Online Submissions: wjg.wjgnet.com
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doi:10.3748/wjg.15.1934

World J Gastroenterol 2009 April 28; 15(16): 1934-1942
World Journal of Gastroenterology ISSN 1007-9327

TOPIC HIGHLIGHT

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Five years' experience with capsule endoscopy in a single center

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Received: February 1, 2009 Revised: March 19, 2009
Accepted: March 26, 2009
Published online: April 28, 2009

Abstract

Capsule endoscopy (CE) is a novel technology that facilitates highly effective and noninvasive imaging of the small bowel. Although its efficacy in the evaluation of obscure gastrointestinal bleeding (OGIB) has been proven in several trials, data on uses of CE in different small bowel diseases are rapidly accumulating in the literature, and it has been found to be superior to alternative diagnostic tools in a range of such diseases. Based on literature evidence, CE is recommended as a first-line investigation for OGIB after negative bidirectional endoscopy. CE has gained an important role in the diagnosis and follow-up of Crohn's disease and celiac disease and in the surveillance of small bowel tumors and polyps in selected patients. Capsule retention is the major complication, with a frequency of 1%-2%. The purpose of this review was to discuss the procedure, indications, contraindications and adverse effects associated with CE. We also review and share our five-year experience with CE in various small bowel diseases. The recently developed balloon-assisted enteroscopies have both diagnostic and therapeutic capability. At the present time, CE and balloon-assisted enteroscopies are complementary techniques in the diagnosis and management of small bowel diseases.

Key words: Capsule endoscopy; Small bowel diseases; Obscure gastrointestinal bleeding; Crohn's disease; Celiac disease; Indications; Contraindications

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Kav T, Bayraktar Y. Five years' experience with capsule endoscopy in a single center. *World J Gastroenterol* 2009; 15(16): 1934-1942 Available from: URL: http://www.wjgnet.com/1007-9327/15/1934.asp DOI: http://dx.doi.org/10.3748/wjg.15.1934

INTRODUCTION

Examination of the small bowel (SB) has been considered a challenge for several anatomical (i.e. distance from external orifices, length) and physiological (i.e. active peristalsis) reasons. Conventional techniques of endoscopy are limited by length while radiologic examinations, such as barium studies, are insensitive for the evaluation of pathology in the SB. An ingestible miniature camera device capable of obtaining images of the whole small intestine was developed due to a need for the exploration of this "final frontier". Video capsule endoscopy (CE) is a breakthrough in medical history for noninvasive imaging of the entire small intestine[1-3]. It was first introduced in 2000, and since then more than 700 studies have been published, which is indicative of its ease and the widespread acceptance of this new diagnostic tool[4]. According to reports by Given Imaging, more than 650 000 CEs have been performed, representing an increase in the utilization of this technology of approximately 15% over the previous year[5]. Problems with reimbursement, physician training, time requirements for interpretation and lack of therapeutic capability limit the further widespread use of this technology.

A wide range of uses for CE has been reported in the literature, but the majority of the studies have aimed to evaluate the cause of obscure gastrointestinal bleeding (OGIB). Recent studies showed the superiority of CE over conventional methods, but passive features such as inability to insufflate the bowel and to biopsy and lack of therapeutic capability have generated a debate on its advantages[6-14]. Newly developed balloon assisted enteroscopes are also available and have the potential to outscore CE in terms of diagnostic indications and therapeutic applications.

The purpose of this article was to review and share our institution's results using small bowel CE, with special reference to the existing literature.

PROCEDURE

Technical features of the capsule

The Given M2A (Given Imaging; Yoqneam, Israel) video CE is a pill-shaped wireless device with a slippery coating for easy ingestion and measures 11 mm × 26 mm. It is composed of a white light-emitting diode as light source, lens, imaging chip, batteries and a radio transmitter with internal antenna. The image field is 140 degrees and magnification is × 8[4]. Once swallowed, the capsule moves thorough the intestine *via* peristalsis and is excreted in the stool. The camera takes two images per second as it sweeps the intestine and transmits these to eight lead sensor arrays, arranged in a specific manner and taped to the anterior abdominal wall, connected to a recording device in the belt for the duration of the battery life, which is 6-8 h. Once the study is completed, the recording device and sensor arrays are removed and the images (50 000-60 000 images total) are downloaded to a computer with reporting and processing of images and data (Rapid, Given Imaging) software that displays the video images on a computer monitor. This software includes a localizing system, blood detector and some features to assist the interpreter. The suspected blood indicator is quite good at detecting active bleeding, but is not so useful at detecting other lesions and does not replace careful examination of the CE. It is recommended that patients avoid magnetic fields such as magnetic resonance imaging (MRI), and metal detectors until the capsule is excreted in the stool, which usually occurs in 24-48 h.

