Above: View of Interactive Atlas, showing selected anatomical structures (left) and model list of human anatomy (right).

**VHJOE** is an interactive online journal utilizing a powerful tool: the **Visible Human Interactive Atlas**. This web-based application, developed by the Center for Human Simulation, provides unparalleled views of human anatomy. By loading models of selected organs, and manipulating an image plane, unique images of human anatomy are created **realtime** and loaded into your browser window.
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Visible Human Segmented Anatomy Models

This issue of VHJOE presents expert reviews from Dr. Baron on intestinal stenting and Dr. Rex on some interesting aspects regarding polypectomies. These articles give some clinical pearls and practical demonstrations from physicians with a large “hands-on” and academic experience in their respective topics. We hope the reader can use these articles and the other expert reviews in VHJOE to improve his or her own practice of medicine.

For my part, I would like to show how the Visible Human Interactive Atlas may be useful in understanding this issue’s review articles through the use of anatomy models. (A model is a segmented part of real anatomy from the Visible Human database.) Usually, when one accesses the Visible Human data through the Visible Human Interactive Atlas, one makes an anatomy model to use as a target in which to orient a plane. The plane then returns the detailed anatomy from the Visible Human database. However, the models are also useful as study guides, and can be moved laterally, vertically, rotated, and zoomed in or out. In my opinion, the respective anatomy covered by the review articles seems like it can be better visualized using models than using oblique slices. One can see for instance, the tortuosity of a normal colon in the area of the sigmoid colon and at the splenic and hepatic flexures. I encourage the reader to see and manipulate these models using the links supplied in this editorial.
Dysphagia in a Man with Down’s Syndrome

Introduction: A 51-year-old man with Down’s Syndrome presented with dysphagia, aspiration and a possible fistula. A diagnosis of verrucous squamous cell carcinoma was eventually made through an open biopsy.

Methods for EUS Capture: Video was made using SVHS tape and digitally converted with Adobe Premiere software. Other images were captured using digital cameras and edited on Adobe Photoshop software.

Disclaimer: No experimental therapies were used. All procedures were performed after obtaining written or verbal permission from the subject’s legal guardian.

Case: A 51-year-old patient with Down’s syndrome presented with pneumonia. His symptoms failed to resolve with antibiotic therapy and further workup suggested the possibility of a tracheoesophageal fistula and he was transferred to a tertiary care facility. He lived in a group home. His cognitive impairment from Down’s syndrome was significant, and he did not communicate verbally. He had a 20 pound weight loss but otherwise had no obvious complaints. His past history was significant for reflux disease and hypothyroidism. He had a previous cholecystectomy and appendectomy.

His only medication was levothyroxine, 125 mcg per day.

His exam revealed the stigmata of Down’s syndrome. There was no adenopathy. His lung exam revealed rhonchi. Chest CT showed esophageal thickening through the distal 2/3 of the thorax. There was also significant mediastinal adenopathy.

An EGD with biopsy was done showing esophageal obstruction beginning at 25 cm from the incisors; the endoscope could not be passed further than 33 cm from the incisors. (Video 1).

Biopsies revealed hyperplastic squamous epithelium and fungal elements (Figures 2A and 2B).

An EUS with FNA was performed of the mediastinum with FNA showing non malignant squamous cells and admixed inflammation (Figure 3).

An Olympus ultrathin GIF XP 160 endoscope was used to traverse the overgrown mucosa. Passage of the endoscope and biopsies cleared a channel through the abnormal mucosa. A barium swallow done immediately after endoscopy demonstrated no evidence of an esophagopleural fistula. It was presumed the patient had been aspirating.

Since it was unclear if this was a reactive epithelial proliferation or a malignancy, the patient was treated with diflucan and antibiotics for 4 weeks, placed on a liquid diet, and brought back for reevaluation.

Although the patient appeared to have no symptoms related to esophageal obstruction while on the liquid diet, a follow-up EGD now showed essentially complete obstruction of the esophagus at 28 cm from the incisors. The ultrathin endoscope could only be advanced to 32 cm and a wire could not be guided into the stomach fluoroscopically. Multiple deep biopsies were again taken which returned benign tissue (Figures 4A and 4B).
A CT scan at that time (Figures 5A, 5B, and 5C) showed progression of the disease process.

The patient was therefore taken to the OR where an open gastrostomy, mini-laparotomy, and intraoperative EGD were performed. At the time of surgery, the GE junction was found to be “rock” hard and impassible with a finger from the gastrostomy. The GE junction was then manipulated, and a stiff guidewire was forced endoscopically from the esophagus into the stomach. Savary dilation to 8 mm was accomplished, and a 15 cm long Ultraflex stent (Flange of 23 mm and diameter of 17 mm) was placed endoscopically, while the distal end was positioned manually from the gastrostomy just distal to the tumor.

The diaphragm was opened and intrathoracic biopsies of the esophagus were performed. Histology revealed invasive squamous cell carcinoma (Figures 6A and 6B).

The patient was completely palliated by the stent. A barium swallow done three days post operative showed good function (Figures 7A and 7B). A repeat EGD at 30 days showed no evidence of esophageal impairment.

**Discussion:**

Verrucous carcinoma of the esophagus is a rare clinicopathologic entity (1-4). Verrucous carcinoma is a well-differentiated squamous cell carcinoma characterized by verrucous (papillary) architecture. Approximately 20 cases of esophageal verrucous carcinoma have been reported in the world literature (1), but there are also cases reported from essentially every other squamous covered site (5-10). The occurrence of verrucous cancer in subjects with Down’s syndrome has not been previously reported.

Verrucous carcinoma generally has a predominantly pushing margin rather than an overtly infiltrative pattern characteristic of most squamous cell carcinomas. It is also characterized by minimal cytologic atypia and pronounced parakeratosis. The lack of marked cytologic atypia and overt infiltration often lends an appearance of reactive squamous hyperplasia with parakeratosis on superficial endoscopic biopsies as it did in this case (4). Verrucous carcinoma should be suspected in clinically large villiform lesions despite the lack of marked squamous atypia or obvious invasion. Clinicopathologic correlation is essential in ultimately making a diagnosis based on endoscopic biopsies since a diagnosis of malignancy can only be made if invasion is seen. This is problematic since the invasion occurs deep to the luminal overgrowth. As illustrated, endoscopic biopsies often fail to show the diagnostic malignant component.

