Diagnosis of Small–Intestinal Disease with Capsule Endoscopy

TOMOYoshi SHIBUYA*, SUMIO WATANABE*

*Department of Gastroenterology, Juntendo University Faculty of Medicine, Tokyo, Japan

Capsule endoscopy (CE) is a feasible, non–invasive and safe modern–day medical procedure for the detection and diagnosis of small–intestinal lesions that are not accessible with a conventional colonoscope or an upper gastrointestinal endoscope. CE reflects a very much desired advance in the identification and diagnosis of intestinal disorders. CE is a tiny device bearing a camera, which is swallowed by the patient. As it moves along the intestine, multiple images are taken from the inside wall of the intestine and wirelessly transmitted to a recorder, which is attached to the patient. Recently, CE has gained an unrivalled popularity for examinations of the small–bowel.

Key words: capsule endoscopy, small bowel

The development of CE for clinical practice

The original CE model was developed by Given Imaging (Yoqneam, Israel) 1). The idea for the clinical application of CE is attributed to Gavriel Iddan, an electro–optical engineer at the Rafael Israel Military Armament Development Authority working on guided missile technology. Iddan produced a disposable pill–sized camera, which passed through the digestive tract, and continuously sent signals to an outside receiver. In May 2001, Iddan’s invention was approved for general clinical application in Europe, and in the same year, by the US Food and Drug Administration (FDA). During the same period, Yamamoto, et al 2), developed a double–balloon endoscope (DBE), which is based on a new insertion technique that makes it possible to insert an endoscope into the distal portion of the small–intestine. Since the introduction of CE and DBE into clinical practice, major progress has been made in the diagnosis and management of patients with disorders of the small–intestine.

In Japan, CE was approved by the Japan Ministry of Health, Labour and Welfare (MHLW) in April 2007, and reimbursement for CE costs was approved by the Japan Social Insurance Agency in October 2007. Initially, the indication for CE was gastrointestinal (GI) bleeding of unknown origin after negative upper and lower GI examinations, better known as obscure GI bleeding (OGIB). In July 2012, the MHLW cleared the Patency Capsule for use with CE and expanded the indications for CE to patients with known or suspected small–intestinal disease, including visualization and diagnosis of Crohn’s disease.

Physical features of CE

The physical size of CE (PillCam SB2, Given Imaging) is 26×11 mm. The capsule takes images at the rate of two frames per second. In the current CE models, the battery life is 8–16hr for video recording and transmission. The images are wirelessly transmitted to a receiver device usually attached to the patient. The images can be downloaded to a computer workstation, which can display the images as a video film. An abnormal image may have to be found from among over...
When reading the CE images, it is often difficult to distinguish the critical thumbnail from the multitude of other images. Therefore, the CE manufacturers have developed several adjunct techniques for image enhancement. One of these software devices is the Flexible Spectral Imaging Color Enhancement (FICE). The FICE software creates a spectral image of a specific wavelength by using an ordinary image to obtain high-contrast images essentially by selecting the wavelength suitable for a specific vessel or tissue structure. The known advantages of this new digital processing system include enhanced detection, identification of pathologic changes and improved accuracy in diagnosis. Accordingly, FICE makes it possible to obtain detailed enhanced images of mucosal structures. Additionally, FICE in CE can enhance areas of bleeding or colored lesions and facilitate rapid identification of lesions by processing the images under conditions where intestinal fluid can distort image quality.

The complications associated with CE

One serious complication encountered during CE is capsule retention, which is defined as a failure to excrete the capsule during a period of 2 weeks or longer, requiring medical, endoscopic, or surgical intervention. Based on this risk, CE is contraindicated in patients who are known to have intestinal strictures, patients with swallowing disorders, or patients with a history of bowel obstruction. Recent abdominal surgery is a relative contraindication, along with a history of abdominal imaging or small-bowel CD showing obstruction. In patients with obstructive complications or one of the aforementioned risks, cross-sectional imaging should be undertaken before CE. However, it is believed that absence of strictures on cross-sectional imaging per se does not preclude capsule retention. It would appear that the rate of capsule retention is dependent on the indication for which CE is undertaken. In healthy controls, no capsule retentions were reported. The rate of retention in patients with obscure gastrointestinal bleeding is 1.5%. In patients with known Crohn’s disease, the rate of retention is 5%, while in patients with suspected Crohn’s disease, the retention rate is 1.4%.

The patency capsule was developed to test the safety of proceeding with diagnostic CE. It has the same shape and dimensions as the prototype CE. It comprises a dissolvable body and an identification tag that is detectable by radiography. The dissolution of the patency capsule (Given Imaging) starts after 30 hr. The capsule can be detected by radiography. When the patency capsule is normally excreted or is not detectable by radiography in the small-bowel 30 hr after ingestion, it is usually safe to carry out a diagnostic CE.