Bowel preparation

Pre-procedure bowel preparation is a controversial issue. Some favor the bowel preps and prokinetics. Incomplete SB transit during the examination occurs in about 20% of patients[6]; however, according to data from the international conference on capsule endoscopy, it was suggested that there was no need for routine use of bowel preparations[11]. We performed CE in an ambulatory outpatient setting, but there were some inpatients. All of the patients undergoing CE examination had bowel preparations before the procedure. Each patient was administered 3 L of polyethylene-glycol solution for bowel cleansing. Patients fasted overnight for at least 12 h before taking the capsule. After ingestion of the capsule, patients were allowed to drink clear liquids after 2 h and eat a light meal after 4 h and were observed for 8 h at the study site.

INDICATIONS

Capsule endoscopy is mainly indicated for the evaluation of SB diseases, particularly for the diagnosis of OGIB. CE can be used in a variety of conditions including Crohn's disease (CD), malabsorption, chronic diarrhea, evaluation of refractory iron deficiency anemia, abdominal pain, polyposis syndromes, celiac disease, and detection of SB tumors. Graft versus host disease (GVHD) and follow-up of small intestine transplantation are rare indications, but our experience thus far did not include such patients. CE with high frame rate (PillCam Eso, Given Imaging) can be used for esophageal disorders, such as noninvasive evaluation of esophageal varices, esophagitis and Barrett's esophagus[11]. Table 1 shows the indications and contraindications for Capsule Endoscopy.

Table 1 Indications and contraindications of capsule endoscopy

Indications	Contraindications
Small bowel	Absolute
Obscure gastrointestinal bleeding	Bowel obstruction
Overt GI bleeding	Extensive and active Crohn's
Occult (positive FOBT)	Disease ± strictures
Evaluation of iron deficiency anemia	Intestinal pseudo-obstruction
Crohn's disease	Young children (< 10 years)
Suspected Crohn's disease	Relative
Indeterminate colitis	Cardiac pacemakers
Assessment of mucosal healing	Implanted electromedical
Determine post-operative recurrence	Devices
Abdominal pain	Dysphagia
Graft-versus-host disease	Previous abdominal surgery
Surveillance of polyposis syndromes	Pregnancy
Celiac disease	Diverticulosis
Suspected small bowel tumors	
Follow-up of small intestine transplantation	
Evaluation of abnormal small bowel imaging	
Evaluation of drug induced injury	
Esophagus	
Barrett esophagus	
Esophagitis	
Variceal evaluation	

We reviewed our database in a retrospective evaluation of the characteristics and findings of patients who underwent CE examination between 2003 and 2008. All patients had upper and lower GI endoscopies before the CE study. There was no clinical sign of intestinal obstruction, but patients with suspected CD had radiologic examinations to exclude obstruction. A total of 120 CE examinations were performed from 2003 to 2008 for various indications. The average patient age was 47.7 ± 18.2 (min: 13 - max: 97), 45 were female (37.5%) and 75 male (62.5%). The CE completely evaluated the entire SB in 89 patients (74.2%). Indications for CE were OGIB (57.5% of cases), diarrhea (15%), abdominal pain (5.8%), other indications such as known CD, and surveillance for polyposis syndromes. CE study was normal without any finding in 22.5% of patients. We did not use CE for esophageal disorders and there were no findings suggestive of esophageal diseases.

OGIB

Gastrointestinal bleeding is a common problem encountered by gastroenterologists during clinical practice. Proximal and distal bleeding sites are mostly identified by means of endoscopy and colonoscopy. The bleeding