The case subject’s initial biopsies demonstrated what appeared to be reactive squamous hyperplasia associated with colonization by fungal organisms consistent with Candida sp. Subsequent biopsies as well as EUS guided brushings and fine needle aspiration demonstrated cytologically bland squamous epithelium with only mild atypia. Histologically, these findings were favored as being reactive. However, given the clinical description of a mass, a low-grade squamous carcinoma was considered in the differential diagnosis. Ultimately an open biopsy of this mass demonstrated diagnostic material with focal unequivocal invasion by a well-differentiated squamous cell carcinoma consistent with a verrucous carcinoma of the esophagus.

It is important to confirm invasion when a papillary overgrowth is found, and cancer is suspected. One can not assume that the gross appearance is enough, as benign squamous proliferation can also occur. For example, a verrucous proliferation has been reported in infectious conditions such as blastomycosis (11). Furthermore, foreign bodies can cause a verrucous proliferation...
as is occasionally seen following esophageal stenting (12).

Summary
The reported outcomes in subjects with verrucous esophageal cancer suggests that this is a deadly disease, despite the bland histology. Approximately 2/3 of the reported subjects died of disease or direct complications of therapy. The follow up of reported survivors is short (three years or less) (1). This interesting condition requires a high index of clinical suspicion and persistence in obtaining a definitive diagnosis.

References

Review || Todd H. Baron, M.D.

Enteral Stents

Introduction: Enteral stents are defined as stents deployed within the stomach, small bowel and colon. Enteral stents are designed to treat malignant luminal obstruction of the gastrointestinal tract. Although their use is primarily for palliation of malignant obstruction, they can also be used within the colon as a pre-operative modality. This review will provide an overview of the techniques and outcomes of enteral stent placement for malignant disease.

Basic Principles: Gastrointestinal SEMS (self-expandable metal stents) may be placed under endoscopic guidance with the aid of fluoroscopy by gastroenterologists or by interventional radiologists using only fluoroscopic guidance. Endoscopic placement allows more remote locations (distal for the upper tract, proximal for colon) to be accessed (1-3). Although many of the principles for placement of enteral SEMS apply to both endoscopic and radiologic insertion, this article will focus on the endoscopic techniques of placement. Much of the data on the effectiveness and outcome following enteral stent placement comes from series published in the field of interventional radiology. It is assumed that regardless of the method of stent placement, the effectiveness is the same, assuming the insertion rates and complication rates related to insertion are similar.

SEMS are composed of a variety of metal alloys with varying shapes and sizes depending on the individual manufacturer and organ of placement. The stent incorporates deep into the wall of the organ. This reaction allows anchoring of the stent and helps to prevent stent migration. With the use of covered stents this integration does not always occur and a higher rate of stent migration is seen (4). SEMS may produce imaging artifacts on both computer tomography (CT) and magnetic resonance imaging (MRI) localized to the area around the stent that may prevent accurate interpretation. Most SEMS materials appear safe for MRI, but factors such as stent shape, orientation to the magnetic field, and type of alloy composition influence signal intensity in vitro. Therefore, in a patient who has undergone enteral stent placement this information should be obtained before an MRI is performed (5,6).

Upper Gastrointestinal Tract Stents

Indications: Clear indications for placement of SEMS in the upper gastrointestinal tract are documented malignant obstruction of the stomach, duodenum, or small bowel. Advanced carcinoma of the pancreatic head is the most common malignancy causing malignant gastric outlet obstruction. Other malignancies include unresectable cholangiocarcinoma, primary or recurrent gastric carcinoma, and metastatic disease to the duodenum or proximal jejunum. Recurrent malignancies at sites of gastroenteric anastomoses are also an indication for stent placement (7). Covered stents may be useful for treatment of malignant fistula from the stomach.
or duodenum to surrounding structures.

Contraindications
Contraindications to placement of SEMS in the upper gastrointestinal tract are free perforation with signs of peritonitis or tension pneumoperitoneum. An additional contraindication is the documentation of multiple sites of obstruction not within an area that could be covered by one or two stents. Documented peritoneal carcinomatosis is a relative contraindication to stent placement. Known benign disease, including strictures and adhesions, is considered a contraindication to stent placement.

Placement Techniques
In the United States, there is only one self-expandable stent approved by the food and drug administration (FDA) for placement in the duodenum for gastric outlet obstruction (Enteral® Wallstent, Microvasive Corporation, Natick, Massachusetts, USA). Many of the published series of SEMS placement in the upper gastrointestinal tract have been those in which standard or modified esophageal stents were used for treatment of gastric and duodenal obstruction (8-10). Outside of the U.S., a variety of covered SEMS designed for gastroduodenal use are available. These include the Choo stent (11) (Solco Intermed Co. Ltd. Seoul, Korea and MI Tech Co., Ltd., Pyungtaik-City, Korea), Song stent (12) (Stentech, Seoul, Korea), and Niti-S stent (12) (TaeWoong Medical, Seoul, Korea).

The techniques of insertion are different when using esophageal stents (non-TTS [through-the-scope] delivery systems) as opposed to the Enteral® Wallstent (TTS insertion). The disadvantage of the Enteral® stent is that it is not available in a covered version and is therefore susceptible to obstruction by tumor ingrowth or tissue hyperplasia induced by the stent. The bare metal ends of the Enteral® stent may cause perforation of the bowel wall (14). The common pathway for successfully placing an expandable metal stent, whether TTS or non-TTS, is the passage of a guidewire across the stricture.

Initial Placement of Guidewire
Prior to placing gastroduodenal SEMS, it may be helpful to obtain a radiographic contrast study (upper gastrointestinal barium examination) to assess the anatomy, length of stricture and degree of obstruction. However, such information may not be obtainable in the presence of complete obstruction.

Most lesions producing gastric outlet obstruction will be within the reach of a standard upper endoscope. For lesions distal to the second portion of the duodenum, it is usually necessary to use a colonoscope. Materials that should be readily available include biliary-type catheters and biliary guidewires. Hydrophilic biliary guidewires (Terumo, Tokyo, Japan) are especially useful in order to “cannulate” or access obstructive or nearly obstructive lesions. A stiff 0.035” guidewire (Savary-type wire, or 0.038” Amplatz extra stiff, Cook Medical, Spencer, IN or Amplatz 0.038” stiff guide wire Meditech/ Boston Scientific, Watertown, Mass., USA) is needed for stability in stent placement once the lesion has been accessed. Water-soluble radiographic contrast may also be needed to define stricture length as well as to insure correct passage of catheters within the gastrointestinal lumen. If marking of the tumor margins is desired, injection needles for placement radiopaque contrast are needed.