Indications

The major clinical indications for CE include evaluation of occult or overt OGIB, suspected Crohn’s disease, suspected small-bowel tumor, surveillance of inherited polyposis syndromes, and evaluation of protein losing-enteropathy. The most common small-bowel findings reported for patients with OGIB were vascular lesions (40.4%), inflammatory lesions (29.9%), neoplasia (22.2%), diverticula (4.9%), and other lesions (2.7%). The data from Europe, the USA, and Australia were similar, where vascular lesions accounted for 62.2%, 63.0%, and 70.5%, respectively. However, the distribution of positive findings was different between Asia (China, Japan, Korea, etc) and the West (Europe, North America, including Australia), with inflammatory lesions (37.6%) and vascular lesions (65.9%) being the most common findings, respectively, in the two regions.

CE is known to have a better yield compared with either radiographic contrast studies or push enteroscopy (PE) for establishing the etiology of OGIB. A recent meta-analyses of 14 studies in patients with OGIB reported yields of 63% for CE and 28% for PE. CE was also compared to cross-sectional imaging in several studies and was found to be superior to either small-bowel follow through or computed tomography (CT) enteroclysis. The diagnostic efficiency of DBE and CE has been shown to be similar by a recent meta-analysis.

Vascular lesions

The most common small-bowel findings proved in patients with OGIB are angioectasias (50%).
ulcers (26.8%), and neoplastic lesion (8.8%). However, common vascular lesions including angioectasia are adaptation of the endoscopic treatment. Typical cases of angioectasia detected by CE, are presented in Figure–1.

Enteropathy associated with NSAIDs

Non-steroidal anti-inflammatory drugs (NSAIDs) are one of the most commonly used drugs in the world. Upper GI side effects are very common complications associated with NSAID use. Recently, NSAID-induced enteropathy has been visualized by CE as well as by balloon assisted enteroscopy (BAE). NSAID enteropathy is frequent and is often asymptomatic. However, extensive bleeding, stricture, or perforation may occur. The incidence of intestinal complications in healthy volunteers after taking NSAIDs was recently reported to be 55% to 75%.

Figure–2 shows a representative case of NSAID induced enteropathy as revealed by CE.

**Crohn’s disease**

In Western countries, CE has been applied to
examine the small-bowel mucosa. However, as stated above, in Crohn’s disease patients, capsule retention is likely in up to 5% of the patients with a diagnosis of Crohn’s disease\(^8\). Therefore, initially the diagnosis of Crohn’s disease by CE was a contraindication in Japan due to likely presence of asymptomatic stenosis. After July 2012, when the patency capsule was shown to be successful, CE for the evaluation of the small-bowel mucosa in patients with Crohn’s disease became acceptable.

Tumorous lesions

In patients with small-bowel (SB) tumors, the most common indication for CE is an obscure bleeding: in patients who underwent CE for various causes, the incidence of SB tumors ranged from 2% to 9%\(^{22, 23}\). Small-bowel tumors such as gastrointestinal stromal tumors, carcinoids, lymphomas, and cancers have been discovered by CE, mostly as polyps, masses, or stenosis. The introduction of CE has had a major impact on detection rate of small-bowel tumors, almost tripling the detection rate\(^{24}\), notwithstanding the fact the presence of...
tumors leads to capsule retention in 10%-25% of cases. A typical case of small-bowel tumors as detected by CE is presented in Figure-3.

Other applications of CE

Given that CE can reveal the inside of the intestine, it should be a feasible procedure for detecting tapeworms, which often colonize the human intestine. Once the presence of the worm is confirmed, the physician with the aid of CE can judge if additional vermifugal treatment is required via the detection of the proglottides, scolex or forefront of the parasite. Broadly speaking, CE may be applied to precisely locate and identify worm-size parasites in the intestine. An example showing Diphyllobothrium nihonkaiense infection detected by CE is shown in Figure-4.

Detection of small-intestinal lesions associated with SLE

Systemic lupus erythematosus (SLE) is a widely known autoimmune disorder of diverse clinical features, and can affect multiple sites in the body. It is known that many SLE patients have intestinal involvement, which is often missed during surveying with conventional methods. CE has appeared to be a relevant approach to detect and diagnose small-intestinal lesions associated with SLE, which are difficult to detect by CT. A case of small-bowel SLE lesions detected by CE is presented in Figure-5.

Concluding remarks

The development and introduction of CE into clinical practice represents a major advance in the visualization and diagnosis of GI lesions and beyond. CE allows physicians to undertake diagnostic investigations at sites in the small-intestine, which cannot be reached by conventional colonoscopy or by upper GI endoscopy. While CE provides the best opportunity to view the inside of the small-intestine, it has several drawbacks including limited battery life, retention of the capsule at narrowed areas due to stenosis, strictures or tumors, and the demand for time to examine countless number of images CE provides, which can be a tedious, time-consuming task for the conscientious physician. However, currently work is in progress on other novel devices, which are expected to reflect further advances in our endeavor to improve the quality of GI disease management.

Acknowledgment

The authors thank Dr. Osamu Kobayashi for introducing a case for this report.

Figure-5 CE detection and the diagnosis of small-intestinal lesions associated with SLE
References