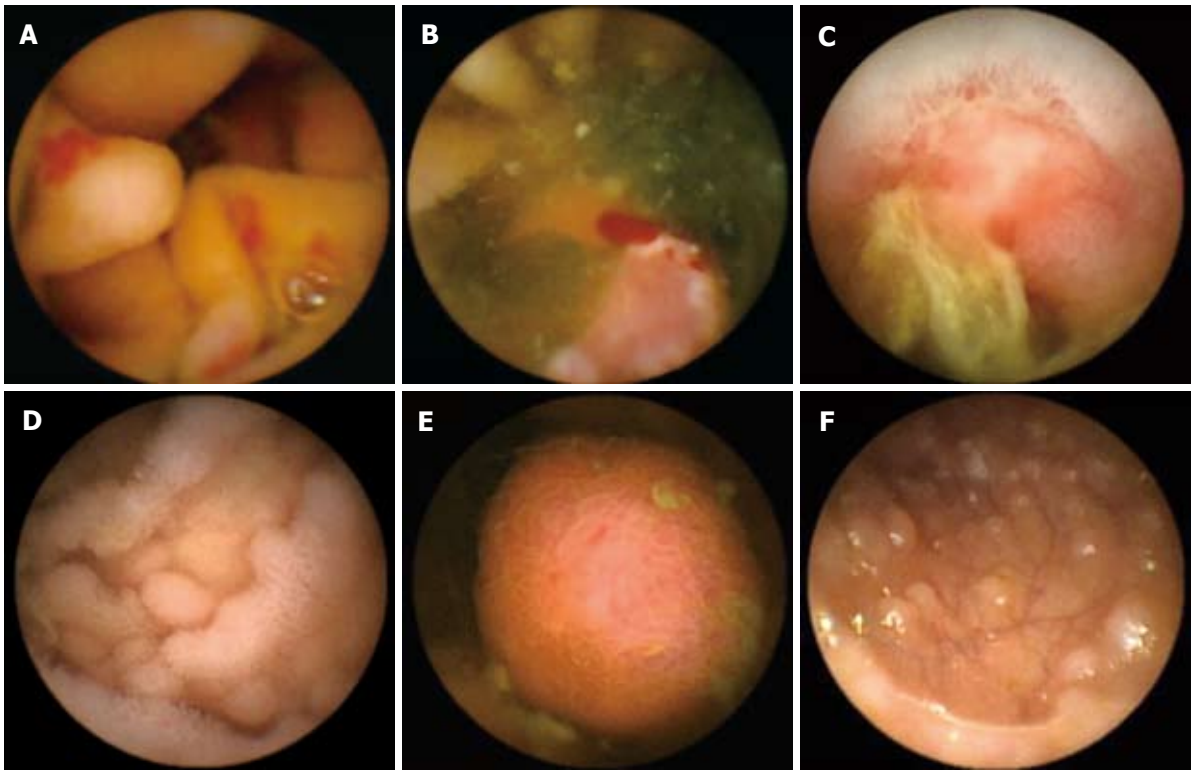

Figure 1 VCE images of lesions found in patients with obscure-overt GI bleeding. A: Multiple angiodysplasias in the jejunum; B: A jejunal mass with active bleeding; C: An ileal ulcer in a patient with newly diagnosed Crohn's disease. VCE images of small bowel polyps; D: Benign lymphoid hyperplasia located diffusely through the GI tract in a patient with CVID; E: A jejunal polyp in a patient with peutz-jeghers disease; F: Multiple small polyps in the ileum in the same patient depicted in Figure 1 E.

source is not identified in 3%-5% of cases despite the utilization of multiple studies[15,16]. OGIB is defined as bleeding from an unidentified source that persists and recurs after a negative endoscopy examination[16,17].

Obscure GI bleeding is the most common indication for CE examination. CE has a high diagnostic yield in OGIB, which may lead to early diagnosis and revision of the management strategy. CE facilitates effective decision-making regarding subsequent investigations and treatments[4].

Diagnostic yield of CE for OGIB varied between 31% and 91%[9,17-31]. Lema and Ruano-Ravina[32] reviewed the published studies of CE for OGIB and reported that sensitivity ranged from 79% to 95% and specificity from 75% to 100%. The positive predictive value (PPV) varied from 94% to 100% and the negative predictive value (NPV) from 80% to 100%. CE led to a change in therapeutic management in 9%-77% of patients. A recent study by Albert *et al*[33] reported that CE detected the bleeding source in 76.8% of patients.

The diagnostic yield of CE in OGIB depends on the type of bleeding. Pennazio *et al*[17] found that the highest yield of CE was in patients with active bleeding (92.3%) compared to those with obscure occult bleeding (44.2%). Researchers observed a reverse relationship between findings and time after last bleeding episode. The longer the time from last bleed, the lower the diagnostic yield. Do the lesions discovered by CE have any bleeding potential or clinical importance in terms of management change? Saurin *et al*[18] showed that CE detects more lesions, but only half of them have true bleeding potential.

