A REVIEW ON ROBOTOC CAPSULE ENDOSCOPY

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ABSTRACT

A swallowable wireless miniature camera used to capture images of the gastrointestinal (GI) mucosa is called a capsule endoscope. Given Imaging created the first capsule endoscope type, which was authorized in Western nations in 2001. Prior to the development of double-balloon endoscopy (DBE) and capsule endoscopy (CE), there was no reliable method for diagnosing and treating individuals with unclear gastrointestinal bleeding. Bleeding of unclear cause that continues or returns following a negative primary or first endoscopy (colonoscopy or upper endoscopy) result is termed as obscure gastrointestinal bleeding. The PillCam SB was the first capsule endoscope device and is currently considered a first-line tool for identifying small bowel anomalies. In April 2007, it received approval in Japan. Oblique gastrointestinal bleeding is the primary indication for using the PillCam SB. Capsule retention, or the capsule staying in the digestive tract for at least two weeks, is almost the only side effect of Capsule endoscopy.DBE has the ability to retrieve a retained capsule. One of CE's drawbacks is that it can't be used for endoscopic procedures or to acquire biopsy specimens. For the management of cryptic GI bleeding, however, a PillCam SB plus DBE seems to be the most effective combination. A number of novel capsule endoscope types have been created recently, including the Olympus CE for small bowel examination, the PillCam ESO for esophageal illness research, and the PillCam COLON for colonic neoplasia diagnosis. Capsule Endoscopy is anticipated to improve many facets of GI disease assessment and treatment in the near future.

Keyword : - *Endoscopy, Colon, GI bleeding, Polyps*.

INTRODUCTION:

A swallowable wireless miniature camera used to capture images of the gastrointestinal (GI) mucosa is called a capsule endoscope. In 2001, Given Imaging (Yoqneam, Israel) produced the first capsule endoscope type, which was subsequently certified in Europe and the US. Double-balloon endoscopy (DBE), which is predicated on a novel insertion technique that permits the insertion of an endoscope into the distal section of the small bowel, was created by Yamamoto et al. nearly simultaneously[1]. The assessment and care of patients with GI bleeding and cryptic GI bleeding have drastically changed since capsule endoscopy (CE) and DBE were introduced into clinical practice[2]. Bleeding of unclear cause that continues or returns following a negative primary or first endoscopy (colonoscopy or upper endoscopy) result is termed as obscure gastrointestinal bleeding. Instead of being divided into upper and lower GI bleeding, GI bleeding has been categorized into three categories (upper, mid, and lower GI bleeding) due to the ease with which the small bowel can be seen with both CE and DBE. Upper gastrointestinal bleeding is defined as bleeding above the Vater's ampulla and within the range of an esophagogastroduodenoscopy (EGD[3]). Colic bleeding is described as lower GI bleeding, which can be

assessed by colonoscopy, while small-bowel bleeding from the ampulla of Vater to the terminal ileum is characterized as mid-GI bleeding, best studied by CE and DBE[4] .

Fig: 1 Capsule Endoscopy

Ref: **https://www.lanermc.org/community/lane-health-blog/what-is-a-capsule-endoscopy**

WHY IS CAPSULE ENDOSCOPY IS USED[5,6,7]

Digestive system issues are diagnosed by capsule endoscopy. Your doctor can benefit from capsule endoscopy:

- Recognize gastrointestinal disorders such as ulcerative colitis, celiac disease, and Crohn's disease.
- Determine the reason behind the inexplicable gastrointestinal bleeding.
- Recognize stomach cancer.
- Look for tumors or polyps in your digestive system.
- Check for disorders such as Barrett's esophagus in your esophagus.
- Determine the reason behind the unexplained stomach pain.
- Perform additional testing.

ANATOMY NAD PHYSIOLOGY

The evaluation of the stomach, colon, small intestine, and esophagus can be done by capsule endoscopy. It is swallowed like any other capsule, passing down the esophagus and into the stomach. It then enters the duodenum, jejunum, and ileum after passing past the pyloric sphincter. The capsule enters the cecum after passing through the ileocecal valve. After passing through the colon, it is eventually expelled via a bowel movement. Although the patient will frequently be there to see the capsule pass through, abdominal images can be used to assess the video capsule's full transit.

