

ENDOSCOPIC EVALUATION OF SMALL BOWEL

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Abstract : Small Bowel, the historic black box of gastrointestinal tract, is no more a mystery to the endoscopist. Of the established enteroscopic methods, push enteroscopy using enteroscope or colonoscope can reach only up to mid jejunum, leaving meters of small intestine unexamined. Intraoperative enteroscopy can examine the entire small intestine but has associated surgical morbidities and mortality. Advent of Capsule endoscopy and Double balloon endoscopy has changed the management of small bowel diseases from surgery to endotherapy. Capsule endoscopy has made the small bowel examination painless and more complete but is limited by lack of therapeutic potential, limited battery life, insensitivity in counting number of lesions and risk of capsule retention. Capsule Endoscopy has shown superiority over other diagnostic modalities in the diagnosis of obscure GI bleeding and non stricturing small bowel crohn's disease, with an incremental yield of more than 30%. With Double and single balloon enteroscopes, endoscopic therapies such as endoscopic haemostasis using injection and argon plasma coagulation, polypectomy, endoscopic resection, balloon dilatation, foreign body extraction and luminal stenting have become feasible even in the small intestine.

Keyword: Push enteroscopy, Intraoperative enteroscopy, Double balloon enteroscopy, Single balloon enteroscopy, Capsule endoscopy.

INTRODUCTION

The small intestine which accounts for 75% of the total length and 90% of the surface area of the gastrointestinal tract has long remained inaccessible to endoscopist. Using conventional enteroscope or colonoscope only the proximal jejunum and distal most ileum can be examined. With the advent of wire less capsule endoscopy and double balloon enteroscopy the entire small intestine has become accessible for endoscopic inspection, tissue acquisition and therapy.

Last one decade has seen substantial advancement in the field of small intestinal endoscopy. Special endoscopes with variable shaft stiffness have been designed for push enteroscopy which allow better transmission of force to the tip. Coupling of enteroscope and over tube apparatus in double balloon or single balloon enteroscopy has extended the diagnostic and therapeutic benefits of push enteroscopy to the entire small bowel. Introduction of wire less capsule endoscopy (WCE) in 2001 by Given Imaging Ltd. has changed small bowel imaging to painless, less invasive and more complete examination.

Various endoscopic methods of small bowel imaging

Of the all available methods, push enteroscopy, double balloon enteroscopy and intra-operative enteroscopy have therapeutic capabilities; sonde & capsule enteroscopy (IOE) are only diagnostic. Double Balloon Enteroscopy and IOE are usually performed after a presumptive diagnosis is made with prior imaging or WCE and when the need for therapy is clear.

Established Methods

- Push Enteroscopy
- Enteroscopy using colonoscope
- Ileoscopy & colonoscopy
- Intraoperative enteroscopy (IOE)

New Methods

- Wire less capsule endoscopy (WCE)
- Double balloon enteroscopy (DBE)
- Single balloon enteroscopy

Obsolete Method

- Sonde Enteroscopy

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PUSH ENTEROSCOPY

Push enteroscopes are modification of standard video endoscopes with a working length of 2.2 to 2.5m, external diameters of 10.5 to 11.7mm and working channel diameter of 2.7 to 3.8mm. The push enteroscopy is performed per orally as routine upper endoscopy. Once the curve of the second part of duodenum is crossed, pulling back with clockwise torque produces paradoxical advancement. The ligament of treitz is usually encountered at 85-110cm from the incisors. Further viewing requires a full tip deflection. A variable length of small bowel (30-160cm) can be examined by this technique. The procedure is usually performed on outpatient basis under conscious sedation and takes between 10 and 45minutes. It can be accomplished with a pediatric or a standard colonoscope^{1, 4, 6}. (Fig.1)