The procedure should be performed in a room equipped with fluoroscopy. It is imperative to have a gastrointestinal nursing assistant who is facile in complex therapeutic endoscopic procedures such as ERCP with metal stent placement.

The patient should be placed in the left lateral decubitus or prone position. A prone position allows for a better anatomic view under fluoroscopy. The supine position should be avoided because patients with complete gastric outlet obstruction are at high risk for aspirating retained gastric contents. With the use of standard intravenous conscious sedation the endoscope is passed to the site of obstruction. If the endoscope can be passed with minimal difficulty through the obstruction, this should be attempted, but it is important to note that the procedure can be safely completed without passing the endoscope through the stricture. Applying excessive force to the endoscope or aggressively dilating the stricture in order to pass the endoscope through the obstruction is unnecessary and increases the risk of perforation.

If the endoscope passes easily through the lesion, a stiff 0.035” guidewire with a floppy tip is placed through the endoscope channel and passed distally at least 20 cm beyond the point of obstruction. If the endoscope cannot be passed easily through the lesion, a hydrophilic biliary guidewire preloaded through a standard biliary catheter is used to “cannulate” or traverse the stricture as is done during ERCP (Figure 1). Once the wire has passed fluoroscopically through the stricture, recognized by the anatomically correct position of the wire passing into an air filled distal bowel loop (Figure 2), the catheter is advanced over the guidewire through the lesion. Water-soluble radiographic contrast is injected to confirm both proper position and luminal patency. At this point the guidewire is exchanged for a stiff 0.035” guidewire and the procedure proceeds as described below, depending on the type of stent chosen.

Stent Selection and Placement
The stent chosen should be at least 3 to 4 cm longer than the obstruction to allow an adequate margin of stent on either side of the obstruction. Covered stents have the advantage of closing fistula and preventing obstruction from tumor ingrowth or tissue hyperplasia. Dedicated Enteral® Wallstents are uncovered. The advantage of the Enteral® Wallstent is the ability to pass through the working channel of the endoscope and a long enough delivery system to pass through a colonoscope to allow stenting of lesions as far as beyond the ligament of Treitz.
Visible Human Journal of Endoscopy

Non-TTS Placement: The endoscope is withdrawn leaving the guidewire in place. The stent is then loaded onto the guidewire and advanced fluoroscopically to the lesion. The endoscope can then be reinserted alongside the stent delivery system to allow endoscopic guidance during deployment. Since the delivery system has no support and poor mechanical advantage it tends to loop in the greater curvature preventing forward advancement. Options to assist passage of the stent include a) preloading a snare into the endoscope, passing the snare over the delivery system, then advancing the endoscope and snare over the endoscope. The snare is closed and the endoscope advanced, advancing the stent (15); b) Using a rat-tooth forceps to grasp the stent and advance it forward (8); c) Modification of the delivery system. This has been applied to the Ultraflex stent. The handle is cut, and a plastic sheath is advanced over the string to extend the delivery system (16); d) Placement through a mature gastrostomy tract (17), and e) Use of external compression on the greater curvature of the stomach.

TTS Placement: If the Enteral® Wallstent is used, an endoscope with a therapeutic working channel (≥ 4.2mm) is required to allowing passage of the 10Fr delivery system. When stents are placed beyond the proximal and second duodenum a therapeutic channel adult colonoscope is usually required. After the guidewire is in position, the stent is passed over the guidewire through the working channel and is deployed under direct endoscopic guidance while maintaining the proximal position in the desired location while the stent is deployed from the distal end (Figures 3, 4 and 5).

Once the stent is fully deployed the ends of the stent should be carefully inspected fluoroscopically. If either end is not secured or fully expanded to produce a waist, the endoscopist should be suspicious that the stent chosen may have been too short to cover the entire length of the stricture. At this point contrast can be injected into the stent to assess complete patency. If needed, a second (rarely third) overlapping stent may be required to adequately treat the stricture.

The duration of the procedure is highly variable and is dependent on the degree of difficulty one encounters traversing or accessing the stricture. At least one full hour of time should be allotted once sedation is administered.

Concomitant Biliary Obstruction

In patients with malignant duodenal obstruction, coexistent biliary obstruction is commonly present and has usually occurred prior to gastric outlet obstruction (2). Because the biliary tree is usually endoscopically inaccessible through the mesh wall of a self-expandable metal duodenal stent when it has been placed across the papilla, an endoscopically expandable metal biliary stent should be placed if possible in patients with known or impending biliary obstruction prior to duodenal stent placement.BILE then flows effectively through the biliary and duodenal stents as they cross within the duodenum. To treat biliary obstruction following duodenal stent placement across the papilla, a percutaneous transhepatic approach is usually required. Stenting of both the duodenum and bile duct represents the non-surgical equivalent of a double surgical bypass.

Limitations

Limitations of successful placement include inability to pass a guidewire through the stricture, anatomic difficulties such as severe looping within the dilated stomach, or complicated post-surgical anatomy. Some patients with advanced malignancies and gastroduodenal obstruction may not improve following successful stent placement because of other unidentified sites of malignant gastrointestinal obstruction, diffuse peritoneal carcinomatosis with bowel encasement, or functional gastric outlet obstruction from neural (e.g. celiac axis) involvement by tumor.

Most patients will not be able to tolerate a solid diet. Leafy or raw vegetables should be avoided which could result in stent occlusion.

Severe complications may occur during or late after placement of gastrogastric and jejunal SEMS. Intra-procedural complications that may occur include complications of conscious sedation, pulmonary aspiration, stent malposition perforation and bleeding. Late complications include distal stent migration, bleeding and perforation as well as fistula formation. Stent migration may be completely asymptomatic or result in bleeding, perforation, or obstruction. Symptomatic stent occlusion from tumor overgrowth, ingrowth, or food impaction requires endoscopic intervention. Obstruction by tumor ingrowth or overgrowth is usually managed with placement of additional stents through the original stent(s) (Video Clip 1).