PARTS OF ROBOTIC CAPSULE[8]

Fig: 2 A wireless capsule endoscope (WCE): (1) Optical Dome, (2) Lens holder, (3) Lens, (4) Illuminating LEDs, (5) CMOS imager, (6) battery, (7) ASIC RF transmitter, (8) Antenna.

Ref: http://www.yalemedicalgroup.org/news/ymg proctor.

CAPSULE ENDOSCOPY OF THE SMALL BOWEL

A brief overview of history

Given Imaging produced the first capsule endoscope model in history, known as M2A (mouth to anus). Following clinical testing and assessment, M2A was granted approval for general clinical use in Europe in May 2001, and by the FDA in the United States in August of the same year. [1,2]

M2A was first authorized by the FDA as an additional tool for the imaging of small intestinal anomalies. Subsequently, in July 2003, it authorized M2A as a primary diagnostic tool for small intestinal anomalies, based on data from a meta-analysis. Following the introduction of esophageal CE (PillCam ESO; Fig. 3) [5] also developed by Given Imaging, M2A was renamed PillCam SB, which means "small bowel"; Fig. 4.

In 2003, the first clinical CE trial for small-bowel diseases, including Crohn's disease, was conducted in Japan at Social Insurance Central Hospital (Tokyo) and Dokkyo Medical University (Tochigi). The Ministry of Health, Labour, and Welfare of Japan authorized PillCam SB in April 2007, and the Social Insurance Agency of Japan authorized CE cost reimbursement in October 2007[9].

Olympus has also developed EnddoCapsule EC type a CE for the small intestine that is now approved in Europe but not in Japan. Since 2001, more than 600,000 PillCam SB capsules have been deployed globally.

Fig. 3. PillCam ESO (11 mm x 26 mm): capsule endoscope for investigating esophageal diseases

Ref: https://images.app.goo.gl/W9U6fUjLFcakhxRUA

PILLCAM SB SYSTEM :

The capsule endoscope body, an external receiving antenna made up of eight sensor arrays with a portable hard drive attached for data recording, and a specially designed PC workstation (RAPID: reading and processing images and data) with specialized software for image review and interpretation comprise the three parts of the PillCam SB system[10]. A metal oxide silicon (CMOS) chip imager, a short focal lens, six white light-emitting diode lighting sources, two watch batteries, and a UHF band radio telemetry transmitter make up the PillCam SB capsule (11 mm ₴ 26 mm, 3.64 g). A 140° field of vision, 1: 8 magnification, a 1-to 30-mm depth of view, and a minimum size of detection of roughly 0.1 mm are some of the image's properties.

Up to 55 000 still photos (in JPEG format) can be captured by the device with an engaged PillCam SB capsule, which takes pictures at a rate of two frames per second until the battery runs out, which happens after roughly eight hours.[9,10]

Fig. 4. PillCam SB (11 mm x 26 mm): a first-line tool for the detection of abnormalities of the small bowel