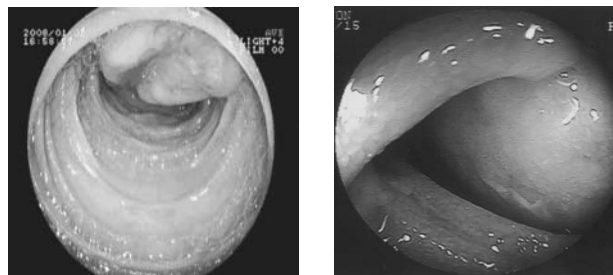


Fig1: Small Bowel Mass lesion seen on push enteroscopy

Indications for Push Enteroscopy

Diagnostic

- Obscure gastrointestinal bleeding
- Malabsorption syndrome & unexplained diarrhoea
- Evaluation of small bowel tumors.
- Exploration of radiographic abnormalities of proximal small bowel

Therapeutic

- Theromocoagulation of bleeding lesions.
- Placement of jejunostomy tubes.

Surveillance

- Polyposis syndromes.

INTRA OPERATIVE ENTEROSCOPY

Intra operative enteroscopy allows a complete examination of the small bowel & is the current “gold standard” for diagnosing obscure GI bleeding.

Intra operative enteroscopy requires an enteroscope or a colonoscope to be passed orally or through an enterotomy, in an anesthetized patient. It is performed in a darkened operating room while the endoscopist views the endoscopic image and the surgeon watches the transilluminated intestine. The surgeon pleats segments of small intestine over the endoscope as endoscopist examines the bowel mucosa during insertion to avoid mucosal trauma being misdiagnosed as vascular lesions.

The diagnostic accuracy of Intra operative enteroscopy for mucosal diseases ranges between 70 – 100%. Reported *complications* include prolonged postoperative ileus, mucosal or serosal tears, wound infection and multi organ failure.

It should be reserved for patients with massive, continuous or recurrent gastrointestinal hemorrhage when other less invasive methods have failed to detect the source of bleeding^{4, 6}.

SONDE ENTEROSCOPY

It is a primitive fibro optic enteroscope with working length of 2.5 to 4.0m. The sonde enteroscope is passed orally or nasally and is advanced into the duodenum with the aid of another orally passed endoscope. It is then propelled through the small bowel by peristalsis. The length of time (from 4-5 hrs) taken for this examination makes patient intolerant. Sonde enteroscopy is no longer in use⁴.

DOUBLE BALLOON ENTEROSCOPY (DBE)

Double balloon enteroscopy is based on the principle often expressed as the inchworm method or insertion with shortening of intestine²⁴. Both diagnostic and therapeutic double balloon enteroscope are commercially available. Both have a working length of 2.0m with a diameter of 8.5 to 9.4mm and a working channel of 2.2mm and 3.2mm respectively. A disposable 1mm thick latex balloon is mounted on the tip of the scope before the procedure. The over tube is a soft flexible tube with length of 1.45m and a latex balloon permanently mounted on its distal end. An automated pressure control pump that assures a maximum pressure of 45mmHg is attached to the balloon part of the endoscope and the over tube.

Double balloon enteroscopy can be performed via the oral as well as the anal approach. (Fig.2). The inflated balloon on the over tube is used to maintain a stable position while the enteroscope is advanced. The over tube balloon is deflated whilst the enteroscope balloon is inflated and the over tube is advanced along the distal end of the enteroscope, the “Push procedure”. With both balloons inflated the enteroscope and the over tube are pulled back, the “pull procedure”, which pleats the intestine along the over tube. This procedure is repeated and the device is advanced through the intestine in increments of up to 40cm. Double balloon enteroscopy is usually performed under conscious sedation as an out patient procedure with fluoroscopic guidance and the average time for each approach (per oral or per anal) is 75min. The procedure is performed until the lesion is found or until scope could not be advanced further. At this time, the small bowel mucosa is tattooed with India ink, and a decision is

made whether a subsequent procedure from the other approach is necessary^{4, 6}.

