

## Prediction of patency capsule retention in known Crohn's disease patients by using magnetic resonance imaging

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**Background and Aims:** Evaluation of small-bowel patency is recommended before swallowing video capsule endoscopy to prevent capsule retention. This study aimed to evaluate the ability of magnetic resonance enterography (MRE) to predict patency capsule (PC) retention in patients with Crohn's disease and to identify the most predictive imaging features for retention.

**Methods:** Fifty-seven patients prospectively underwent MRE and PC. Two radiologists predicted PC retention. Interrater reliability was determined by using Cohen's  $\kappa$  coefficient. The sensitivity, specificity, and positive and negative predictive values were calculated for the predictions. Evaluation of the imaging features was done using the  $t$  test and receiver-operating characteristics;  $t$ -tests were also performed on the clinical parameters.

**Results:** The  $\kappa$  value for interrater reliability was 0.58. The sensitivity, specificity, PPV, and NPV for the predictions by the 2 radiologists were 92.3%, 59%, 40%, 96.3%, and 100%, 52.3%, 38.2%, 100%, respectively. The maximal stricture length ( $9.7 \pm 3.66$  cm vs  $7.0 \pm 3.08$  cm,  $P = .04$ ) and the number of prestenotic dilations ( $1.9 \pm 1.07$  vs  $1.0 \pm 1.38$ ,  $P = .03$ ) were associated with PC retention. The area under the receiver-operating characteristic curves was 0.69 for the maximal stricture length and 0.751 for the number of prestenotic dilations. The phenotype of the disease was the only clinical parameter significantly correlated with PC retention.

**Conclusions:** MRE has a high NPV and sensitivity for PC retention. When capsule retention is suggested by MRE, PC should be performed before the video capsule endoscopy examination. The maximal stricture length and the number of prestenotic dilations were found to be the most predictive imaging features for PC retention. (Gastrointest Endosc 2016;83:182-7.)

Crohn's disease (CD) is a chronic relapsing inflammatory disease characterized by mucosal and transmural inflammation of the bowel wall. It is often discontinuous

*Abbreviations:* CD, Crohn's disease; MRE, magnetic resonance enterography; NPV, negative predicting value; PC, patency capsule; PPV, positive predictive value; SBFT, small-bowel follow through; VCE, video capsule endoscopy.

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and can involve any portion of the GI tract. CD has been subclassified by disease phenotype. The Montreal classification characterizes the disease phenotype according to 3 parameters: age at onset, location, and behavior of disease (inflammatory, fistulizing, or stenotic type).<sup>1</sup>

The behavior of the disease changes over time. In patients with the inflammatory type at diagnosis, fistulizing or stricturing adverse events are likely to develop within 5, 10, or 20 years.<sup>2</sup>

Endoscopy plays an important role in the evaluation and monitoring of established CD, but visualization of the small bowel by means of conventional endoscopy is not possible beyond the duodenum and proximal to the terminal ileum.<sup>3</sup>

Video capsule endoscopy (VCE) was developed in 2000 by Given Imaging Ltd (Yoqneam, Israel)<sup>4</sup> and allows direct visualization of the entire small bowel in a minimally invasive procedure. Indications for the use of VCE include suspected CD, extent of CD, obscure GI bleeding, a diagnosis of celiac disease, GI tumors, nonsteroidal anti-inflammatory drug-induced small-bowel damage, and surveillance of polyposis syndrome.<sup>5</sup> The

most common adverse event of VCE is retention due to stenosis. Its incidence is often dependent on the indication for VCE. Retention among patients with known small-bowel CD has been reported to be as high as 13%.<sup>6</sup> It is a major concern because retention could lead to surgery due to small-bowel obstruction.<sup>7</sup>

A dissolvable patency capsule (PC) was developed with the aim of evaluating patency of the GI tract before giving the actual VCE. It consists of a lactose body mixed with 5% barium and a radiofrequency tag. The body is coated with an impermeable membrane, except for a small window on each of the 2 timer plugs that are located at each end of the capsule, and allows penetration of intestinal fluids. If the capsule is retained in the intestine, the timer plugs erode after 30 hours, leading to PC body dissolution.<sup>8</sup>

Radiological imaging techniques are complementary to endoscopic evaluation of CD. While evaluating the new criterion standard for diagnostic imaging in CD, Dambha et al<sup>9</sup> found magnetic resonance imaging to be the most accurate imaging tool for assessment of disease extent and distribution.