Ref: https://images.app.goo.gl/XKUytftvv8eMz6nn7

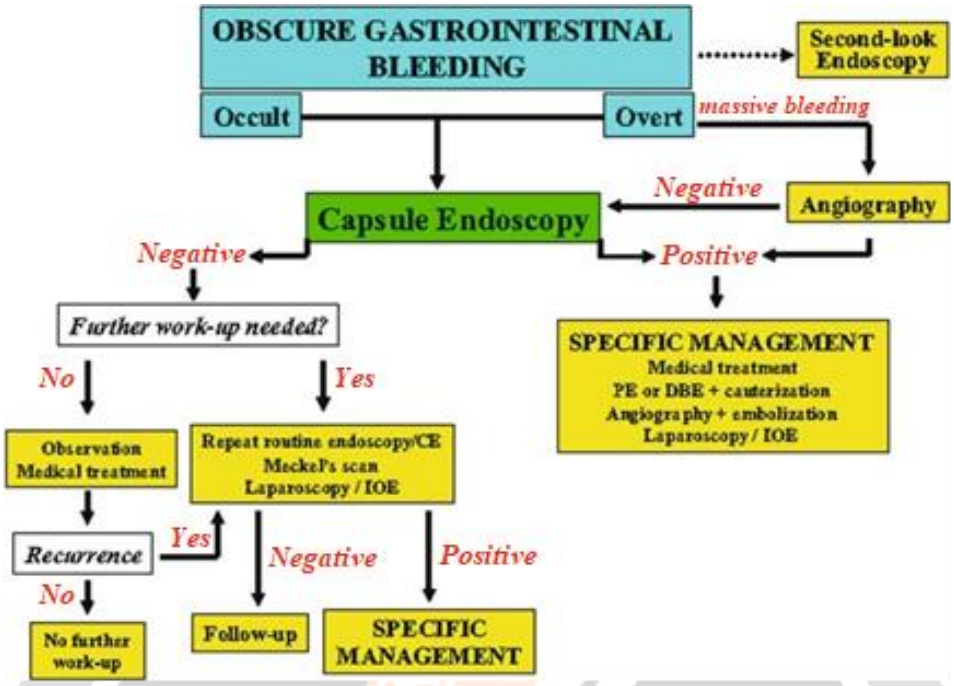

Fig. 5. Algorithm for capsule endoscopy in cases of obscure gastrointestinal bleed- ing. PE, push enteroscopy; DBE, double- balloon endoscopy; CE, capsule endoscopy; IOE, intraoperative endos- copy. Second-look endoscopy: upper and lower gastrointestinal endoscopy should be repeated before investigation of the small bowel and will frequently identify lesions overlooked at the initial endos- copy. Massive bleeding: patients with significant active bleeding are unsuitable candidates for endoscopy[11,12,13].

Ref; https://images.app.goo.gl/76sKqUvcjEdWZYAo7

OTHER TYPES OF CAPSULE ENDOSCOPE

S.NO	WCE company	Size, mm	Weight, g	Field of view	Images/sec	Battery life	Resolution, pixels
1	EndoCapsule; Olympus America, Inc, Center Valley, Pennsylvania	11 × 26	3.5	145°	2	8 hours	512 × 512
2	PillCam SB2; Given Imaging, Ltd, Yoqneam, Israel	11 × 26	2.8	156°	2	8 hours	256 × 256
3	PillCam SB2EX; Given Imaging	11 × 26	2.8	156°	2	12 hours	256 × 256

4	MiroCam; Intromedic Co Ltd, Seoul, Korea	11 × 24	3.3	170°	3	11 hours	320 × 320
5	PillCam ESO2; Given Imaging .	11 × 26	!4	169°	18	8 hours	256 × 256

Type 1 EndoCapsule EC

Olympus also created the EndoCapsule EC type 1 small-bowel capsule endoscope. Between the Olympus CE and PillCam SB systems, there are two distinctions. The Olympus capsule is equipped with an external real-time image viewer (External Viewer) monitor and a high-resolution CCD.Thirteen The EndoCapsule was shown to be statistically nonsignificantly more effective than the PillCam SB at detecting bleeding sources in patients with suspected small-bowel bleeding, according to recent randomized research comparing these two types of capsule endoscopes[14,15,16]

Type 2 PillCam ESO

Given Imaging specifically created PillCam ESO (Fig. 3), which is identical in size and form to PillCam SB (Fig. 4), to study esophageal disorders. Patients with Barrett's esophagus or gastroesophageal reflux illness are the primary candidates for PillCam ESO. The FDA approved it in response to a research conducted by Eliakim et al. that was published in abstract form. For the accurate noninvasive detection of portal hypertensive gastropathy and esophageal varices, PillCam ESO may be a useful substitute for EGD. However, a recent multicenter study found that while PillCam ESO may be helpful in patients who are afraid to undergo EGD, it is not recommended as a main screening tool for Barrett's esophagus in its current form[11,12]

TYPE 3 PillCam COLON

Fig. 6. PillCam COLON (11 mm x 31 mm): capsule endoscope for detecting colonic neoplasias

