

# Increased Diagnostic Yield of Capsule Endoscopy in Patients with Chronic Abdominal Pain

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## Abstract

**Background and Study Aims:** Chronic abdominal pain is one of the most common chief complaints, but the underlying pathophysiology often remains unknown after routine clinical evaluation. Capsule endoscopy (CE) is a new technique for the visualization of the entire small bowel. The aim of this study was to evaluate the diagnostic efficacy of CE in patients with chronic abdominal pain of obscure origin.

**Patients and Methods:** Two hundred forty three patients with chronic abdominal pain with no significant lesions were enrolled in this study. CE was performed in all patients.

**Results:** A diagnosis was made in 23.0% of patients screened with CE. Of the 243 patients, 19 (7.8%) were diagnosed with Crohn's disease, 15 (6.2%) with enteritis, 11 (4.5%) with idiopathic intestinal lymphangiectasia, 5 (2.1%) with uncinariasis, and a number of other diagnoses including small bowel tumor, ascariasis, and anaphylactoid purpura. Five patients had abnormal transit time, and capsule retention occurred in two patients.

**Conclusions:** In contrast to other previous studies, we found that CE is an effective diagnostic tool for patients with abdominal pain.

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## Introduction

Chronic abdominal pain (CAP) that persists either continuously or intermittently for more than three months is one of the most common chief complaints in clinical medicine. The causes of abdominal pain are varied and complex, and include both functional and structural gastrointestinal abnormalities. Unfortunately, in many patients with CAP, the underlying cause of the disease remains unknown even after routine laboratory testing.

Capsule endoscopy (CE) is a new technology for painless endoscopic imaging of the entire small bowel [1,2]. To date, several studies have demonstrated that CE is superior to barium follow-through, push enteroscopy, and computed tomography (CT) for the diagnosis of small bowel disease [3–5], and more specifically for the evaluation of patients with obscure gastrointestinal bleeding [6–10] and Crohn's disease [11–14]. However, there is a paucity of data regarding the diagnostic yield of CE in patients with CAP, and in previously published studies, CE was not informative in these patients [15,16]. The primary objective of our study was to determine the diagnostic efficacy of CE in patients with CAP of obscure origin.

## Methods

### Ethics statement

After informed of the benefits and potential risks of capsule endoscopy examination, all the patients signed an informed

consent form prior to their enrollment for capsule endoscopy examination. In addition, all the patients agreed that their clinical examination results could be used for non-commercial teaching or scientific research purposes and these verbal consents were recorded in the patient file. All the patient information was anonymized prior to analysis. The Ethical Review Committee (the First Affiliated Hospital, College of Medicine, Zhejiang University) approved this retrospective study and stated that "This study appears to be in accordance with the scientific principles generally accepted and to the ethical standards of research. The study was led in the respect of the Chinese law and regulation".

### Patients and controls

Inpatients and outpatients who complained of either continuous or intermittent abdominal pain for at least three months at the First Affiliated Hospital, College of Medicine, Zhejiang University between January 2006 and December 2012 were screened for enrollment in this study. Patients were excluded if they presented with any of the following conditions: pregnancy, symptoms/signs of bowel obstruction, presence of implanted pacemaker, swallowing disorders, and any abdominal surgery except appendectomy. Two hundred forty three patients (136 male and 107 female, with mean age of 44.1 years) were enrolled in this study.

Out of 243 patients, 112 patients complained of mid-epigastric pain, 37 of lower abdominal pain, and 94 of diffuse abdominal pain. All patients underwent routine clinical examinations and

**Table 1.** Demographic data and clinical characteristics of the study population.

Characteristics	OMOM	PillCam SB	Total
No. of patients	144	99	243
Sex			
Male	75	61	136
Female	69	38	107
Median age (range), years	44.9(15–76)	44.0(9–79)	44.1(9–79)
Positive findings	32	24	56
Yield, %	22.2%	24.2%	23.0%

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laboratory tests (including blood tests, urine tests, and stool examinations), ultrasound examinations or computed tomography (CT), esophagogastroduodenoscopy, and colonoscopy. We did not perform any barium studies as they are rarely used in our hospital. The studies did not reveal any obvious lesions that could contribute to clinical manifestations of disease.