Outcomes

The larger series published in the endoscopic and interventional radiologic literature (4,8-13,18-28) are presented in Table 1. Overall, the technical success rate for placement is high (approximately 90-100%) with clinical success (ability to consume p.o. intake)
Colonic Stents

Overview
At the present time, all SEMS specifically designed for use within the colon are uncovered. However, covered esophageal stents have been used in the colon to combat problems with tumor ingrowth and to close fistulae (29). Any type of expandable metal stent may be used within the colon including esophageal, tracheobronchial, and biliary stents (30). In the United States, there are two self-expandable stents approved by the food and drug administration (FDA) for placement in the colon for malignant colonic obstruction. These are 1) the colonic Z-stent (Wilson-Cook Medical, Winston-Salem, NC); and 2) the Enteral® Wallstent, (Microvasive Corporation). The advantages of using the Enteral® Wallstent over other stents are the much longer and smaller diameter (10Fr) delivery system that allows passage of stents directly through the working channel of the endoscope. This increases mechanical advantage and lesions as far proximal as the proximal ascending colon may be successfully stented (Video Clip 2) (3). A theoretical advantage of the Wilson-Cook Z-stent (31) is the larger diameter of the lumen compared to the Enteral® Wallstent. One further advantage of the Z-stent is that is does not shorten during deployment.

Most lesions producing colonic obstruction will be within the reach of a standard flexible sigmoidoscope or upper endoscope. For lesions proximal to the descending colon it is necessary to use a colonoscope. If the Enteral® Wallstent is chosen for passage through the working channel of the endoscope, a therapeutic working channel ≥ 4.2mm diameter is required.

Indications
There are two major indications for placement of colonic stents for relief of colonic obstruction: pre-operative decompression and palliation of advanced malignancy. These will be discussed separately.

• Pre-operative Decompression
Primary colorectal cancer that produces left-sided colonic obstruction is the most common indication for placement of SEMS for pre-operative decompression. These patients traditionally are treated with a diverting colostomy and resection followed by a later reanastomosis. Additionally, patients with total colonic obstruction are frequently ill with co-morbid medical conditions and electrolyte disturbances. Therefore, successful placement of an expandable metal stent allows for stabilization of the acute illness, an elective resection with evaluation of extent of disease and comorbid medical conditions and a one-stage operation. The tumor and stent are resected en bloc at the time of resection (Figure 6).

• Palliation of Obstruction
In patients with primary or recurrent colorectal carcinoma where the disease is widely metastatic, or the patient with potentially resectable disease but a non-operative candidate because of co-morbid underlying conditions, colorectal stent placement may serve as a palliative modality of obstruction (Figures 7 and 8). Additionally, patients with local pelvic tumors (ovarian carcinoma) or metastatic disease to the pelvis and colonic obstruction may achieve palliation of obstruction with colonic stenting (32).

Patients with malignancy within the pelvis may suffer from fistulae to surrounding structures such as the vagina or bladder. In this setting, covered esophageal stents have been used to close such fistulae and allow for non-surgical palliation (29).

Contraindications
Colonic perforation is considered a contraindication to placement colonic SEMS and plain radiographs should be obtained immediately prior to stent placement in order to exclude free perforation. Benign disease is considered a contraindication to SEMS placement, although there are case reports of their use for both pre-operative decompression and for dilation of refractory benign strictures (33).

Placement Techniques

• Patient Preparation and Positioning
It may be helpful to obtain a retrograde radiographic contrast study (water-soluble or barium enema examination) to assess the anatomy, length of stricture and degree of obstruction (Figure 9) (30). It is important to consider that there may be other sites of obstruction that would negate any effect of stenting a single site of obstruction.

Patients with complete obstruction have usually evacuated any stool below the lesion and therefore a colonic preparation is usually unnecessary. In those patients who have subtotal obstruction in the distal colon, one or two cleansing enemas are usually an adequate preparation. In patients with more proximal lesions and subtotal obstruction, a cautious standard colonoscopy bowel preparation should be given. Prophylactic antibiotics should be considered in patients with complete obstruction and a markedly dilated colon because introduction of air during the procedure may promote microperforation and bacteremia (30).

The patient should initially be placed in the left lateral decubitus position. Rotating the patient into the supine position allows for a better anatomic view under fluoroscopy, if used. Standard intravenous conscious sedation is usually administered, but is not absolutely necessary for treating distal lesions.
**Description of Procedure**

Placement of SEMS in the rectum and distal sigmoid: the use of non-TTS stents is analogous to esophageal stent placement. Placement of TTS stents, which are usually necessary for treating more proximal obstruction, is similar to that described previously for treatment of gastroduodenal and proximal jejunal lesions. These two approaches to SEMS placement will be discussed separately below.

**Non-fluoroscopic guided stent placement**

**Non-TTS Stent Placements:** For distal left-sided lesions, some authors prefer to assess the entire lesion entirely under endoscopic guidance (31). If the endoscope cannot be passed through the lesion, the stricture is cautiously balloon dilated using a 15 mm TTS balloon. A 10 mm endoscope is then passed through the stricture to allow placement of a Savary guidewire as high as possible above the lesion. The endoscope is withdrawn while the stenosis is measured and the position/orientation of the lumen is assessed. After the undeployed stent is passed across the stricture, the endoscope is reinserted to verify and monitor the exact position of the distal end of the stent during deployment. Alternatively, in patients with intrinsic lesions, some authors have used laser therapy to initially recanalize the lumen to allow passage of the endoscope and guidewire for facilitate placement of SEMS (31). Both of these methods allow for stent placement without the use of fluoroscopy.

**TTS Stent Placement:** If the endoscope passes easily through the lesion, a stiff 0.035” guidewire with a floppy tip is placed through the endoscope channel and passed distally at least 20 cm beyond the point of obstruction. Once the stent passes through the endoscope channel, the endoscope is withdrawn below the distal margin of the stricture and the stent is deployed under direct endoscopic guidance.

**Endoscopic/Fluoroscopic Stent Placement**

If the endoscope cannot be passed easily through the lesion, a hydrophilic biliary guidewire preloaded through a standard biliary catheter is used to traverse the stricture as described previously for upper gastrointestinal stenting. Once the wire has passed through the stricture, recognized fluoroscopically by the anatomically correct position of the wire passing into an air-filled, dilated proximal bowel, the catheter is advanced over the guidewire through the lesion. Water-soluble radiographic contrast is injected to confirm position and lumenal patency. At this point the guidewire is exchanged for a stiff 0.035” guidewire and the stent is deployed (Figure 10).