Ref: https://images.app.goo.gl/fcuB4v94AYGL4Xre8

Given Imaging recently created the PillCam COLON (Fig. 6, 11 mm x 31 mm) to identify colonic neoplasms. PillCam COLON has been used in two pilot studies,56,57 and sizable prospective multicenter research is currently in progress.58 Interestingly, our interim analysis shows that PillCam COLON can detect certain polyps that a standard colonoscopy misses[17,18]

Type 4 Patency capsule

Given Imaging has created a lactose-based patency capsule that dissolves spontaneously to determine the degree of stenosis and bowel patency. The capsule is comparable in size to PillCam ESO and PillCam SB. The patency pill dissolves in 40–100 hours if the route is obstructed. It has been questioned whether the original model is safe and effective. A novel patency capsule model including a biodegradable body has been created recently. Prior to conventional CE, the novel patency capsule can be used to forecast and decrease the risk of retention and impaction. It is a valid predictor of functional patency in suspected or even known cases of intestinal stricture[19,20]

MARKETED AVAILABLE ROBOTIC CAPSULES FOR ENDOSCOPY

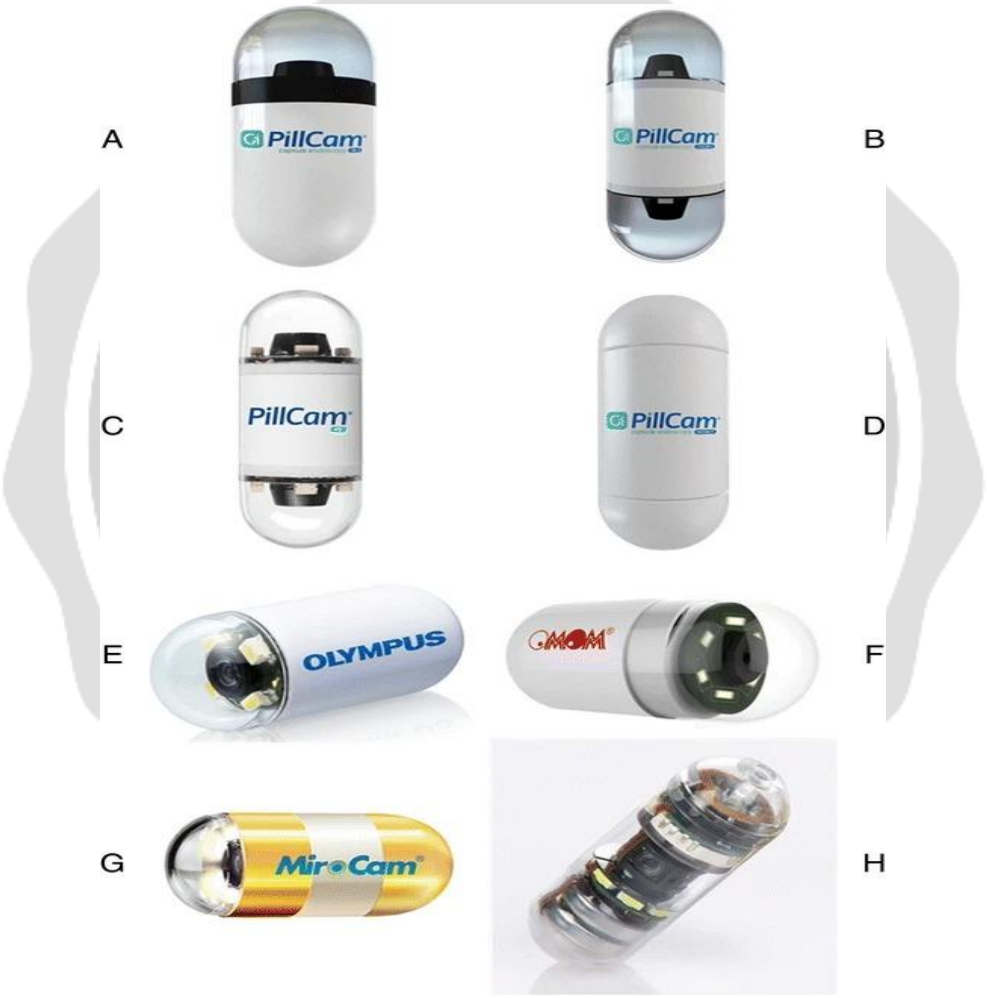

FIG: 7 A PillCam®SB3 (Given Imaging); **B** PillCam®COLON2 (Given Imaging); **C** PillCam®UGI (Given Imaging); **D** PillCam®PATENCY (Given Imaging) - Courtesy of Medtronic, Inc.; **E** EndoCapsule (Olympus); **F** OMOM capsule (Chongqing Jinshan Science & Technology) - Reprinted from Intest Res 2016;14(1):21-29 with permission; **G** MiroCam (Intromedic); and **H** CapsoCam (CapsoVision) [21,22,23]

Ref: https://link.springer.com/article/10.1007/s12213-016-0087-x

CONCLUSION

In conclusion, robotic capsule endoscopy represents a significant advancement in medical imaging technology, offering enhanced maneuverability and diagnostic capabilities compared to traditional capsule endoscopy. With its potential to improve patient comfort, increase diagnostic yield, and provide more accurate assessments of gastrointestinal conditions, robotic capsule endoscopy holds promise for revolutionizing the field of gastrointestinal imaging. However, further research and clinical trials are needed to fully evaluate its efficacy, safety, and cost-effectiveness compared to existing methods. Nonetheless, its development signifies a step forward in minimally invasive diagnostic procedures, potentially leading to better patient outcomes and quality of care.

REFERENCES

1. Ell C, Remke S, May A, Helou L, Henrich R, Mayer G. The first prospective controlled trial comparing wireless capsule endos- copy with push enteroscopy in chronic gastrointestinal bleeding. Endoscopy 2002;34:685–9.