### Capsule endoscopy

For CE, 144 patients were examined by OMOM CE system (JinShan Science & Technology Co, Ltd, ChongQing, China) and

**Table 2.** CE findings in 243 patients with chronic abdominal pain.

	OMOM	PillCam SB	Total
No. of patients	144	99	243
Specific capsule endoscopy findings			
Ileal and jejuna ulcers	23	19	42
Ileal occupation	1	0	1
Jejunal occupation	0	1	1
Intestinal lymphangiectasia	9	2	11
Erythema and edema in jejuna and ileum	4	3	7
Ileal and jejuna polyps	1	0	1
Uncinariasis	5	0	5
Ascariasis	0	2	2
Diverticulum	1	0	1
Fistula	0	1	1
Follicular hyperplasia	1	2	3
Presumed diagnosis after capsule endoscopy			
Crohn's disease	9	10	19
Enteritis	8	7	15
Idiopathic intestinal lymphangiectasia	9	2	11
Uncinariasis	5	0	5
Ascariasis	0	2	2
Small bowel occupying lesion	1	2	3
Anaphylactoid purpura	0	1	1

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**Figure 1. Ulcers and stenosis found by CE.** Ulcers and stenosis in the upper part of the small intestine were found by CE in a 56-year-old woman with abdominal pain. The diagnosis of Crohn's disease was confirmed both surgically and pathologically. doi:10.1371/journal.pone.0087396.g001

99 patients were examined by Given PillCam SB Diagnostic System (Given Imaging Ltd., Yoqneam, Israel).

The patients were maintained on a liquid diet for one day and fasted for at least 10 hours prior to the examination. When the capsule was activated, the patient ingested it with one glass of water. Two hours after swallowing the capsule patients were allowed to drink water and in another two hours could have a light snack. The examination lasted approximately eight hours, and during this time the patient avoided any physical activity that involved sweating and abstained from bending. At the end of the procedure, the sensor belt and data recorder were removed by the physician.

### Statistical analysis

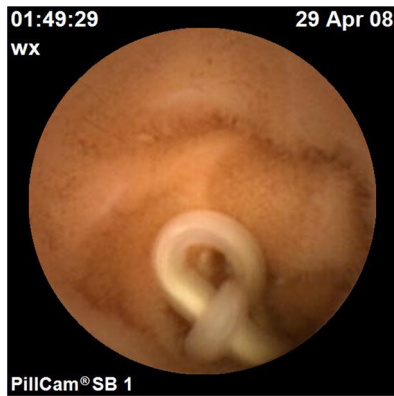
All the data recorded were analyzed by professional gastroenterologists.

### Results

Demographic data and clinical characteristics of the study population are listed in Table 1. Of the 243 patients evaluated, 56 patients were diagnosed with abnormalities in the small intestine (yield 23.0%). Forty four of these patients presented with periumbilical pain as the primary symptom (yield 78.6%). Specific CE findings included ulcers, erythema and edema, occupation,



**Figure 2. Hookworms identified by CE.** Hookworms throughout the small bowel were identified by CE in a 42-year-old woman with lower abdominal pain for three years. doi:10.1371/journal.pone.0087396.g002

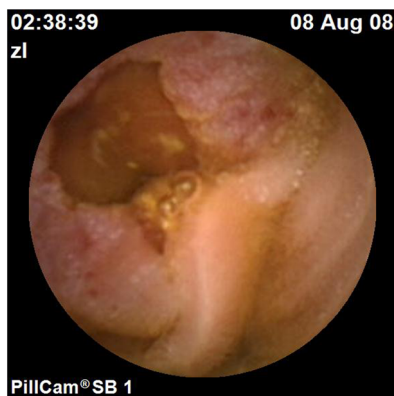


**Figure 3. Roundworm detected by CE.** Roundworm was detected by CE in the small bowel in a 49-year-old woman with periumbilical pain for more than one year.  
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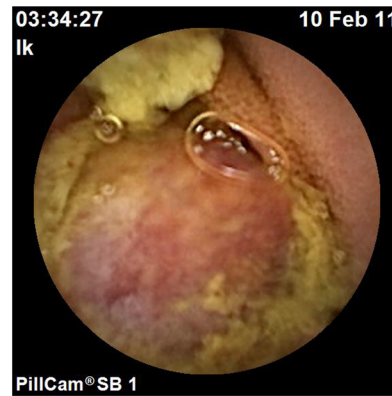
lymphangiectasia, diverticulum, fistula, uncinariasis, and ascariasis. The presumed diagnoses included Crohn's disease (19 patients), enteritis (15), idiopathic intestinal lymphangiectasia (11), uncinariasis (five), small bowel occupying lesion (three), ascariasis (two), and anaphylactoid purpura (one) (Table 2).