Magnetic resonance enterography (MRE) is a radiological imaging modality that involves the use of magnetic resonance imaging to assess the small bowel after ingestion of oral contrast agent. It is a nonionizing technique that allows multiplanar acquisition with high-contrast resolution and has the ability to evaluate loops of small bowel not amenable to endoscopic visualization. It accurately depicts both intraluminal and extraluminal disease manifestations.<sup>10</sup>

Guidelines for the assessment of inflammatory bowel disease by imaging techniques were recently published.<sup>11</sup> They recommend evaluation of small-bowel patency before administration of VCE, by using either PC or cross-sectional imaging.

The aims of our study were to evaluate the ability of MRE to predict PC retention and to find the most MRE predictive imaging features for PC retention.

## METHODS

### Study protocol

The study was approved by the institutional review board, and informed consent was obtained from each participant. Inclusion criteria included known adult CD patients in remission or experiencing mild disease symptoms for at least 3 months, as determined by a Crohn's Disease Activity Index score lower than 220.

Exclusion criteria included complete clinical remission for more than 2 years, patients taking steroids in the previous 3 months, and patients with unstable medication dose (a stable medication dose was defined as 60 days for thiopurines and methotrexate, 60 days for infliximab, and 30 days for adalimumab and for aminosalicilate agents).

Data collected for each patient included age, sex, disease duration, previous surgery, disease phenotype and

location according to the Montreal classification, CDAI score, C-reactive protein level, and current treatment.

### Magnetic resonance enterography

All MRE examinations were performed at our institution by using a 1.5-T GE Optima MR450w scanner with GEM Suite (GE Healthcare). Distention of the small bowel was obtained by using oral contrast: 360 mL Osmitol (mannitol) 20%, diluted in 1.5 L of water. Patients were instructed to drink 4 doses of 465 mL every 15 minutes an hour before undergoing the MRE examination. During the last 15 minutes, patients received via infusion 150 mL of saline solution containing 0.5 mg of glucagon in a slow drip.

Patients were placed in the supine position in the magnetic resonance scanner. Protocol for magnetic resonance image acquisition outlined in Table 1 was performed. Axial and coronal liver acquisition with volume acquisition sequences were acquired before and 40 seconds after intravenous administration of gadolinium (0.5 mmol/mL by 0.2 mL/kg).

Two board-certified abdominal radiologists with 1 and 10 years of experience in reading MRE gave a positive or negative prediction for PC retention. The senior radiologist also evaluated each MRE scan for radiological imaging features characteristic of CD. The MRE imaging features included the number of segments, the number of strictures (a reduction in the bowel lumen diameter at least 80% lower than that measured in a normal adjacent non-prestenotic loop),<sup>12</sup> the number of prestenotic dilations (>2.5 cm), the maximal stricture length, the maximal wall thickness (>3 mm), and the number of enhanced segments (Fig. 1).

### Patency capsule

Within a maximal interval of 2 weeks after the MRE study, all patients underwent a PC examination (Agile patency capsule; Given Imaging). Before PC administration, patients were restricted to a 24-hour liquid low-fiber diet and a 12-hour fast, similar to the regular VCE examination protocol.

Patients were asked to check for PC excretion in their stool. If it was not seen excreted intact by the patient, patients were screened 30 hours after ingestion by the radiofrequency identification scanner. Complete passage of the patency capsule was defined as lack of detection of the patency capsule by the scanner 30 hours after ingestion. If the capsule was detected by the scanner, PC location was verified on a plain abdominal film, as seen in Figure 2.

### Statistical analysis

Interrater reliability was determined by using Cohen's  $\kappa$  coefficient. The sensitivity, specificity, PPV, and NPV of the radiologists' predictions for PC retention were calculated for all patients. *t* Tests were performed on the evaluated imaging features of patients with diseased segments to

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