**Outcomes**

Table 2 summarizes the major case series published on colonic stents.

**Pre-operative Stent Placement**

There are several series describing successful pre-operative placement of colonic SEMS allowing for subsequent one-stage resection of the tumor and stent, and avoidance of a colostomy (34-37). Two studies have compared the outcome of patients undergoing endoscopic placement of SEMS for relief of acute large bowel obstruction following by elective resection to those patients undergoing surgical intervention alone (38,39). Two of 13 patients treated with colonic SEMS required colostomy compared to 10 of 13 patients in the traditional surgical group. When the data was analyzed for the pre-operative patients, a cost savings of 28.8% was seen in the SEMS group because of a decrease in total hospital days, days spent in the intensive care unit, and fewer surgical procedures. A more recent prospective study demonstrated similar findings (39). A primary anastomosis with avoidance of colostomy was achieved significantly more often (85% vs. 41%) in the SEMS group. Total hospital stay, ICU stay and severe complications were significantly lower in the SEMS group.

In a comprehensive systematic review of all colorectal stent literature from 1990 through 2000, colorectal stent placement was successful as a bridge to surgery in 85% of 223 cases and 95% had a one-stage operation (40).

**Palliation of Obstruction**

Several other series have demonstrated successful palliation of malignant colonic obstruction with successful avoidance of colostomy (30;34,37,41-46). In some series, the stents effectively palliated obstruction for more than one year. The largest series of endoscopic stent placement for palliation of obstructive primary rectal and rectosigmoid obstruction was published by Spinelli et al. (31). Stents were successfully placed in 36 of 37 patients. Three early migrations occurred. Twenty-eight of the remaining 33 patients had good long-term resolution of obstruction without need for further treatment.

Nearly all series have used uncovered stents. One study found an unacceptably high rate of migration using fully covered stents (47). However, in a recent study using partially covered stents in 16 patients with covered stents placed for palliation of malignant left sided
obstruction only two stent migrations occurred (29). At a mean follow-up of 21 weeks, no stent occlusion was seen.

In the previously mentioned comprehensive systematic review of all colorectal stent literature from 1990 through 2000, colorectal stent placement was successful as a palliative modality in avoiding a colostomy in 90% of 336 cases (40).

- Limitations
  Limitations of successful placement include inability to pass a guidewire through the stricture, and anatomic difficulties such as a severely angulated and “fixed” sigmoid which prevents advancing to the site of the lesion. Some patients with widely advanced malignancies and colonic obstruction may not improve following successful stent placement because of other unidentified sites of malignant gastrointestinal obstruction or diffuse peritoneal carcinomatosis with small bowel encasement (30).

Severe complications may occur during or late after placement of colorectal SEMS. Intra-procedural complications that may occur include complications of conscious sedation, stent malposition, perforation and bleeding. Two important tips are helpful to avoid intra-procedural perforation. The first is limiting the amount of air insufflation during the exam, especially in patients with a dilated cecum. The second is avoiding aggressive pre- or post-stent dilation (30,40).

Late complications include distal stent migration, bleeding and perforation. Stent migration may be completely asymptomatic or result in rectal bleeding or tenesmus. Removal of distally migrated stents from the rectum is not technically difficult. Proximal migration following successful placement does not occur, but malposition or maldeployment of a stent completely above the stricture is usually of no sequelae, assuming additional stents are placed to relieve the obstruction (personal experience). Stents placed very distally in the rectum may produce tenesmus, rectal pain or fecal incontinence and patients with distal rectal obstruction should be advised of this possibility prior to stent placement. In general, if the stent is placed at least 2 cm proximal to the upper end of the anal canal it does not interfere with anal function. Symptomatic stent occlusion from tumor overgrowth, ingrowth, or stool impaction requires endoscopic intervention. Obstruction by tumor ingrowth or overgrowth is usually managed with placement of additional stents through the original stent(s).

There is little data concerning the safety of SEMS in the colon or rectum in the setting of prior or concomitant radiation therapy. One case report suggests that concomitant chemotherapy and radiation therapy may be safe (48). It is possible that this approach may promote stent migration as the tumor shrinks in response to treatment.

In the previously mentioned comprehensive systematic review of all colorectal stent literature from 1990 through 2000, mortality related to stent placement was 1% of 598 patients. Colorectal stent placement was complicated by perforation in 0 to 7%, stent migration in 3-22%, bleeding in 0-5%, and reobstruction in 0-15% (40).

Summary
For upper gastrointestinal stent placement, palliation of malignant gastric outlet obstruction is a viable alternative to in patients with unresectable cancer and a poor performance status. For colonic stents, pre-operative stenting may allow a one-stage operation and avoidance of a colostomy. In patients undergoing palliation of obstruction, SEMS may allow avoidance of surgery altogether. Newer stent designs for both upper and lower gastrointestinal use are needed that are covered while still allowing delivery through the endoscope channel, and are associated with low migration rates.

References:
Introduction: Colonoscopic polypectomy has been shown in three studies to prevent about 80% of incident colorectal cancers (1-3). Despite this, the actual performance of polypectomy is only partly science and mostly an art form that has developed over 30 years of anecdotal reporting of polypectomy practices. If one were to judge the level of evidence supporting individual polypectomy techniques currently practiced, none of it would be “Level A” evidence. Given these limitations, this paper is an unapologetic commentary on pearls and pitfalls in polypectomy, based solely on the practices and writings of previous experts in colonoscopy and on the author’s own experience. This paper is not comprehensive in its review of polypectomy technique, but rather focuses selectively on issues that the author finds to be often a source of error or that the author perceives might be better or more safely performed in general practice.

