Advances in Small Bowel Imaging - Capsule Endoscopy

Praveen Sharma*

Abstract
The small bowel has been a difficult area to examine due to its anatomy, location and relative tortuosity. Capsule technology has revolutionized the imaging of small bowel. Capsule endoscopy has been recommended as the 3rd diagnostic test for patients with obscure bleeding after a normal endoscopic evaluation of the upper and lower gastrointestinal tract. Many studies have established its role in other clinical situations, such as detection of small bowel lesions in Crohn’s disease, non steroidal anti-inflammatory drug enteropathies, celiac disease, small bowel polyposis syndromes and small bowel tumors. Capsule endoscopy of the oesophagus is recommended as an alternative to oesophagogastroduodenoscopy for screening Barrett’s oesophagus, esophageal varices and of the colon for colorectal cancer.

Introduction
Endoscopic examination of the small intestine was difficult to explore with the available endoscopic and radiological techniques. Investigation with push enteroscopy usually does not allow the investigation of more than 60 cm of proximal jejunum. The last few centimeters of the ileum are accessible by ileocolonoscopy. New diagnostic technique is required for the evaluation for entire small bowel. Recent advances in development of low power complementary metal-oxide silicon (CMOS) imagers, mixed signal application specific integrated circuit (ASICs) and white light emitting diodes (LEDs) made possible development of a new type of endoscope – the swallowable video capsule (Figures 1, 2). Capsule endoscopy (CE) was launched at the beginning of this millennium. Small bowel CE, therefore, represents a major advance as it is a safe, non-invasive procedure1-3 and it is cost-effective in a variety of clinical situations.5,8 This technique evaluates endoscopically, with high resolution images, the whole small bowel, avoiding any sedation, surgery or radiation exposure. Currently, CE is recommended, after a negative gastroscopy and colonoscopy in patients with obscure gastrointestinal bleeding.8 CE is also useful in other clinical situations, such as detection of small bowel lesions in Crohn’s disease, non steroidal anti-inflammatory drug enteropathies, celiac disease, small bowel polyposis syndromes and small bowel tumors.9-17

What is Capsule Endoscopy?
CE is performed by ingestion of a small (26×11 mm) disposable battery powered pill containing a complementary metal oxide semiconductor camera which provides a field of view of 156°, a variable depth of view (1-30 mm), and a resolution of 0.1 mm. Four light emitting diodes illuminate the lumen of the bowel (Figures 1, 2).

Patient need to remain following 8-10 hours fasting the capsule is swallowed. A meta-analysis by Rokkas et al18 supports the concept of a purgative preparation before CE. The studies included in the meta-analysis administered different quantities of PEG (polyethylene glycol) ranging from 2 to 4 liters, mostly administered the evening before the CE and the use of simethicone has been studied to improve small bowel visualization for CE studies. Eight skin leads are placed to the patient’s anterior abdominal wall and connected to the hard drive. The camera is activated by removal of the capsule from its magnetic holder and takes 2-3 images per second and transmits these by means of radio frequency to a sensor array placed on the patient’s abdomen and from here to a recording device in a belt that the patient wears for the duration of the battery life (8-10 h). Now the patient swallows the capsule with a few sips of water, then the capsule is passively moved along by peristalsis. Two hours after ingestion, the patient is allowed to drink, while eating is allowed after 4 h. During the procedure the patient may carry on with his daily activities. After the 10-12 hours recording device is removed and the recorded images are downloaded to

*Assistant Professor, Department of Hepatology, Institute of Liver and Biliary Sciences, Vasant Kunj, New Delhi-110060
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Fig. 1 : Capsule used for capsule endoscopy

Fig. 2 : Obscure G I Bleed (lesion seen in deep jejunum)
the enteroscope and the overtube are inflated and deflated with air to enable the endoscope to pass through the small intestine. These balloon enteroscopy can be performed through the oral (anterograde) or anal (retrograde) route. A large meta-analysis comparing capsule endoscopy with double balloon enteroscopy in patients with small bowel lesions, mostly OGB showed that the two procedures have similar diagnostic yield in small intestinal disorders. These procedures are complementary to CE in the detection and management of the small intestine lesions.

CE may be an alternative to biopsy of the small intestine for detecting villous atrophy in patients with suspected coeliac disease after serological testing. A large meta-analysis found that it had an overall sensitivity of 83% and specificity of 98%. Capsule endoscopy is especially good at detecting complications of coeliac disease, such as small intestinal adenocarcinoma, lymphoma, and ulcerative jejunitis.

The main contraindication to performing CE is the suspicion or knowledge of an obstruction in the gastrointestinal tract. The retention of the device is the main complication of the procedure and is defined when CE remains in the digestive tract for a minimum of 2 wk. The frequency of this problem varies, depending mostly on the clinical indication for CE, and ranges from 0% in healthy subjects, to 1.5% in patients with obscure gastrointestinal bleeding, to 5% in patients with suspected Crohn’s disease and to 21% in patients with intestinal obstruction. A plain abdominal radiograph should be obtained to confirm excretion of capsule if the video fails to show that it enters the colon. Patient should not undergo magnetic resonance imaging after CE until the capsule as passed out.

