Capsule Endoscopy – State of the Art

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Key Words

Capsule endoscopy • Small bowel endoscopy capsule • Esophageal endoscopy capsule • Colon endoscopy capsule

Abstract

Capsule endoscopy is a new technology that was recently introduced into clinical practice for the diagnosis of gastrointestinal diseases. As of today, three different capsule types have been produced, designed for the exploration of the small bowel (PillCam SB), the esophagus (PillCam ESO) and the colon (PillCam Colon). The PillCam SB has gained widespread acceptance as a powerful tool for the diagnosis of bleeding from the small bowel as well as for other indications. The PillCam ESO has been used to study patients with gastroesophageal reflux disease, for the screening of Barrett's esophagus, and for the screening and surveillance of esophageal varices in patients with cirrhosis. The results of the pilot studies carried out with this capsule have been encouraging. Large-scale studies are ongoing. The evaluation of the potential of the PillCam Colon capsule is still in its infancy: the two pilot studies published showed that this capsule can produce high-quality images of the colon. The potential of this capsule for clinical purposes, such as colon cancer screening, needs to be evaluated.

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Introduction

Capsule endoscopy (GIVEN Capsule Endoscopy System; GIVEN Imaging Ltd, Yokneam, Israel) is a new technology that was recently introduced into clinical practice for the diagnosis of gastrointestinal diseases. The first endoscopic capsule (PillCam SB), introduced in 2001, was designed for the study of small bowel lesions and has gained widespread acceptance as a powerful tool for the diagnosis of bleeding from the small bowel as well as for other indications. The PillCam SB was followed in 2004 by the introduction of the PillCam ESO capsule, for the diagnosis of gastroesophageal reflux disease and for the screening and surveillance of esophageal varices in patients with cirrhosis, and in 2006 by the introduction of the PillCam Colon capsule, for the diagnosis of colonic diseases. The latter two capsules are currently undergoing intensive investigation to test their safety and performance for the proposed indications.

The GIVEN Capsule Endoscopy System

The capsule endoscopy system has the same basic structure for all three capsules: it consists of the ingestible capsules, of a sensor array applied to the abdominal or chest wall, of a digital recorder that the patient wears on a belt, and of a workstation with dedicated software for downloading and reading the images captured by the capsules. The procedure starts with the application of the

sensor array and of the belt carrying the recorder to the patient. The patient then swallows the capsule, which travels through the digestive tract propelled by peristalsis, and is expelled with the stool after 1–7 days. During passage, the capsule transmits 2–14 (depending on the capsule type) high-quality images per second to the recorder. After the capsule batteries are spent, the recorder is retrieved and connected to the workstation for downloading the images. The software in the workstation produces videos that can be examined by the investigators.

Small Bowel Endoscopy Capsule (PillCam SB)

The PillCam SB has been widely applied in clinical practice. This capsule has a single CMOS imager that produces 2 images/s. The duration of the PillCam SB batteries is about 8 h.

The first indication for which this capsule was tested was obscure gastrointestinal bleeding (i.e. bleeding that recurs or persists after a negative upper and lower conventional endoscopy (EGDS and (ileo)colonoscopy)). Several studies have shown that the PillCam SB has a high sensitivity and specificity for this indication [1–3]. In addition, patients treated according to the diagnosis made by capsule endoscopy can achieve resolution of their clinical problem in a high proportion of cases [1]. As a result, a recent consensus conference has concluded that ‘capsule endoscopy should be part of the investigation of patients with obscure GI bleeding’ [4].

The PillCam SB has subsequently been used to study other small bowel diseases, such as inflammatory bowel disease and celiac disease. In inflammatory bowel disease, a meta-analysis [2] has shown that capsule endoscopy is more sensitive for assessing small bowel mucosal lesions compared to other imaging modalities. Therefore, the conclusion of the above consensus conference has been that ‘capsule endoscopy may have an important role in the evaluation of some patients with known or suspected Crohn’s disease’ [5]. For celiac disease, the available data show that capsule endoscopy has reasonably high sensitivity and specificity for untreated celiac disease, when compared to histology. In addition, in a study in patients with suspected celiac disease [6], including those with biopsy-proven celiac disease, capsule endoscopy had a sensitivity of 95% to detect celiac disease, with a very high concordance between capsule endoscopy and histology. As a consequence, the conclusions of the above-mentioned consensus conference were: ‘There is adequate evidence to support the use of capsule endoscopy as a

prognostic test for patients who have treated and previously confirmed celiac disease and develop alarm symptoms. Furthermore, capsule endoscopy could at present be used as an alternative to biopsy in selected patients who are unwilling or unable to undergo EGD for confirmation of villus atrophy’ [7].

Esophageal Endoscopy Capsule (PillCam ESO)

The PillCam ESO differs from the PillCam SB in that it has two CMOS imagers, one at each end. Each imager produces 7 images/s (14 images/s in total). A special ingestion procedure has been devised to slow down esophageal transit, in order to capture a sufficient number of esophageal images for interpretation. The duration of capsule batteries of the PillCam ESO is 20 min.

The PillCam ESO has been used to study patients with gastroesophageal reflux disease, for the screening of Barrett’s esophagus [8–12]. Using conventional EGDS as the gold standard, the sensitivity and specificity of capsule endoscopy for the diagnosis of Barrett’s esophagus ranged between 67 and 100% and between 80 and 95%, respectively, in the various studies.

The PillCam ESO has also been used for the screening and surveillance of esophageal varices in patients with cirrhosis in two pilot studies [13, 14]. The concordance of the capsule findings with those of conventional EGDS for assessing the presence of varices was 97 and 84%, respectively. In addition, in one of the studies [13], varices were graded both with the PillCam ESO and with EGDS, with good concordance between the two techniques.

In conclusion, the PillCam ESO is a promising tool for the evaluation of Barrett’s esophagus and esophageal varices, but the results of the pilot trials must be validated in large-scale studies on appropriate patient populations.

Colon Endoscopy Capsule (PillCam Colon)

The PillCam Colon has two CMOS imagers that capture 2 images/s each. It also has a wider angle of view in comparison with the PillCam SB and automatic light control. Five minutes after ingestion, the capsule shuts down for 2 h to conserve energy. The evaluation of the potential of this capsule is still in its infancy: so far, two pilot studies have been published [15, 16] which showed that the PillCam Colon can produce high-quality images of the colon. The potential of this capsule for clinical purposes, such as colon cancer screening, needs to be evaluated.

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