate depiction of the bowel wall microvasculature and the perienteric tissues. The preliminary experience with first-generation US Doppler-enhancing air-filled contrasts (Levovist®), confirmed it as a sensitive method to differentiate between a phlegmon and an abscess [19].

Second-generation US contrast agents are filled with gases other than air. These new US contrast agents allow real-time imaging of microbubble signals, due to their physical properties. Many authors based on isolated case reports suggest that CEUS could be extremely useful in distinguishing between these two types of inflammatory masses since phlegmons show intra-lesional enhancement, while in abscesses only partial enhancement is observed [20–22]. However, as far as we know, the usefulness of second-generation US contrast in the evaluation of inflammatory masses has not been studied in a series of patients.

The purpose of the study was to evaluate the diagnostic accuracy of CEUS to differentiate between phlegmon and abscess in the peritoneal cavity.

## 2. Materials and methods

### 2.1. Patients

We performed this retrospective study after receiving approval from the local Ethics Committee of our hospital. Our Institutional Review Board waived requirement for informed consent given the retrospective nature of our study. In our 600-bed community hospital, every patient with acute or subacute abdominal pain is admitted for US evaluation. Moreover, we always initially perform US to rule out the presence of complications in patients with CD and clinical relapse. A CEUS examination is always performed if an inflammatory mass is detected in the sonographic examination.

Patients who underwent scheduled or urgent CEUS for gastrointestinal application in our hospital between June 2006 and May 2012 were identified retrospectively through a computerized database that stores and codes all the examinations performed by our department. A clinical radiologic report was generated at the time of the sonographic examination by a senior gastrointestinal radiologist with experience in CEUS. The sonographic reports of these patients were reviewed to identify all reports that included the terms “inflammatory mass”, “phlegmon” or “abscess”, regardless, if it was subsequently confirmed or not.

We performed 871 contrast-enhanced ultrasound (CEUS) for gastrointestinal examinations between June 2006 and May 2012. Of these, a group of 80 patients were included because terms as “inflammatory mass”, “phlegmon” or “abscess” were in the report. Nine examinations were excluded because of lack of confirmation or inadequate follow-up. Our final cohort consisted

**Table 1**

Data from lesions regarding the etiology and techniques which confirmed the diagnosis of phlegmon or abscess in 57 inflammatory mass evaluated.

	Phlegmons	Abscesses	Total
Crohn's disease	18	22	40 <sup>a</sup>
Acute appendicitis	3	7	10
Acute diverticulitis	0	6	6
Perforated neoplasm	0	1	1
Total	21	36	57
Techniques which confirmed the diagnosis <sup>b</sup>			
Percutaneous drainage	0	18	18
Surgery	10	13	23
CT	4	15	19
MRI	11	5	16

<sup>a</sup> 28 out of 33 patients with CD had confirmed inflammatory masses. There were 40 bouts in 28 patients, 10 of them had two bouts separated by a long period and 2 patients had two inflammatory masses in a different location.

<sup>b</sup> 19 patients had two techniques (CT or MRI) and percutaneous drainage or surgery).

of 71 inflammatory masses in 50 patients, 22 women and 28 men with an average age of  $41 \pm 15$  years (range: 18–77). Thirty three patients had a confirmed diagnosis of Crohn's disease, 10 had acute appendicitis, six patients had acute diverticulitis and one patient a perforated cancer of the sigmoid colon (Table 1).

Table 2 shows demographic characteristics of the 33 patients with CD. Four patients had previous resection surgery. Three patients had three episodes separated by a period longer than one year, 11 patients had two bouts. Three patients had two inflammatory masses in different intra-abdominal sites.

### 2.2. US examination

US examinations were performed by using a US unit (Aplio 80; Toshiba, Tokyo, Japan), initially with a 3–6 MHz convex-array transducer and then, for detailed examination, with a 6–10 MHz probe.

**Table 2**

Demographic and disease-specific information of the 33 patients with CD complicated by an intra-abdominal inflammatory mass.

Men	19 (57.6%)
Age (mean and range)	38.94 years (21–67)
Smokers	17 (51.5%)
Montreal classification at diagnosis	
A	A1: 4 (12.1%); A2: 26 (78.8%); A3: 3 (9.1%)
L	L1: 26 (78.8%); L2: 3 (9.1%); L3: 4 (12.1%)
B	B1: 20 (60.6%); B2: 6 (18.2%); B3: 7 (21.2%)
Time of diagnosis of the inflammatory mass	
Disease onset	6 (18.8%)
Complication during follow-up	27 (81.8%)
Time (months) from diagnosis of CD to development of the inflammatory mass (mean and range)	57.7 (0–192)
Previous surgery	4 (12.1%)
Medications at time of diagnosis of inflammatory mass	
Without treatment	8 (24.2%)
Corticosteroids	4 (12.1%)
Immunosuppressant medication	16 (48.5%)
Corticosteroids and immunosuppressant medication	3 (9.1%)
Immunosuppressant medication and anti-TNF agents	2 (6.1%)

Montreal classification at diagnosis: A (age): A1 <16 years; A2 17–40 years; A3 >40 years.

L (location): L1 ileal; L2 colonic; L3 ileocolonic; L4 isolated upper disease.

B (Behavior): B1: nonstricturing, nonpenetrating; B2: stricturing; B3: penetrating.

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