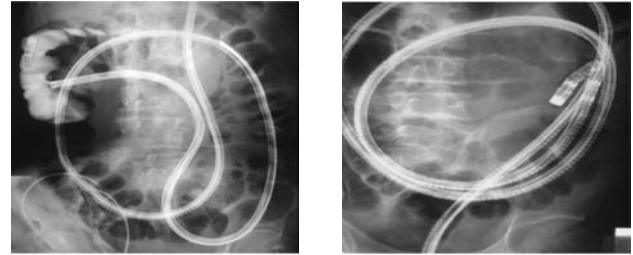


Fig2: DBE – Antegrade Route & Retrograde Route

Therapeutic uses of Double balloon enteroscopy

- Electrocogulation therapies for Obscure GI bleeding
- Polypectomy
- Stricture dilatations
- Foreign body removal
- ERCP in patient with Roux-en-Y-choledochojejunostomy.
- Diagnosis and treatment of small bowel tumor.
- Metallic stenting of malignant small bowel stricture
- Double balloon enteroscopy assisted chromoendoscopy and EUS for small bowel lesions.

Few *complications* that have been reported with double balloon enteroscopy are post procedure abdominal pain (20%), pancreatitis, bleeding and rarely, small bowel perforation after removal of large polyps. In various comparative studies of double balloon enteroscopy and PE, deeper intubations and improved diagnostic yield has been described. The diagnostic yield from double balloon enteroscopy is between 43 & 83% with a subsequent change in management for 57 to 84% of patients. Yamamoto has reported a yield of 76% in 66 patients evaluated for small bowel disease. May et al, in there series of 353 patients, reported a yield of 75%. Subsequent endotherapy using DBE was performed in 59% of patients^{10, 11}.

In patients of obscure GI bleed (Fig.3) due to small bowel angioectasia, double balloon enteroscopy may be preferable to IOE, as repeat procedure may be needed to ablate new lesions that develop over time. In a recent meta analysis of eight studies (n = 277), Xiang Chen et al, concluded that with combination of oral and anal approaches, the yield of double balloon enteroscopy is comparable to that of capsule endoscopy³.

Because of its additional therapeutic advantage double balloon enteroscopy is better than capsule endoscopy and should be used complementary to capsule endoscopy.

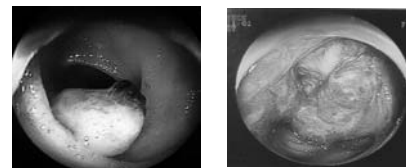


Fig3: DBE - Bleeding polyp in ileum & jejunal carcinoma

SINGLE BALLOON ENTEROSCOPY

This is analogous to double balloon enteroscope, except that, instead of having a balloon hold the tip of the endoscope in position, the tip

of the endoscope is bent 180 degrees through its maximal up-angle or down angle. On this hook shape of the scope, the over tube is inserted without stretching the intestine. The over tube balloon is then inflated and both the scope and the sliding tube are simultaneously withdrawn, thus shortening the intestine. The advantages include low cost and easy handling. It being a new technique, there are only few published experiences to date. Tsujikawa et al published their experience of 80 SBE procedures (39 via oral and 41 via anal route) on 41 patients. In the ante grade approach, they were able to advance 270 cm beyond pylorus in 27 of 39 procedures over a mean of 62.3 minutes. Observation of the deep small intestine by the anal route was possible in 16 of 41 procedures^{8,9}.

Double balloon enteroscopy & Capsule endoscopy in patients with obscure GI bleeding			
	CE	DBE	P Value
Angiodysplasia	76	62	0.189
Tumor	15	23	0.236
Polyp	9	2	0.062
Ulcer	20	20	1
Erosion	11	4	0.113
Crohn disease	4	7	0.544
Diverticulum	1	5	0.216
Fresh blood and clot	7	2	0.176
Others	3	7	0.339
Total	146	132	0.228
Patients number	239	239	

WIRELESS CAPSULE ENDOSCOPY (CE)

Since its approval by Food and Drug Administration (FDA) in August 2000, Wireless capsule endoscopy has become the gold standard in evaluating suspected disease of the small bowel, in a noninvasive, painless and natural (peristalsis propelled) manner. The Given Capsule endoscope is a 26 x 11mm disposable plastic capsule that captures two images per second as it passively travels through GI tract.

