Endoscopic Techniques for Small Bowel Imaging

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KEYWORDS

• Capsule endoscopy • Double-balloon enteroscopy • Single-balloon enteroscopy
• Spiral enteroscopy • Obscure gastrointestinal bleeding • Crohn's disease • Small bowel tumors
• Polyposis syndromes

KEY POINTS

- Capsule endoscopy is a noninvasive test that allows diagnostic evaluation of the entire small bowel.
- Deep enteroscopy techniques (balloon-assisted and spiral enteroscopy) allow endoscopic management of small bowel disorders, including biopsies, polypectomy, dilation of strictures, tattooing, and retrieval of retained capsules.
- The deep enteroscopy techniques have a comparable diagnostic and therapeutic yield in the management of small bowel disorders.
- Capsule endoscopy and deep enteroscopy are considered complementary tests, and capsule endoscopy is often used as a screening tool before deep enteroscopy.
- Double-balloon enteroscopy appears to have the highest success rate for total enteroscopy among all deep enteroscopy techniques, and should therefore be the procedure of choice when total enteroscopy is a desired goal.

INTRODUCTION

Significant advances in small bowel enteroscopy over the last decade have facilitated both the diagnostic evaluation and therapeutic management of small bowel disorders. The small bowel, therefore, is no longer considered the "black box" of the gastrointestinal tract. Multiple enteroscopic tools are now available that differ in their technique and capabilities. Capsule endoscopy enables visualization of the entire small bowel in a noninvasive manner, but is a purely diagnostic test. The deep enteroscopy techniques, which include balloon-assisted and spiral enteroscopy, allow therapeutic interventions in the deeper portions of the small bowel, but are relatively invasive and often protracted procedures. The selection of the appropriate enteroscopy tool is determined by several factors, including clinical presentation of the patient, index of suspicion for a small bowel lesion, and the suspected location of the lesion. This article reviews the use of the enteroscopy techniques, and their advantages and limitations in the evaluation of the small bowel.

ANATOMY OF THE SMALL BOWEL

The small bowel is a tubular organ that is 600 to 800 cm in length, and extends between the pylorus and the ileocecal (IC) valve. It is divided into 3 segments: duodenum, jejunum, and ileum. The duodenum is the most proximal and shortest segment of the small bowel, with a mean length of 25 cm. It is shaped like a C loop. This segment

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is the only one located in the retroperitoneal space, and is therefore relatively fixed. It includes the bulb, second, third, and fourth portions, and extends up to the ligament of Treitz. The ampulla of Vater lies in the second portion of the duodenum. The remainder of the small bowel is suspended in the peritoneal cavity by a broad-based mesentery, and is freely mobile. The proximal 40% of this portion is the jejunum and the distal 60% the ileum. The luminal surface of the small bowel has numerous folds called the plicae circularis. The plicae are most prominent in the proximal small bowel, and decrease in number distally.[1]

Historically, gastrointestinal sources of bleeding were classified as proximal and distal to the ligament of Treitz. Since the introduction of the deep enteroscopy techniques, the gastrointestinal tract is now divided into 3 segments: proximal to the ligament of Treitz, distal to IC valve, and midgut, which refers to the portion of the small bowel that is located between the ampulla and IC valve.[2]

VIDEO CAPSULE ENDOSCOPY

Capsule endoscopy (CE) was introduced in the year 2000, and was the first endoscopic test that enabled visualization of the entire small bowel. There are 4 CE systems currently available. The CE systems used in the United States are Pillcam SB2 (Given Imaging, Yoqneam, Israel) and Endo Capsule (Olympus America Inc, Center Valley, PA). The systems include a capsule endoscope, 8-point sensory array, and a portable data recorder. Both the Pillcam SB2 and Endo Capsule measure 11 $\times$ 26 mm, and contain light-emitting diodes, silver oxide batteries, lens, radiofrequency transmitter, and antenna. The Pillcam SB2 contains a metal oxide semiconductor whereas the Endo Capsule has a charged coupled device.

CE is a noninvasive procedure that can be performed in the outpatient ambulatory setting. Patients are required to fast for an 8-hour period, and most centers recommend a bowel preparation (2 L oral polyethylene glycol) on the night before capsule ingestion. The capsule is usually swallowed by the patient, but can also be delivered directly into the small bowel by endoscopic assistance in patients with dysphagia or risk factors for an incomplete study.[3,4] It is propelled through the small bowel by peristalsis over an 8- to 12-hour period. Images are captured by the camera at the rate of 2 frames per second and transferred by wireless technology to a data recorder that is strapped to the patient's waist. The images can then be downloaded and viewed on a computer that contains the appropriate software. The average physician time for viewing the images ranges from 45 to 120 minutes.[5] The software has features that include multiviewing by simultaneous display of 2 to 4 consecutive images, and a suspected blood indicator.

CE allows visualization of the entire small bowel in 79% to 90% of patients.[6] The test is approved by the Food and Drug Administration for use in patients older than 10 years for the evaluation of obscure gastrointestinal bleeding (OGIB), Crohn's disease, celiac sprue, polyposis syndromes, small bowel abnormalities on imaging studies, and clinical symptoms.

The main disadvantage of CE is its purely diagnostic capability and, therefore, necessity for additional therapeutic procedures in patients with positive CE findings. There also is a high rate of incidental findings in up to 23% of healthy controls,[7] which may result in unnecessary invasive procedures. CE may be limited by incomplete visualization of the small bowel in 15% to 20% of patients.[8] The most important complication is small bowel retention in patients with an underlying stricture or obstruction. This risk ranges from less than 1% in patients with OGIB, up to 13% in patients with Crohn's disease, and 17% in patients with small bowel tumors.[9,10]

Patency Capsule

The patency capsule (PC) is useful for minimizing the risk of retention in patients with a suspected small bowel stricture or obstruction, by selection of those patients who can safely undergo CE. The system includes a PC, scanner, and TesTag. The capsule is 26 $\times$ 11 mm in size, and contains a body with a radiofrequency identification tag (RFID) covered with lactose and barium, and a timer plug on either side of the capsule. The PC is designed to dissolve in gastrointestinal secretions 30 hours after ingestion. Patency of the gastrointestinal tract can be confirmed if the patient witnesses passage of the patency capsule or if the RFID tag is not detected with the scanner at or before 30 hours after ingestion. Fluoroscopy is used in place of the scanner for accurate localization of the RFID tag and in patients with pacemakers.

In a study of 27 patients with suspected obstruction, the PC was excreted intact in 63% of patients over a mean transit time of 25.6 hours. CE was performed in all these patients without any complications of retention.[11] Another large study evaluated 106 patients using PC. Fifty-six percent of patients excreted the capsule intact, and subsequently underwent CE without retention.[12] A study that compared patency capsule with radiologic