Several studies examined the diagnostic role of CE in OGIB and mostly compared the diagnostic yield of CE to other diagnostic modalities. CE is superior to other techniques in diagnosing the source of bleeding. The yield for CE is 63% and 67% compared with 28% for push enteroscopy (PE) and 8% for barium study[34].

Obscure GI bleeding was the most common (57.5% of cases) indication for CE study in our cohort. SB ulcerations were found in 25.8% of patients. Angiodysplasias were present in 12.5% of cases (Figure 1A). Active bleeding was observed in 8.3% of patients. Figure 1B shows a jejunal mass, which was found to be adenocarcinoma, with active bleeding. Diagnostic yield of CE for OGIB was 72.5% in our series. We have been performing single balloon enteroscopy (SBE) (Olympus; Tokyo, Japan) and a few patients underwent both CE and SBE. CE revealed angiodysplasias in two patients with OGIB who were treated with argon plasma coagulation during SBE examination. Balloon assisted enteroscopy and CE should be used as complementary studies. It is advisable to use CE to detect lesions and direct enteroscopy for the therapeutic interventions.

Crohn's disease

Crohn's disease is a chronic inflammatory disease that can involve any part of the GI system, and disease is

confined to the SB in about one-third of the patients. There is no single test to diagnose CD completely, so CD diagnosis can be established with a combination of clinical, endoscopic and histological findings. Most imaging studies lack sensitivity to identify early changes, and endoscopy does not allow total examination of the bowel. CE is able to identify mucosal changes before other technologies. It has a valuable role in the evaluation of the SB in patients with suspected or known CD. The use of CE in the diagnosis of small bowel CD has been examined in several studies. Triester *et al*[35] compared the yield of CE with other modalities in patients with suspected small bowel CD. Diagnostic yield of CE was 63% compared with 23% for barium radiography. When compared with ileocolonoscopy, CE had a higher yield (61% *vs* 46%). Compared with PE, CE had a 38% higher yield, and when compared with CT enterography, the yield of CE was 69% to 30%. Due to its high diagnostic yield, CE will have a very important place in the diagnostic workup of patients with CD, but more studies are needed to make such suggestions. Triester *et al*[35] reported in their meta analysis that there was no statistical significance in the incremental yield between CE and other diagnostic modalities in patients suspected of having CD. However, there was a significant difference in yield of CE over alternative methods in patients with known CD who were being evaluated for SB recurrence[35]. Yield of CE is low when performed in patients with abdominal pain alone; when other criteria are added, this yield is increased[34].

Capsule endoscopy can be used for the assessment of mucosal healing after treatment. The only limitation of CE is its inability to offer biopsy for histological examination. A scoring system has been proposed to evaluate CD on the basis of CE findings of villous structure, ulceration and stenosis. Each variable is assessed by size and extent of the change[36]; however, further studies are needed to clarify the helpfulness of this system. The score provides a common language to quantify mucosal changes associated with any inflammatory process. The index does not diagnose or measure a disease, it measures mucosal change. In addition, this scoring index does not have the discriminatory ability to differentiate between illnesses. This index could be helpful in determining mucosal healing after therapy in CD[34]. Mucosal breaks and aphthous ulcers or erosions are also seen in asymptomatic healthy volunteers. Since nonsteroidal antiinflammatory drugs (NSAIDs) may cause ulcerations resembling those of CD, patients should be advised to stop such drugs at least one month before the CE examination[10]. It is difficult to differentiate these findings with the presence of CD.

Mucosal ulcerations were the most common finding in our patient series, determined in almost one out of four patients. CD was the third most common indication for CE study (6.7% of patients). Patients with CD had severe ulcerations and two patients had strictures that resulted in regional transit abnormality. However, no capsule retention occurred in this group. Moreover, CE changed the management strategy in 10% of patients with a new diagnosis of CD. Another interesting finding was that 37.5% of the patients diagnosed as suspected CD did not have complete examination. Nonspecific jejunoileitis and NSAID-induced erosions were observed in 6.7% of patients. Figure 1C shows a mucosal ulceration.