2. Lewis BS, Swain P. Capsule endoscopy in the evaluation of patients with suspected small intestinal bleeding: results of a pilot study. Gastrointest Endosc 2002;56:349–53.
3. Yamamoto H, Sekine Y, Sato Y, Higashizawa T, Miyata T, Iino S, et al. Total enteroscopy with a nonsurgical steerable double- balloon method. Gastrointest Endosc 2001;53:216–20.
4. Yamamoto H, Kita H. Enteroscopy. J Gastroenterol 2005;40: 555–62.
5. Eliakim R, Yassin K, Shlomi I, Suissa A, Eisen GM. A novel diagnostic tool for detecting oesophageal pathology: the PillCam oesophageal video capsule. Aliment Pharmacol Ther 2004;20: 1083–9.
6. Nakamura T, Shirakawa K, Nakano M, Kanke K, Hiraishi H, Terano A. Present status and prospects of wireless capsule endos- copy (in Japanese). Nippon Shokakibyo Gakkai Zasshi 2004;101: 970–5.
7. Morita E, Tanaka T, Nakamura T, Terabe F, Hirata I, Katsu K, et al. Correlations between video capsule endoscopic findings and clinical activity in Crohn's disease. Dig Endosc 2006;18:263–8.
8. Gheorghe C, Iacob R, Bancila I. Olympus capsule endoscopy for small bowel examination. J Gastrointest Liver Dis 2007;16: 309–13.
9. Shailaja P, Pavani P, Sharmila Bhanu SK, Snehalata G, Satya Ashok K. Overview of Capsule Endoscopy-"Pill Camera". International Journal of Novel Research and Development (IJNRD). 2022; 7(7): e2456-4184.
10. Cave DR. Reading wireless video capsule endoscopy. Gastroin- test Endosc Clin N Am 2004;14:17–24.
11. Lewis B. Capsule endoscopy—transit abnormalities. Gastrointest Endosc Clin N Am 2004;16:221–8.
12. Eliakim R, Sharma VK, Yassin K, Adler SN, Jacob H, Cave DR, et al. M2A esophageal capsule endoscopy is comparable to tradi- tional upper endoscopy in detection of esophagitis and Barrett's esophagus in patients with GERD symptoms (abstract). Am J Gastroenterol 2004;99:S3.
13. Lin OS, Schembre DB, Mergener K, Spaulding W, Lomah N, Ayub K, et al. Blinded comparison of esophageal capsule endos- copy versus conventional endoscopy for a diagnosis of Barrett's esophagus in patients with chronic gastroesophageal reflux. Gastrointest Endosc 2007;65:577–83.
14. Saurin JC. Capsule endoscopy. Endoscopy 2007;39:986–9.
15. Banerjee R, Bhargav P, Reddy P, Gupta R, Lakhtakia S, Tandan M, et al. Safety and efficacy of the M2A patency capsule for diagnosis of critical intestinal patency: results of a prospective clinical trial. J Gastroenterol Hepatol 2007;22:2060–3.
16. Ben-Soussan E, Savoye G, Antonietti M, et al. Is a 2-liter PEG prepara- tion useful before capsule endoscopy? J Clin Gastroenterol 2005;39: 381-4.
17. Dai N, Gubler C, Hengstler P, et al. Improved capsule endoscopy after bowel preparation. Gastrointest Endosc 2005;61:28-31.

