Contrast-enhanced small bowel ultrasound in the assessment of the small bowel in patients with Crohn’s Disease

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Disclosures

No disclosures
Introduction

- Ultrasound is emerging as a reliable, non-invasive method of assessing the small bowel.

- The additive value of using injectable contrast agents is gaining popularity in assessing and following Crohn's small bowel disease.

- Contrast-enhanced ultrasound (CEUS) is a new technique that provides accurate depiction of bowel wall perfusion and the peri-enteric tissues after intravenous administration of microbubble contrast agents with real-time examination.
Introduction

- The normal bowel wall has a layered appearance often referred to as mural-echo stratification (Figs 1 and 2).
- These layers become more prominent in Crohn’s disease (CD) and in the acute setting, can be difficult to distinguish from each other.
- The main ultrasonographic sign in CD consists of wall thickening >3mm.

Figure 1. B-mode ultrasound image shows a markedly thickened bowel loop anterior to the right iliac vessels. Bowel wall thickness measured from mucosa/lumen interface to the serosa (between green arrowheads) measures 8 mm. There is preservation of stratification but mucosa and submucosa are disproportionally thick compared to muscularis propria.
Introduction

- 3-5 MHz convex array transducer is generally used.
- B-Mode US can evaluate the localisation and length of affected bowel segments.
- Transmural extension of the disease occurs in 20-40% of patients at some stage of their disease course.

Figure 2. US shows a cross sectional image of a small bowel loop with wall thickening and posteriorly hypoechoic replacement of the normal bowel wall signature, consistent with focal deep ulceration. Note also the mesenteric fat hypertrophy.
Contrast Enhanced Ultrasound (CEUS)

- Contrast agents used in ultrasound are exogenous substances that can be administered intravenously and circulate in the blood pool to enhance the ultrasound signal.

- All agents used contain gas-filled microbubbles with a diameter of 2-6 μm, which are surrounded by a shell composed of varying lipids or polymers.

- The two types of contrast agents used for intestinal imaging are air-filled agents, also called first-generation contrast agents, and the newer second generation US contrast agents which are filled with inert gases.
CEUS is a two-step procedure: prior to injection of contrast, a baseline US and Doppler study is always performed.

Grey-scale examination is initially used to detect and localise areas of bowel inflammation.

In our institution, we use the thickest and most diseased looking bowel segment to perform quantitative analysis of the contrast agent enhancement. We use a 10 MHz concave transducer to perform the bowel study.

A nurse is always present to administer the contrast agent as a bolus of 0.3 ml (Definity, Lantheus Medical Imaging) through a three-way 20-gauge catheter in a forearm vein followed by a 10 ml normal saline flush.
How we do it - technique

- We commence recording 5 seconds before contrast administration and continue imaging for 3 minutes, recording a cine loop.
- In general, depending on the severity of the disease, bowel wall enhancement occurs 10-20 seconds after injection (Figure 4).
- Enhancement decreases thereafter.
- The rapidity of washout depends upon the severity of bowel wall disease activity and the severity and acuteness of the inflammation.
How we do it - technique

- CEUS can identify patterns of enhancement of the thickened bowel wall – complete enhancement of the bowel wall (pattern 1), enhancement of the inner layers (except the muscularis propria) (pattern 2); enhancement of only the intermediate layer, the submucosa (pattern 3) and complete absence of enhancement (pattern 4).

- Quantitative analysis of the brightness in regions of interest (ROI) of the intestinal wall, using a dedicated software installed into the ultrasound equipment or by a dedicated software of quantification installed on a personal computer. The software obtains a brightness-time curve (Figure 3).

Figure 3. Time-Curve Analysis
Figure 4. B-mode (right image) and CEUS (lower images) in a patient with suspected acute flare of Crohn’s Disease shows markedly thickened small bowel wall (>1cm) in the right lower quadrant. Following injection of ultrasound contrast at 5, 8 and 12 seconds, there is clear progressive and avid enhancement seen best on the anterior wall. This is consistent with active disease.
CEUS findings with Crohn’s Disease

Figure 5. A patient with suspected CD underwent a CEUS following a B-mode ultrasound revealed a thickened loop of small bowel in the right lower quadrant. Note the avid early enhancement of the anterior wall of the now on the left, B-mode image on the right.
CEUS findings with Crohn’s Disease

Figure 6. CEUS images at 1 and 30 seconds show poor enhancement of the bowel wall suggestive fibrostenotic disease in a patient with known CD. Preservation of bowel wall signature, although with submucosal thickening, can be seen.
Our Experience

- We reviewed patients with a known or suspected diagnosis of Crohn’s disease, referred by gastroenterology for a focused bowel ultrasound.
- 53 patients had a focused bowel ultrasound.
- 14 patients had focused bowel ultrasound and CEUS.
Our Experience

Focused Bowel Ultrasound findings correlated with Colonoscopy/ Biopsy/ Clinical Picture and Management

- 31 Normal Ultrasound
- 19 Abnormal ultrasound (thickened/ hyperaemic small bowel suggestive of active disease)
- 3 excluded (inadequate follow up)
Our Experience

- 5 false negatives:
  - 3 patients had normal US but terminal ileal apthous ulcers +/- hyperaemia. NOT treated.
  - 1 normal US but chronic active ileitis on scope and biopsy.
  - 1 normal ultrasound but subsequent MRI showed multifocal strictures- treated with steroids.

- 1 false positive:
  - Thickened small bowel on Ultrasound. Normal scope and biopsy.
## Our Experience

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<tr>
<td>Totals</td>
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- **Sensitivity:** 78% (56-92)
- **Specificity:** 96% (79-99.8)
- **Positive Predictive Value:** 95% (72-99.7)
- **Negative Predictive Value:** 84% (66-94)
Our Experience

- 14 patients had US and CEUS

- 10/14 patients had abnormal ultrasound with moderate or avid bowel wall enhancement

- 4/14 patients had poor/minimal enhancement

- 100% correlation between CEUS and scope/biopsy +/- clinical correlation and follow up.

  - 7 (50%) patients with endoscopy, the CEUS and endoscopic/biopsy findings were concordant
  
  - 7 (50%) patients were managed clinically without requiring endoscopic confirmation, clinical picture and management was concordant with ultrasound findings.
Conclusion

- CEUS is an increasingly utilized investigation both to screen for and to help diagnose CD, and to follow up patients with known CD.
- Advantages include: lack of ionizing radiation, is safe, and non-invasive.
- Its sensitivity and specificity is acceptable with rates comparable with CT, MRI and small bowel contrast studies.
- It’s role in the investigation and treatment algorithm in patients with suspected or established CD is still not clearly defined, but will likely be clarified by future studies.
Thank You