Celiac disease

Celiac disease is an immune-mediated disease characterized by chronic SB inflammation that may result in mucosal atrophy, malabsorption and related clinical manifestations. Diagnosis is based on the combination of serologic, endoscopic and typical histological changes of the SB biopsy in clinically suspected patients. Its prevalence is around 1% in the United States. There are four endoscopic changes suggestive of villous atrophy: loss of mucosal folds, mosaic mucosal pattern, scalloping of the duodenal folds and nodularity of the mucosa[37]. It is no surprise that CE provides high resolution images that contain such changes. Rondonotti[38] evaluated 43 patients with signs or symptoms suggestive of celiac disease and positive serological markers. Patients underwent both CE and upper GI endoscopy. Characteristic histological changes were observed in 32 patients. Using this as a gold standard, 87.5% of patients were diagnosed by CE. Mucosal changes beyond the duodenum were detected in 18 (66.6%) patients and in 3 (11.1%) patients the whole SB was affected.

Another newly published study, searching for celiac disease in older adults, also showed that duodenal mucosa was normal in appearance on CE in 71% of patients, but classic abnormalities of celiac disease were present distally[39].

Overall, CE can detect endoscopic markers of celiac disease. In addition, CE seems to be able to recognize the extent of disease and may be a tool for follow-up. CE has a high sensitivity (range, 70%-95.2%), specificity (range, 63.6%-100%) and high PPV and NPV (96.5%-100% and 71.4%-88.9%, respectively)[38,40-43]. When an atrophic pattern is detected by CE, the patient has a high probability of having celiac disease[37]. CE has also been reported to be able to demonstrate diseases such as adenocarcinoma, lymphoma or ulcerative jejunoileitis, which may complicate the course of celiac disease. A limitation is that CE is able to detect Marsh Ⅲ lesions, which are associated with clear mucosal abnormalities, but may not distinguish between Marsh Ⅰ and Ⅱ lesions[37]. At present, CE is an alternative to endoscopy with biopsy in patients with suspected celiac disease who do not consent to the conventional methods.

Chronic diarrhea was the second most common indication for CE study in our series. Half of these patients did not have any condition that may cause diarrhea. Lymphoid hyperplasia and nodularity were observed in 6.7% of patients. Lymphoid hyperplasia due to common variable immune deficiency was detected in three pa-

tients. Celiac disease was investigated in only one patient but CE examination was completely normal. One patient with iron deficiency anemia had mucosal atrophy on CE examination and was diagnosed as having celiac disease. Figure 1D shows benign lymphoid nodular hyperplasia in a CVID patient.

Small bowel tumors and polyps

Capsule endoscopy is a major advance in the diagnosis of SB tumors. Before the introduction of CE, malignant neoplasms of the SB were often diagnosed at a later stage of the disease, mostly during the work-up of obstructive symptoms. Diagnosis is delayed because conventional imaging techniques fail to detect small neoplasms in almost half of the patients. SB tumors are a rare disease, accounting for 1%-3% of all primary GI tumors. SB mass lesions are responsible for OGIB in up to 10% of patients[44-48]. Early clinical studies of CE have reported a frequency of SB tumors ranging between 6% and 9%[49-54]. This has led to an idea that CE doubled the rate of diagnosing SB tumors. However, a recent multicenter European study showed that the frequency of SB tumors was 2.4% and the most common indication for CE was OGIB[55,56]. SB tumors appear as masses or polyps in most patients and ulcer or stenoses in a minority of patients. It is not possible to distinguish the type of tumor based only on CE pictures. Most of the tumors reside in the mid SB[56].

Capsule endoscopy is also useful for the surveillance of polyps in patients with inherited GI polyposis syndromes (familial adenomatous polyposis and Peutz-Jeghers syndrome), who are at increased risk of developing polyps in the SB. Several studies comparing the yield of CE to other imaging modalities in patients with polyposis syndromes have shown that CE is accurate in the detection of polyps. The same studies also emphasized that CE is not reliable for sizing and determining localization of polyps[57-60]. The duodenum is a potential blind point of CE because the capsule passes quickly with tumble and results in inadequate examination. Wong *et al*[61] reported that CE underestimated the total number of polyps and did not reliably detect larger polyps in that portion.

In our series, SB masses were diagnosed in 4.2% of patients who had tumor resection, and two patients had benign tumors. CE examination was done in only one patient with Peutz-Jeghers disease. CE revealed a few proximal jejunal polyps measuring < 2 cm (Figure 1E and F). Subsequent enteroscopy showed multiple jejunal polyps with diameters up to 8 cm. CE definitely has a potential for use in patients with polyposis syndromes, but more studies are needed.