The diagnosis of Crohn's disease was based on the following criteria: ulcers, mucosal erosion, ileal ulcerated stenosis, and featureless small bowel [11,17,18]. CE detected roundworms (*Ascaris lumbricoides*) and hookworms (*ancylostome*) in patients with ascariasis and uncinariasis, which was previously undetected in the stool examination. The patient with occupation in the proximal jejunum was diagnosed with adenocarcinoma by pathological findings. The patient with small bowel occupying lesion was diagnosed surgically with gastrointestinal stromal tumor. The patient with anaphylactoid purpura had multiple congestion and ulcers in the small bowel (Figures 1, 2, 3, 4, 5, and 6).

Five patients exhibited abnormal transit time of the capsule. One had a prolonged transit time (1 hour 22 minutes to leave the stomach and 9 hours to reach the colon) and four had a rapid transit time (on average, 1 hour 15 minutes to reach the colon). Capsule retention occurred in two patients (0.82%), and localization was confirmed by X-ray KUB in the stomach and pelvic cavity.



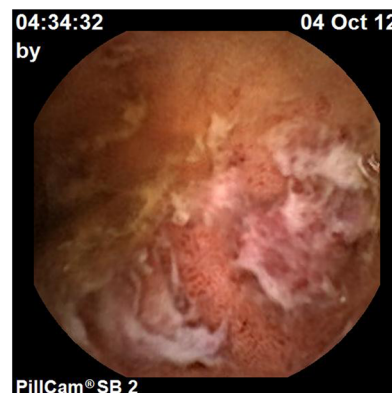
**Figure 4. An occupying lesion identified by CE.** An occupying lesion was identified by CE in the jejunum of a 52-year-old woman with abdominal pain for more than three months. With subsequent pathology evaluation, a diagnosis of adenocarcinoma was confirmed.  
doi:10.1371/journal.pone.0087396.g004



**Figure 5. An eminence lesion identified by CE.** An eminence lesion was identified by CE in the small bowel of a 30-year-old man with periumbilical pain. The lesion was surgically diagnosed as gastrointestinal stromal tumor.  
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## Discussion

For gastroenterologists, the small intestine is known as the “Dark Continent” because of the inherent difficulty to visualize this organ enteroscopically. In particular, small-bowel endoscopy is constrained by procedural discomfort and limits on the advancement of enteroscopes into the small bowel [1]. CE, which allows painless endoscopic imaging of the whole small bowel, has become a very important tool for the diagnosis of many small-bowel disorders [1,19]. For example, gastrointestinal bleeding is the primary and most frequent indication for CE. As reported by various studies, the overall diagnostic yield for obscure gastrointestinal bleeding is in the range of 55%–70%, which is much higher than that for other diagnostic tests [5–10,19]. CE was also efficacious for the diagnosis of small bowel lesions in Crohn's disease, suggesting it may be useful for early disease management [11–14,19]. Moreover, CE can be used to diagnose patients with celiac disease and hereditary polyposis syndromes [20–22]. More recently, small bowel tumors have been detected with CE, where 6–9% of patients were diagnosed small bowel tumors [23–25]. Some studies revealed that CE could help to identify the intensity and extent of the gastrointestinal involvement in patients with anaphylactoid purpura [26–28].



**Figure 6. Multiple congestion and ulcers identified by CE.** Multiple congestion and ulcers in the small bowel were identified by CE in a 17-year-old man with recurrent abdominal pain.  
doi:10.1371/journal.pone.0087396.g006

In contrast to findings of other investigators, we demonstrated that CE increased diagnostic yield (23.0%) for patients with chronic abdominal pain of previously undetermined origin [15,16]. We enrolled patients in our study who complained of continuous or intermittent abdominal pain for at least three months. Our findings made presumed diagnoses of Crohn's disease, enteritis, idiopathic intestinal lymphangiectasia, uncinariasis, small bowel occupying lesion, ascariasis, and anaphylactoid purpura in patients who presented with negative routine clinical examination. Therefore, our data suggest that CE is an effective diagnostic tool for the evaluation of patients with CAP.

The main advantage of our study over others is the enrollment of a large number of patients who had a previous negative clinical workup (including routine laboratory tests, esophagogastroduodenoscopy, and colonoscopy). There are some limitations, primarily the inherent defects of any retrospective study. Although data

collection regarding details of every patient was a priority, tiny omissions were inevitable. Also, we used two kinds of CE, but we believe the intensive and elaborate analyses by our expert gastroenterologists make this potential limitation unlikely.

In conclusion, we found that visualization of the small bowel with CE is a diagnostically effective tool for patients with chronic abdominal pain of obscure origin. Our results have important implications for the diagnosis of multiple disorders of the small bowel and the development and refinement of appropriate treatment regimens clinically.

## Author Contributions

Conceived and designed the experiments: CY YL. Performed the experiments: LY BZ CC MY JD. Analyzed the data: LY YC. Wrote the paper: LY BZ CC MY JD.

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