The contents of capsule endoscope include:

- 1.) a battery - powered complimentary metal oxide silicon (CMOS) chip camera
- 2.) a short focal length lens
- 3.) 6 white light emitting diodes (LED)
- 4.) 2 silver oxide batteries and
- 5.) An UHF band radio telemetry transmitter.

Technique : The standard preparation recommended for Capsule Endoscopy is a clear liquid diet the day prior to capsule endoscopy and an 8 to 12 hrs fasting before the procedure. The capsule gets activated after removal from its magnetic holder. Patient is made to swallow the activated capsule which takes two images every second and transmits them to battery-operated reusable data recorder via eight sensors attached to abdominal wall. As average gastric passage time for the capsule is 1 hour, patient is allowed to drink after 2 hrs and eat after 4 hrs. The battery life of presently available capsules is approximately 8 hrs, after which the data recorder is removed and attached to a computer for the transfer of the acquired images. Capsule Endoscope captures approximately 50,000 images which can be viewed as a video. The average time to read these images is between 45 minutes to 2 hrs^{2,4}.

Limitations includes: 1.) Presence of dark or opaque fluid, food, biliary secretions, air bubbles and mucus, impairs adequate

visualization of intestinal mucosa.; 2.) Slow gastric emptying or small bowel transit prevents capsule from reaching the ileo-cecal valve within the battery life (approx 8hrs) in 17-25% of cases; 3.) Capsule may be caught transiently in the mixing wave (to & fro) of small intestine which limits the ability of the capsule to accurately count the number of lesions seen; 4.) This also precludes the accurate calculation of small bowel length using a standard peristaltic contraction pattern.

Indications

Obscure Gastrointestinal Bleeding

Since its introduction in 2000 capsule endoscopy has shown its superiority over other diagnostic modalities and has significantly improved the management of patients with OGIB(Fig.4). Capsule endoscopy has been compared with other diagnostic modalities in a number of clinical studies. In a meta-analyses of 14 studies (n=396) yield of capsule endoscopy for all findings was 65% versus 28% for push enteroscopy with an incremental yield of 35%. Vascular lesions were found most commonly followed by inflammatory lesions and tumors^{7,13}.

In another meta-analysis of 17 studies (n=526) by Marmo et al. The pick up rate (289 for OGIB) difference between capsule endoscopy and alternative modalities for OGIB was 36.9% (95% CI 29.6-44.1) (P<0.001). In fact, studies comparing double bowel enteroscopy and capsule endoscopy have shown higher diagnostic yield for capsule endoscopy (59.4 – 80% vs 42.9 – 60%) with complete small bowel examination in 90% cases¹².

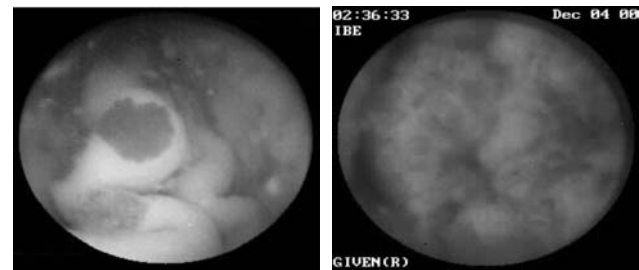


Fig4: CE - Bleeding Angiodysplasia & ileal ulcers

Diagnostic yield of CE and push enteroscopy in the diagnosis of OGIB		
	Capsule	Enteroscopy
Mata	66%	19%
Mylonaki ²²	68%	32%
Sourin	69%	38%
Lewis ²⁰	55%	30%
Ell ²¹	66%	28%

Crohn's Disease : Though uncommon, crohn's disease must be ruled out in patients presenting with abdominal pain, diarrhea, and weight loss or iron deficiency anaemia. A number of studies have been performed to compare Capsule endoscopy with Colonoscopy and Ileoscopy, small bowel follow through, CT enteroclysis and MRI. For diagnosing non structuring crohn's disease Capsule endoscopy is more sensitive than other imaging techniques (Fig.5). In a recent metaanalysis of nine studies (n=250) by Triester et al, comparing capsule endoscopy with other diagnostic modalities, capsule had highly significant incremental yield over all other modalities in patients with established non-stricturing CD but the difference was not statistically significant in patients with a suspected initial presentation of CD.