Other indications

Abdominal pain is one of the most common symptoms of patients referred to the gastroenterologist. Use of CE for the evaluation of abdominal pain is debated. Although some serious causes are identified in such patients, CE is mostly unyielding. If patients with other signs and symptoms of inflammation were selected, than the diagnostic yield was considerably higher[62].

Capsule endoscopy may be helpful in the diagnosis of the following diseases: surveillance for NSAID side effects, Henoch-Schönlein purpura, indeterminate colitis, protein losing enteropathy, intestinal lymphangiectasia, Meckel's diverticulum, follow-up of SB transplantation, GVHD, and bowel changes in refractory pouchitis[1-10,62].

COMPLICATIONS, LIMITATIONS AND SAFETY ISSUES OF CAPSULE ENDOSCOPY

Capsule endoscopy is a safe and well-tolerated procedure for patients, with very low complication rates. Contraindications to CE include the presence of intestinal obstruction, fistulas and strictures. Swallowing abnormalities and esophageal stricture are other contraindications for the procedure. Capsule retention is the major complication of CE. Retention is defined as the indefinite presence of a capsule in the SB. This is different from slow transit, incomplete transit or regional transit abnormalities. In these cases, the capsule stays in the ileum but ultimately passes *via* peristalsis. Retention can cause symptoms of SB obstruction that in turn lead to need for endoscopic or surgical removal of the capsule[63,64].

Retention risk is high in patients with known CD, NSAID stricture, radiation enteritis and SB tumors. The capsule retention rate ranges from 0% to 13%. The rate of retention in patients with OGIB is 5% and in suspected CD 1.4%, and it can be as high as 8% in patients with known CD. Interestingly, no capsule retention was reported in healthy volunteers. The overall frequency of capsule retention is usually 1%-2%[10,63,64]. A negative SB series does not prevent capsule impaction[17]. It is advisable to perform abdominal radiographs within two weeks to identify capsule retention if the capsule did not enter the colon. Therapeutic intervention can be instituted anytime unless the patient becomes symptomatic[4].

The patency capsule (Agile Patency System, Given Imaging Ltd; Yoqneam, Israel) has been developed for the detection of high-risk patients before the procedure. This capsule is identical to the video capsule, with the same dimensions, and is made of lactulose and 5% barium, which make the capsule radiopaque and it dissolves spontaneously after 40 h. The capsule has a radiofrequency identification tag that enables easy detection by a special handheld device. In a recent study that included patients with known strictures, no CE retention occurred if the patency capsule passed safely[65]. Although there are promising data on patency capsule use before CE, it is still not definitive to predict capsule retention based on results of barium studies or patency capsule.

Another theoretic risk is electromagnetic interference with implantable medical devices, pacemakers, *etc*. In a small series of patients, no adverse cardiac effect or

image distortion due to interference was noted. Large sample sized studies are needed to confirm the safety of capsule in this context[66].

Reading the procedure is a time-consuming process and reading time is another limitation of this procedure. The optimal review rate is 15 images/s and it takes over 1 h to read a full 8-h procedure[62]. The reliable interpretation of the CE procedure requires experienced readers (experience of reading at least 20 studies).

Another clinical problem is sizing and locating SB lesions, since location and size are important findings for subsequent management. CE underestimates the number of SB polyps and does not reliably detect large polyps[61]. Technical problems related to the battery and failure of image downloading are also reported. The overall rate of technical failure is around 9%[10]. Incomplete study occurs due to delayed gastric emptying, previous SB surgery, hospitalization and poor bowel cleansing. A gastric transit time longer than 45 min was identified as a risk factor[67]. Reported incompletion rates vary between 0% and 50%, approximately 20% to 30% in most studies[67]. Effect of prokinetic drugs on completion rates is uncertain. Real time viewers of CE may help to identify prolonged gastric stay and in such case, endoscopy can be done to push the CE into the SB.

The overall miss rate of CE is about 11%, ranging between 0.5% for ulcerative disease and 18.9% for neoplastic disease. Of course, this rate is much lower than conventional examinations[47]. Inability to take biopsy or perform any therapeutic procedure is also a limitation of the CE, which makes balloon assisted enteroscopies a good choice for a number of indications.