Small Polyp Removal
The overwhelming majority of colorectal polyps are less than 1 cm in size and the great majority of such polyps will never harm anyone by development into cancer, bleeding, or other symptoms. There is certainly a strong rationale to remove all polyps from the colon in patients with a substantial life expectancy, if for no other reason that it would be too costly to observe them. The author strongly recommends the use of cold snare removal for most sessile polyps < 6-7 mm in size (4). The use of hot forceps is inappropriate for any polyp larger than 5 mm but even for polyps <5 mm, neither hot forceps or cold forceps effectively removes the entire polyp (5). Cold snaring has the advantage of effective removal, though a large study would be needed to determine if it is as effective as hot snaring. Cold snaring has the distinct advantage of eliminating cautery-related complications. The use of electrocautery is the cause of polypectomy-related perforations and it may result in delayed bleeding by injury of submucosal arteries. One concern often expressed about cold snaring is that the polyp may be difficult to retrieve. In fact, the polyp almost always remains in place near the polypectomy site (Video Clip 1) and can be readily suctioned into a trap. In our unit, we retrieve > 95% of polyps removed by cold snaring. If an occasional polyp is lost, it is extremely unlikely to have any significance. A second concern is often that of immediate bleeding. However, small polyps have small vessels and the bleeding that occurs after cold resection of small polyps is capillary bleeding which will invariably stop on its own. The colonoscopist can safely ignore it, unless there is impressive and continued steady streaming from the polypectomy site. In the author’s experience, this happens only occasionally in an anticoagulated patient or a patient with significant liver dysfunction. Thus, in only a rare instance is it necessary to cauterize the site using multipolar cautery or to clip it closed.

The Patient Who Is Anticoagulated or on Antiplatelet Agents
The American Society for Gastrointestinal Endoscopy recommends that no provisions be taken for polypectomy in patients on aspirin (6). In clinical practice, most gastroenterologists, including myself, do make some provision for aspirin use. In patients taking aspirin for primary prophylaxis (often self-prescribed), we typically instruct them to stop aspirin a week to ten days before the procedure and may keep patients off aspirin for up to two weeks after the procedure if electrocautery was used. If patients arrive in the endoscopy unit having taken aspirin despite our instructions, we proceed with their colonoscopy and remove polyps, whatever the size. If there is not a strong indication for aspirin use, however, we ask the patient to remain off of aspirin for two weeks after the procedure, if electrocautery was used. If patients are on aspirin with strong indications for prevention of cardiovascular or neurologic events, we do not discontinue the aspirin. My own rationale for the approach described above is that aspirin and NSAIDS make all lesions in the GI tract more likely to bleed, and there is no reason why this should not apply to polypectomy burns. However, the absolute risk of bleeding from polypectomy burns, in patients on aspirin only, is very low.

Experience in our unit with patients taking both aspirin and clopidogrel (Plavix) has been that this combination is associated with a high risk of bleeding. Considerable caution should be taken in performing therapeutic procedures on patients taking both aspirin and clopidogrel, including polypectomy with electrocautery. We commonly ask patients to discontinue clopidogrel for five days prior to polypectomy and for a variable period of time afterwards, depending on the size of the lesion and the patient’s cardiovascular risk.

For patients on warfarin who are low risk for a thromboembolism (atrial fibrillation without left atrial dilation, deep venous thrombosis after six months of therapy), it is acceptable to discontinue warfarin 3 to 5 days prior to colonoscopy and to resume it following the colonoscopy or after some delay if there appears to be a substantial risk of bleeding. For patients at high risk (e.g. atrial fibrillation with mitral valve disease and left atrial dilation, prosthetic mitral valves), it is usually acceptable to discontinue warfarin and continue Lovenox as an outpatient, giving the last dose 24 hours prior to the procedure. Both Lovenox and warfarin can then be restarted on the evening of the procedure. We often perform colonoscopy in high-risk patients while they continue on anticoagulation and remove the small polyps using cold forceps or cold snare. In some instances, we remove slightly larger polyps with electrocautery and place a clip over the site; anecdotal, this practice has been successful. [However, the ASGE recommends that for polypectomy, anticoagulation should be reversed (6).] Since most patients undergoing colonoscopy have either normal
colors or only small polyps, the approach described above of trying the procedure while the patient is anticoagulated probably results in cost savings. If a larger polyp for which electrocautery is needed is identified, the patient can be scheduled for a repeat colonoscopy on another day, the warfarin discontinued, and the patient placed on Lovenox. Although Lovenox is less expensive than hospitalization and heparinization, the safety of Lovenox in high-risk patients has not been established by prospective trials. Certainly discontinuation of warfarin, followed by hospitalization and intravenous heparinization after the INR has drifted down, is an alternative. In this case, intravenous heparin is discontinued four hours prior to the colonoscopy and restarted 4 to 6 hours afterwards. Whenever patients are to be re-anticoagulated, consideration should be given to clipping the polypectomy site closed, if feasible (Video Clip 2). Prospective studies of the effectiveness of this practice are needed.

Large Pedunculated Polyps

 Experienced colonoscopists should be able to remove essentially any mucosally-based pedunculated polyp, regardless of size. Endoloop, or the detachable snare, is effective in preventing bleeding in one small randomized trial (7), and its use should be considered an option (Video Clip 3). Truly huge pedunculated polyps occasionally require piecemeal resection of the head, in order to pair it down a size that allows getting the snare around the base. In this instance, it is best to send the base as a separate pathologic specimen, since if cancer is present, it is most important to know if it is in the section adjacent to the polyp stalk. Rotating the patient can facilitate snaring the very large polyp, by changing its position as it moves with gravity.

Access Problems

Areas where access problems occur commonly are on the medial wall of the cecum, just proximal to the ileocecal valve, and on the proximal sides of folds, flexures, and turns. Large sessile polyps located on the proximal side of sharp sigmoid bends can be problematic. The easiest solution is to remove the polyp in retroflexion. In the left colon, this can be accomplished using an upper endoscope that is evaluated before insertion to ensure that it has maximum tip deflection. For the polyps in the proximal colon, a pediatric colonoscope can be useful. The author has tested a prototype Olympus pediatric variable stiffness colonoscope with a short bending section, which has a very tight turning radius and allows retroflexion anywhere in the colon, including in the cecum (8) (Figures 1A-1F).

The Very Flat Polyp

Occasional very flat polyps can be impossible to snare and the problem persists after submucosal saline injection. In the rectum and sigmoid, the best solution is the EMRC cap (9). In the proximal colon, such polyps can be treated by biopsy, followed by ablation, or one can try a snare designed to dig into the mucosa such as the Olympus barbed snare.