Capsule retention remains a risk in patients with crohn's disease even when radiological investigations do not reveal any stricturing disease. Risk is 5% in patients with established crohn's disease^{7, 14}.

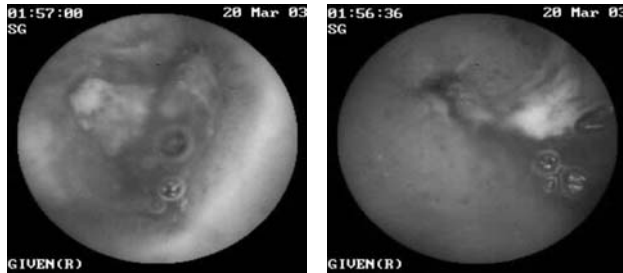


Fig.5: Capsule Endoscopy – Ileal ulcer

Capsule Endoscopy versus other Modalities in IBD

Summary of Incremental Yield (IY) of CE over other modalities in IBD			
	Total yield CE (%)	Total other modality (%)	% IY for CE (95% CI)
vs. SB Radiography	66	24	42 (0.30-0.54)
vs. Ileoscopy	61	46	15 (0.02-0.27)
vs. CT Enterography	75	37	38 (0.23-0.54)
vs. Push Enteroscopy	51	7	44 (0.31-0.57)
vs. Small Bowel MRI	60	40	20 (0.41-0.81)

Celiac Disease : Capsule endoscopy is useful in two situations. First it has been used as a virtual histology tool in patients with positive celiac serology. Capsule reveals typical mucosal changes of celiac disease including mosaic pattern, scalloping, “octopus leg” appearance, loss of mucosal folds and atrophy. Secondly, it has been used for detection of celiac related complications including ulcerative jejunitis, stricture and small bowel lymphoma in patients on gluten free diet but with ongoing symptoms^{15, 16, 17}.

Familial Polyposis Syndromes : Capsule endoscopy has been used in a small number of studies for small bowel surveillance of polyposis syndromes familial adenomatous polyposis and Peutz-jegher's syndrome^{18, 19}.

CONTRAINDICATIONS OF CAPSULE ENDOSCOPY

- Patients with known or suspected GI obstruction, strictures, or fistulas based on the clinical picture or pre procedure testing.
- Patients with cardiac pacemakers or other implanted electro-medical devices.
- Patients with swallowing disorders.
- Pregnancy.

COMPLICATIONS

Capsule Retention²⁵:

It is defined as having a capsule endoscope remain in the digestive tract for a minimum of 2 wks. Capsule retention is suspected when

1. Obstructing lesion is seen.
2. Repetitive views of the same area of small bowel with no distal mucosa

seen.

3. Excessive luminal contents.
 4. Failure to see colonic mucosa during the examination.
- Incidence of Capsule Retention is 0 – 13% in various series.

Causes of Capsule Retention

1. Crohn's disease
2. NSAID enteropathy
3. Small bowel tumor
4. Radiation enteritis
5. Surgical anastomotic stricture

Managing Retention

Obtain abdominal radiograph after 2 wks. Endoscopic or surgical intervention may be required. Surgical intervention not only allows for the removal of the retained capsule but also removes the offending pathology.

Biodegradable Patency Capsule

Self dissolving capsule made of cellophane walled cylinder filled with lactose and 10% barium for radio opaqueness. It is protected by a wax plug at one end and has a specifically sized hole that allows the influx of intestinal fluid, which in turn dissolves the lactose in 120 hrs or 5 days²⁵.

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