18. de Franchis R, Avgerinos A, Barkin J, et al. ICCE consensus for bowel preparation and prokinetics. Endoscopy 2005;37:1040-5.
19. Niv Y, Niv G. Capsule endoscopy: role of bowel preparation in suc- cessful visualization. Scand J Gastroenterol 2004;39:1005-9.
20. Sharma VK, Eliakim R, Sharma P, et al. ICCE consensus for esophageal capsule endoscopy. Endoscopy 2005;37:1060-4.
21. Spada C, Hassan C, Marmo R, et al. Meta-analysis shows colon capsule endoscopy is effective in detecting colorectal polyps. Clin Gastroen- terol Hepatol 2010;8:516-22.
22. Spada C, Hassan C, Munoz-Navas M, et al. Second-generation colon capsule endoscopy compared with colonoscopy. Gastrointest Endosc 2011;74 581-9.e1.
23. Eliakim R, Yassin K, Niv Y, et al. Prospective multicenter performance evaluation of the second-generation colon capsule compared with colonoscopy. Endoscopy 2009;41:1026-31.
24. Banerjee R, Bhargav P, Reddy P, et al. Safety and efficacy of the M2A patency capsule for diagnosis of critical intestinal patency: results of a prospective clinical trial. J Gastroenterol Hepatol 2007;22:2060-3.
25. Boivin ML, Lochs H, Voderholzer WA. Does passage of a patency capsule indicate small-bowel patency? A prospective clinical trial. Endoscopy 2005;37:808-15.
26. Cohen SA, Gralnek IM, Ephrath H, et al. The use of a patency capsule in pediatric Crohn's disease: a prospective evaluation. Dig Dis Sci 2011;56:860-5.
27. Signorelli C, Rondonotti E, Villa F, et al. Use of the Given patency sys- tem for the screening of patients at high risk for capsule retention. Dig Liver Dis 2006;38:326-30.
28. Postgate AJ, Burling D, Gupta A, et al. Safety, reliability and limitations of the given patency capsule in patients at risk of capsule retention: a 3-year technical review. Dig Dis Sci 2008;53:2732-8.
29. Maudedmanufacturer and user facility device experience. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfmaude/text search.cfm. Accessed August 1, 2012.
30. Skogestad E, Tholfsen JK. Capsule endoscopy: in difficult cases the capsule can be ingested through an overtube. Endoscopy 2004;36:1038.
31. Leung WK, Sung JJ. Endoscopically assisted video capsule endoscopy. Endoscopy 2004;36:562-3.
32. Toth E, Fork FT, Almqvist P, et al. Endoscopy-assisted capsule endos- copy in patients with swallowing disorders. Endoscopy 2004;36:746-7.
33. Swain P, Adler D, Enns R. Capsule endoscopy in obscure intestinal bleeding. Endoscopy 2005;37:655-9.
34. Swain P. Wireless capsule endoscopy and Crohn's disease. Gut 2005;54:323-6.
35. Cave D. Capsule endoscopy and Crohn's disease. Gastrointest Endosc 2005;61:262-3.