The Large Sessile Polyp

The usual guidelines for endoscopic resectability of a large sessile polyp are that the lesion should occupy no more than 30% of the circumference of the colon and not extend across two haustral folds. These are only guidelines and experts often remove larger polyps if they appear to be readily accessible. The most important determinant of accessibility is usually the section of the colon that the polyp is in. Thus, in the large caliber right colon, transverse, or rectum, polyps that occupy 50% or even more of the circumference may be resectable. The main difficulty with polyps extending across two haustral folds is the section that dips down between the haustral folds. This area can be very difficult to access.

For submucosal saline injection, it can be useful to add a few drops of methylene blue to about 60cc of normal saline or D50. D50 stays in place and maintains the

Figure 1A: The ileocecal valve is seen in retroflexion.

Figure 1B: A small polyp is seen on the proximal side of a haustral fold and resected using cold snare resection.

Figure 1C: A small polyp is seen on the proximal side of a haustral fold and resected using cold snare resection.

Figure 1D: A small polyp is visible in the forward view.

Figure 1E: A different adenoma is seen in retroflexion. Video Clip 4: A large sessile polyp involving about 50% of the rectum is removed using submucosal saline injection with methylene blue, followed by piecemeal snare resection. A small amount of residual flat polyp just proximal to a fold must be ablated using the argon plasma coagulator.

Figure 1F: In retroflexion, the polyp could be snare resected and residual polyp ablated using the argon plasma coagulator.

Video Clip 4: A large sessile polyp involving about 50% of the rectum is removed using submucosal saline injection with methylene blue, followed by piecemeal snare resection. A small amount of residual flat polyp just proximal to a fold must be ablated using the argon plasma coagulator.
submucosal cushion longer than saline (10). The goal should be to resect all of the polyp and any residual flat disease that cannot be resected, all in the first attempt (Video 4). Resection is preferable to ablation, though most large sessile polyps have at least some small section of extremely flat disease that must be ablated or removed using the EMR cap. No randomized trials have compared ablation tools but most experts currently favor the argon plasma coagulator (Video Clip 4) (11). It allows a controlled cauterized burn in a non-contact fashion. Power settings should be 40 watts in the esophagus, up to 45 watts in the right and transverse colon, and can increase progressively in the distal colon, and can last as much as 60 to 65 watts in the distal rectum.

Correct Pathological Interpretation
Sometimes serious mistakes are made in the management of endoscopically resected polyps based on their pathologic interpretation. The most serious errors follow the use of the terms, “carcinoma in-situ” or “intramucosal adenocarcinoma” (12) (Figures 2A-2D). Neither of these pathologic entities constitutes colorectal cancer and both are associated with a zero risk of metastasis. Therefore, if a polyp has been endoscopically resected in patients with such pathologic readings, the patient should be considered cured. In order to avoid confusion, it is best for the pathologist not use these terms but rather refer to both entities as “high grade dysplasia.” If invasive cancer is present, the pathologist must designate the proximity of the cancer to the endoscopic resection line, the degree of differentiation, and whether the lymphatic (vascular) invasion is present. Various studies have used different margin criteria (1, 2, or 3 mm) as acceptable. At a minimum, the cancer should not abut the resection line or surgical resection should be recommended.

Follow-Up of Large Polyps
Large pedunculated polyps with high-grade dysplasia, provided the endoscopist is sure there has been complete resection, can undergo their first follow-up in three years. If adenocarcinoma is detected in the polyp and histologic criteria are favorable and a decision is made to not perform surgery, some have advised a re-inspection of the polypectomy site and biopsy in three months. Although the value of this practice is questionable, there is no clear data to prove that it has no value.

Large sessile polyps removed in piecemeal fashion should be followed closely to ensure complete resection, regardless if the dysplasia is low-grade or high-grade. I typically recheck the site in three months, though some people wait as long as six months. If the polypectomy site appears free of polyp, there is a rationale to perform yet another reexamination in one year. This is because of so-called “late recurrences,” which may account for up to half of all recurrences after removal of large sessile polyps (13). In my own anecdotal experience, biopsy of the polypectomy scar at three months effectively predicts which patients will subsequently develop a recurrence of over-poly. If dysplastic tissue is present in the polypectomy base, this predicts the subsequent recurrence of an overt polyp.

References
EUS in the Literature || Manoop S. Bhutani, M.D.


This is a single center experience of 23 EUS examinations in 20 patients for mediastinal masses of unknown origin, suspected mediastinal cysts or follow up of a known cyst. In 19 patients, the definite diagnosis of a mediastinal cyst was established by EUS. In three cases, the cyst contents were aspirated by EUS-FNA. EUS-FNA in a fourth case of solid appearing duplication cyst resulted in severe sepsis secondary to mediastinitis with thoracotomy revealing an infected bronchogenic cyst.

EUS imaging is a useful technique for further diagnostic characterization of mediastinal cysts. However, as shown by the authors, one should resist the temptation of performing EUS-FNA in these patients due to risk of an infectious complication. This complication would be even more significant when the patient with a mediastinal cyst is asymptomatic and the cyst is incidentally discovered (a not so uncommon scenario). Thus, EUS-FNA in these lesions should be performed when the additional information from FNA is clearly going to assist in clinical decision making.


The aim of this study was to report the sensitivity, cytological diagnoses, EUS features, complications, clinical impact, and long term clinical follow up of a single center experience with EUS-FNA of benign and malignant solid liver lesions in 77 patients. Depending on the status of unclassified lesions, the sensitivity of EUS-FNA for the diagnosis of malignancy ranged from 82% to 94%. EUS detected malignancy in 41% of patients with previously negative examinations.

For the 45 subjects with cytology positive for malignancy, EUS-FNA changed management in 86% of patients.

This study adds to the increasing reports of EUS-FNA in liver lesions and shows that this appears to be an area where EUS can have significant clinical impact. However, since liver lesions are easily approachable by interventional radiology via the percutaneous route, the application of EUS for liver lesions at a particular institution may be dependent on the quality and expertise of interventional radiologists as well the quality of the CT/MRI scanners. As the authors have correctly pointed out, comparative studies between EUS-FNA and percutaneous FNA biopsy with the regards to accuracy and complications are needed. At the current level of knowledge, decision to perform EUS-FNA for solid liver lesion (and its sequence in comparison to percutaneous FNA or other imaging tests) should be done on a case to case basis depending on the institutional expertise and the clinical situation.