Contraindication for Capsule Endoscopy

- Patients with known or suspected GI obstruction, strictures, or fistulas based on the clinical picture or preprocedure testing
- Patients with cardiac pacemakers or other implanted electro-medical devices
- Patients with swallowing disorders
- Pregnancy

Indications for Capsule Endoscopy

- Obscure gastrointestinal bleeding
- Small bowel Crohn’s disease
- Assessment of coeliac disease
- Screening and surveillance for polyps in familial polyposis syndromes

CE now has an established role in patients with persistent obscure gastrointestinal bleeding (OGB) who have had a negative gastroscopy and colonoscopy (Flow diagram-1 and Figure-2). This technique is also being used commonly for other conditions which includes detection of small bowel lesions in Crohn’s disease in patients in which other methods have failed to provide a diagnosis, diagnosis of celiac disease and its complications, non steroidal anti-inflammatory drug enteropathies, small bowel polyposis syndromes and small bowel tumors (Figure 3). The diagnostic yield of capsule endoscopy, with other procedures, in patients with OGB confirmed the superiority of CE over other procedures for imaging the small bowel. However, most of these studies were conducted before the introduction of single or double balloon enteroscopy. This procedure uses an enteroscope equipped with an overtube to visualize and treat lesions in the small intestine. One (in case of single balloon) or two latex balloon (double balloon) at the tip of the enteroscope and the overtube are inflated and deflated with air to enable the endoscope to pass through the small intestine. These balloon enteroscopy can be performed through the oral (anterograde) or anal (retrograde) route. A large meta-analysis comparing capsule endoscopy with double balloon enteroscopy in patients with small bowel lesions, mostly OGB showed that the two procedures have similar diagnostic yield in small intestinal disorders. These procedures are complementary to CE in the detection and management of the small intestine lesions.

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Oesophagus and Colon

The oesophageal capsule measures 11×26 mm and acquires video images from both ends of the device (14 frames/s). ECE (Esophageal capsule endoscopy) has been shown to have moderately high sensitivity and accuracy in the diagnosis and surveillance of Barrett esophagus in patients with gastroesophageal reflux disease but has not demonstrated superiority to esogastroduodenoscopy in cost-effectiveness models (Figure 4). In patients with portal hypertension, ECE has a sensitivity of 63% to 100% for screening of esophageal varices, but does not seem to be superior to esogastroduodenoscopy in its cost effectiveness. No serious complications have been reported after ECE although a low rate of esophageal capsule retention (0.7% to 2.2%) has been reported, usually because of unsuspected esophageal strictures. The contra-indications of oesophageal capsule endoscopy are the same as those usually adopted for the use of small bowel exploration, including any suspicion of stenosis at any level of the GI tract. Dysphagia, swallowing disorders, and severe motility diseases are more specific contraindications in the context of oesophageal investigation.27,31

In contrast, colon capsule endoscopy (CCE) is likely to be useful in the diagnosis of colorectal cancer when colonoscopy is incomplete or contraindicated. The colon capsule uses the same technology as the small bowel and oesophageal corresponding devices, but is slightly longer than the previous ones; it measures 11×32 mm2 and has dual cameras, located at both ends, allowing image acquisition with a frame rate of 4 frames/s. It is able to operate with a pre-programme delay mode in order to save energy until it reaches the colon. The first two prospective studies on colon capsule endoscopy for the detection of polyps looked at measures needed to ensure a clean colon, which is essential for good quality imaging. The reported sensitivity varied from 50% to 70%, and specificity from 73% to 100%, when comparing colon capsule with colonoscopy for the detection of polyps.11,13 A recent prospective study of 36 patients reported that colon capsule endoscopy was a reliable way to inspect the colon; this may increase compliance with colorectal cancer screening.34 Although initial experiences were clearly focused on the detection of colonic neoplasia, CCE has also been shown to detect a variety of lesions such as diverticulosis, proctitis, angioomas and melanosis coli.35,36

Conclusion

Capsule endoscopy is a reliable, well accepted and tolerated by the patients, which allows complete exploration of the small intestine. The advent of CE has dramatically changed the diagnosis and management of many diseases of the small intestine, such as obscure gastrointestinal bleeding. Crohn’s disease, small bowel tumors, polyposis syndromes, etc. Lately this technique has also been used for esophageal and colonic diseases. The introduction of CE and deep enteroscopy has allowed the endoscopist access to the small intestine that was only previously possible using intraoperative enteroscopy. CE offers the advantages of total bowel visualization during a single examination, and helps the endoscopist in deciding the route for doing deep enteroscopy (single balloon or double balloon enteroscopy).

References


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