In our patient cohort, the most common cause for an incomplete examination was premature battery failure in 20 patients (16.7%), followed by technical problems, of the capsule itself, in seven patients (5.8%). No complication related to the CE procedure was observed. There was no capsule retention event. Two patients' studies showed regional transit abnormality. One was due to severe CD with stricture, and the other patient had an ileal adenocarcinoma that was diagnosed after operation for ileal perforation. Although there was a temporal relation of perforation to CE study (2 d after the study), no capsule was detected in the preoperative radiograms and CE was not the likely cause of perforation. There was no patient with an implantable cardio defibrillator or pacemaker among our cohort, but it seems safe to use the capsule in these patients. Based on our data, we can say CE is a safe procedure. Placing the capsule directly in the duodenum by means of dedicated devices or endoscopy may lower the incomplete examination rate. However, by doing so, we can miss esophageal and gastric disorders in which CE is also informative. Therefore, if selective placement of the capsule is preferred, the proximal GI tract should be carefully reexamined. Higher capture rate and longer battery life could resolve these obstacles.

OTHER TYPES OF CAPSULE ENDOSCOPE

The Olympus Endo Capsule (Olympus; Tokyo, Japan) has been in the Turkish market for a while, but there is not yet sufficient experience with its use. It differs from the PillCam by having a high resolution image chip and an external real time viewer. There are additional SB capsule systems that are not currently available in Turkey. One is from China, the OMOM pill (Jinshan Science and Technology; Chongqing, China) and there is also a Korean model (MicroCam, Intromedic; Seoul, Korea)[68,69]. Both the capsule endoscopes are similar to the PillCam in terms of battery life, dimensions, field of view and picture intervals. The first trials of the MiRo capsule and OMOM capsule were published in 2008 but they were without FDA approval. The MiRo capsule uses a novel telemetry technology known as "electric-field propagation", which uses the human body as a conductive medium for data transmission. A pair of gold plates coated on the surface of the capsule acts as a transmitter. This is claimed to be superior in terms of battery life since the CE has few power-consuming components. Bang *et al*[68] used this new capsule in 45 healthy adults and it produced good image quality and capture rates. This capsule may also be used for the colon due to the long battery life. The first trial of the OMOM CE revealed comparable results to the PillCam. The authors express the cost advantage over other CEs, which could affect the choice of CE systems because of reimbursement problems[69]. PillCam SB2 and EndoCapsule have real time viewer capability that may shorten the examination once the cecum is seen. PillCam ESO was specially designed for investigation of esophageal disorders. It may be an accurate noninvasive method for detection of esophageal varices and portal hypertensive gastropathy, but it may not be suitable as a screening tool for Barrett's esophagus[12]. PillCam COLON is bigger than the standard PillCam SB capsule (11 mm × 31 mm). It was developed for detection of colonic neoplasia. It is a promising tool but further studies and improvements are needed before its regular use[70].

In summary, capsule endoscopy is a new diagnostic modality for the diagnosis and management of GI disorders. It is a simple and well-tolerated procedure. Capsule retention is the major complication. Care must be taken in patients with symptoms suggesting partial obstruction and CD. SB series and computerized tomography enteroclysis before CE may reveal stenosis. The newly developed patency capsule may be an alternative for detection of stenoses.

The value of CE in patients with OGIB appears to be high and is supported by high yields in the literature. CD and celiac disease appear to be areas where use of CE would be helpful. There may also be an indication for CE in CD surveillance and follow-up. The diagnostic role of CE extends beyond the SB. PillCam ESO and COLON showed promising outcomes in diagnosing esophageal and colonic diseases. More

research is needed to explore the feasibility of CE in these contexts.

Blind spots of CE such as the duodenum should be examined by a second look endoscopy before the CE procedure, especially in patients with OGIB. After negative endoscopic examinations, CE should be recommended as a first-line investigation over balloon assisted enteroscopies in view of its noninvasiveness, higher probability of visualizing the entire small intestine and the similar diagnostic yield of both investigations. Such an approach may decrease the time between diagnosis and intervention. A second look CE may reveal more findings in up to 35% of patients who had prior nondiagnostic CE.

CONCLUSION

The newly announced CEs would fire up the competition for new innovations and possible cost reductions, making possible the widespread use of this technology. Improvement in capsule design for better luminal visualization by coupling with a second backward camera, higher frame rates for viewing and longer battery life will definitely overcome the blind spots resulting in complete and detailed examination of the whole GI tract from the mouth to anus with just one capsule, as the capsule named M2A has denoted.

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