This is a review paper in the Expert Approach Section of the journal Endoscopy. The aim of the expert approach section is to contribute to the dissemination and standardization of new endoscopic procedures. Authors from three distinct geographic areas combine forces, sharing their experience to form a consensus of opinion. The paper reviews the basic principles of EUS guided cystogastrostomy as well the echoendoscopes and accessories needed to get the job done. The procedure is described in a step by step fashion with good figures. Literature and success rate in 79 published cases of EUS guided pancreatic pseudocyst drainage is nicely tabulated and cross referenced. This is a nice technical review for endoscopists interested in this technique.

Technical Updates || Farzin Imani, M.D, Ph.D.

Charged-Coupled Device and Video Endoscopy

Modern flexible video endoscopes with photosensitive charged-coupled device (CCD) chips were introduced in the 1990s as an extension of the development of first fiberoptic endoscopes in 1960s. The CCD was first invented by researchers at the Bell Labs as a new type of computer memory. Soon it became apparent that it could be used as a light sensitive element, which could capture images similar to a film in a camera. The small size, low voltage, low energy consumption, and low cost have lead to rapid proliferation of the CCD. Many optic instruments including endoscopes and digital cameras have been equipped with CCD for image capturing.

CCD chip is made of silicon, which is sensitive to light of wavelengths less than 1.1 microns. (The wavelength of visible light being 0.4-0.7 microns). The surface of CCD is divided to several hundred thousand to several million identical light sensitive elements or pixels. Pixels are arranged in an orderly fashion on the chip. The resolution of the images is directly related to the number of the pixels. The light energy packets (photons) falling on each pixel is absorbed by the silicon and cause a reaction to take place. This reaction generates electrical charge (electrons). The generated electrons are hold in the pixel until the reading phase. Once it has been read, the cycle starts again.

The ratio of generated electron to the received energy defines the sensitivity of the CCD, which has a relatively constant value over a wide range of absorbed energies. The quantum efficiency of a CCD is the ratio between the number of produced electrons to the number of incident photons at a given wavelength. This number is non-linearly correlated with the frequency of the light.

Image-reading is performed by the orderly shifting
of electrons to the adjacent cells. First, all rows are shifted vertically (downward, Figure 1) and the last row is placed in a Horizontal Shift Register (HSR). Then the data in the HSR is serially transmitted to the A/D (Analog to Digital) converter of a video processor. This process of row shifting to the HSR is repeated until all the stored electrons are transmitted to the video processing unit (Video Clip 1).

Reproduction of Color Images

The CCD is inherently a monochromatic sensor. Reproduction of color images requires separate measurement of the intensity of the red, green and blue components of light. In video endoscopy, the two techniques of “sequential illumination” and “static filter” are used for this purpose.

In the “sequential illumination” technique, the area under examination is exposed consecutively to red, green and blue lights. A Xenon lamp with a rotating wheel filter provides primary light colors for exposure. The video processor is synchronized with this wheel and temporarily stores the returning signals from CCD in three memory banks depending on the color of the light at the time of exposure. After receiving the data for all three colors, the video processor either generates synchronized RGB signals or combines them as a composite color video signal for the monitor to display.

Another technique used in video endoscopy to generate images is the “static filter.” This filter, which is composed of multiple primary color filter stripes, is mounted on the CCD during device fabrication. Each CCD pixel responds only to the light of the particular color of its filter. The major benefit of this approach is the reduction of the complexity of the system. However, this approach also reduces the effective resolution of the image.

Blooming Phenomenon and Anti-Blooming Gates

Each pixel has a limited capacity for electrical charge. The maximum charge an individual pixel can hold before saturating and leaking it to surrounding pixels (full well) varies among CCDs. The maximum well capacity depends on the size of the pixel. The larger the pixel, the more it can hold the charge, before it leaks to the adjacent pixels.

If the CCD is subject to overexposure, it will produce image-smearing due to a phenomenon known as “blooming,” which deteriorates the quality of the image. In order to prevent this image deterioration, some sensors offer anti-blooming gates that are manufactured on the chip to prevent leakage of charge. However, since anti-blooming gates are constructed into the light sensitive areas of the chip, they reduce the size of the pixel by about 30%, diminishing the sensitivity of the CCD. Chips with anti-blooming gates are generally not recommended, if overexposure can be avoided altogether.

Figure 2 below is an illustration of a typical CCD without anti-blooming gates. Pixels are 15 microns by 15 microns with a capacity of 165,000 electrons.

Figure 3 below is an illustration of a typical CCD with anti-blooming gates. Pixels are 15 microns by 15 microns with capacity of 120,000 electrons.

Future of Video Endoscopy

The resolution and sensitivity of CCD chips are constantly improving. This will result in a significant enhancement of the quality of video endoscopes. Production of smaller CCDs with higher resolutions will provide the opportunity to include two or more sensors in an endoscope. By using two sensors to look at a lesion from different angles, the examiner will have a stereoscopic view of the lesion, which will facilitate diagnostic and therapeutic procedures.

References

In this issue, we are showing a video clip from the Female Visible Human data base (Video Clip 1). This particular movie starts in a cross sectional orientation at the anal canal and then goes proximally into the pelvis. The vagina and urethra are inferior to the rectum in this film clip. The distal colon has fecal material in it, which distends the rectal vault.

This movie is useful for visualizing the orientation between the female genitourinary structures and the rectal vault, and is of value in reading CT scans or in performing radial array rectal ultrasonography.

Labeled still images are shown from the start (Figure 1A) and the end (Figure 1B) of the clip. A comparison image of male and female anatomy is also shown from the mid rectum (Figure 2). Since the Female Visible Human data base is not currently available on the WEB, there is no link to interact with these structures. [Online only: However, a link to the Visible Human Interactive Atlas has been made in the mid rectum of the male (Figure 3) for those wishing to compare the pelvic anatomy of the male and female.]

Figure 1A: Still image from starting point of Video Clip 1. Image is from the Female Visible Human data base.

Figure 1B: Still image from ending point of Video Clip 1. Image is from the Female Visible Human data base.

Figure 2: Comparison image of female (left) and male (right) anatomy from the mid rectum.

Figure 3: Image from Visible Human data base of male anatomy from the mid rectum.