

REVIEW

Capsule endoscopy

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Abstract

Capsule endoscopy (CE) is a simple, safe, non-invasive, reliable technique, well accepted and tolerated by the patients, which allows complete exploration of the small intestine. The advent of CE in 2000 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.* CE has become the gold standard for the diagnosis of most diseases of the small bowel. Lately this technique has also been used for esophageal and colonic diseases.

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INTRODUCTION

A few years ago, the assessment of small bowel pathology was a major dilemma, especially when it came to the management of obscure gastrointestinal bleeding. Evaluation of the patients was frequently unsatisfactory because of the inability to completely visualize the small bowel mucosa with the available endoscopic and

radiological techniques. Capsule endoscopy (CE) was launched at the beginning of this millennium and since then has had a very important impact on managing obscure gastrointestinal bleeding and many other small bowel diseases.

CAPSULE ENDOSCOPY

Until a few years ago, the small bowel was an organ which was very difficult to explore with the available endoscopic, radiological and nuclear medicine techniques. In routine practice, only the last few centimeters of the ileum were accessible to retrograde visualization by ileocolonoscopy. Exploration from the proximal side by push, sonde or intraoperative enteroscopy were invasive procedures that did not always allow us to visualize the lesions in the small bowel^[1]. Sonde enteroscopy had been abandoned in the 90's because it was a tedious technique (long duration of the procedure) and it had several technical limitations. Push enteroscopy is limited by the depth of insertion of the scope and is poorly tolerated. Intraoperative enteroscopy is the most effective of these techniques, but it is the most invasive with a significant percentage of adverse side effects^[2].

With wireless CE we can provide a simple, safe, non-invasive, reliable procedure, well accepted and tolerated by the patient, which has revolutionized the study of the small bowel. This technique evaluates endoscopically, with high resolution images, the whole small bowel, avoiding any sedation, surgery or radiation exposure^[2].

Currently, CE is recommended as a third stage examination, after negative gastroscopy and colonoscopy in patients with obscure gastrointestinal bleeding. Also many studies have established, with a growing body of evidence, that this technique is cost-effective in other clinical situations, such as detection of small bowel lesions in Crohn's disease in patients in which other methods have failed to provide a diagnosis, non-steroidal anti-inflammatory drug enteropathies, celiac disease, small bowel polyposis syndromes and small bowel tumors^[2]. Other possible indications are HIV patients with gastrointestinal symptoms^[3], malabsorptive syndromes other than celiac disease^[4], Henoch-Schonlein purpura^[5], patients with small bowel transplants^[6] and with intestinal graft *versus* host disease, particularly in monitoring the response to immunosuppressive therapy^[7].

The acquired knowledge of the wide range of lesions that can be found in the small bowel, encouraged the

implementation of some diagnostic and therapeutic techniques, such as double balloon enteroscopy, MRI-enteroclysis and CT-enteroclysis^[2].

The capsule endoscope is a disposable, small, swallowable, wireless, miniature camera which allows us to get a direct visualization of the gastrointestinal mucosa^[8]. The initial capsule endoscope was developed by Given Imaging (Yoqneam, Israel) and approved in Europe by the European Medicines Agency and in the United States by the Food and Drug Administration in 2001^[8]. This technique is available in over 4500 gastrointestinal centers throughout the world.

The capsule which measures only 11 mm × 26 mm and weighs 3.7 g, holds a metal oxide semiconductor imaging-chip video camera, 6 white light-emitting diode illumination sources, 2 silver-oxide batteries and a radio telemetry transmitter. The image field is 140 degrees, magnification is × 8 and the depth of view is 1 to 30 mm^[9,10].

Before the capsule is swallowed, 8 skin antennas are taped to the patient's anterior abdominal wall and connected to the hard drive. After an overnight fast, 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^[11].

The camera is activated by removal of the capsule from its magnetic holder and takes 2 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 h). The use of the real time viewer may shorten procedures, as the patient can be disconnected once the cecum is visualized^[11].

After those 8 h, the sensor array and recorded data are removed and the recorded images are downloaded to the computer. It takes on average 40-60 min to read these images^[3,12] and since it is very time-consuming, one possible cost-effective strategy could be the use of expert nurse endoscopists to select images. Some studies have shown that highly motivated nurses and gastrointestinal residents trained to read CE can detect clinically significant lesions at a similar rate to physicians^[13-15]. Since its development, additional support systems have been added to the software to assist the reader, such as localization capability, suspected blood indicator, a multi-viewing feature and quick view modality^[3].

The capsule is excreted with the feces, usually within 24 to 48 h^[16]. CE is usually performed as an outpatient procedure. The presence of intestinal contents or a motility disorder may cause the incomplete visualization of the intestinal mucosa. Several studies have examined the possibilities of improving bowel cleanliness and shortening transit time by means of different medications and different fasting periods. Nevertheless, small bowel preparation is still a controversial issue^[6]. We have participated in a prospective multicenter randomized trial which has shown that bowel preparation with different laxatives does not improve the visualization of the small intestine^[17].

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^[18]. 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^[6] and to 21% in patients with intestinal obstruction^[3]. At present CE has some technical limitations: it cannot be used to obtain biopsy specimens or for endoscopic treatment and it cannot be controlled remotely^[8]. CE has also some clinical limitations which are problems in sizing and locating small bowel lesions^[2], a possible false-negative CE result, due to the fact that the global miss rate is about 11%, ranging from 0.5% for ulcerative lesions to 18.9% for neoplastic disease and the fact that sometimes we can get findings of uncertain relevance in healthy subjects^[8]. Another drawback is that in almost 20% of procedures the capsule does not reach the cecum while it is active^[11].

Since its development, more than 650 000 capsules have been swallowed worldwide^[19] and more than 1000 peer-reviewed publications have appeared in the medical literature. The most important gastrointestinal societies have published guidelines about its use (ASGE^[20], ESGE^[21], BSG^[22]).

In latter years, breakthrough developments in CE technology have enabled the direct visualization of the upper^[23,24] and lower segments^[25,26] of the gut using specifically designed capsules.

In recent issues of this journal we have coordinated the publication of several papers, some covering the latest advances in this field, presenting the use of CE in diagnosis of gastrointestinal bleeding^[27], inflammatory bowel disease^[28], celiac disease^[29], neoplastic disease^[30], non-steroidal anti-inflammatory drugs-enteropathy and rare intestinal diseases^[31], and also its use in pediatric patients^[32]. Others studied the value of intestinal preparation before CE^[33], CE use in the colon^[34] and esophagus^[35], and the Patency and Agile^[36] capsules, and finally another paper was about the future of the CE^[37].

I wish to emphasize here that we have been very successful in convincing some of the most important groups working in this area to write the above-mentioned papers.

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