Endoscopic Stenting: An Overview of Potential Complications

by Sandeep Patel, Rashmi Patwardhan and John Levey

Endoscopic stenting has become widely used for treatment of gastrointestinal and hepatobiliary strictures. These strictures may arise in the esophagus, gastroduodenal region, biliary tree or colon. In almost all cases, metallic stents should only be deployed in malignant strictures. Complications of stenting include perforation, migration, bleeding, occlusion and pain. Following is a review of endoscopic stenting and its complications.

INTRODUCTION

Enteral stenting has been a palliative treatment for malignant gastrointestinal obstruction since its initial use in patients with dysphagia due to esophageal cancer in 1924 (1). The original stents were large and made of rigid plastic thereby making them difficult to place orally. Gianturco devised the first self-expanding metallic stents in 1985 for endovascular use (2). There are two types of metallic stents, the expandable (eg, Strecker) and the self-expanding (SEMS). The former must be positioned inside a predilated stricture and then balloon dilated on to the wall where it takes up its preconfigured shape. SEMS derive their expansile force as a result of their geometric structure and spring into shape on release.

The latest SEMS are made of a nickel and titanium alloy known as nitonol which has the property of "shape memory." This allows the stent to expand to a predetermined configuration after release from the delivery system. Maximal expansion is achieved in 2-5 days, thus applying gentle and even dilation of the stricture. Metallic stents are available in a variety of diameters and lengths, are found in helical (Esophacoil®), knitted (Ultraflex®) and braided (Wallstent®) varieties, and can be covered with a membrane to prevent tumor ingrowth through the interstices of the mesh. They are all available on delivery catheters, some small enough to pass through an endoscope channel. Both plastic and metallic stents are placed under endoscopic and/or fluoroscopic guidance.

Endoluminal stenting has gained wide-spread acceptance and is gaining popularity due to the high success rates in relieving symptoms from malignant obstruction with relatively low complication rates. This article will review the complications associated with esophageal, gastroduodenal, biliary, and colonic stent placement.

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Figure 1. Various sites for gastrointestinal endoluminal stenting. A) Biliary; B) Gastroduodenal; C) Esophageal; D) Colonic.

ESOPHAGEAL STENTS

Esophageal cancer is the seventh leading cause of cancer-related deaths in the United States with the prevalence increasing more rapidly than any other cancer in the U.S. (3). At presentation, three-fourths of patients with esophageal cancer will have disease spread to the lymph nodes with less than half of the patients having resectable disease at the time of diagnosis. Of the patients whom are deemed candidates for resection, only a small percentage of them are cured by surgery. Thus, the prognosis of this inflection is dismal with overall 5 year survival rates less than 10% (4). Therefore, for a majority of patients the focus of treatment has been palliation. Patients generally develop dysphagia from partial or complete obstruction of the esophageal lumen and also lose their ability to eat safely leading to malnutrition, aspiration, and sialorrhea. The major goal of palliative treatment is to relieve symptoms quickly with minimal invasiveness and discomfort. Conventional methods used in the past have included surgical bypass, laser ablation, radiation therapy, and endoscopic alcohol injection, photodynamic therapy, with each being associated with substantial morbidity and mortality (5).

Endoscopic stenting and related techniques for palliation of esophageal cancer are being used with increasing frequency. Peroral stenting opens the lumen of the obstructed esophagus immediately relieving the patients dysphagia allowing them oral food intake and thereby improving his/her nutritional status while also reducing aspiration risks (6). Until approximately 1990, plastic stents placed under endoscopic and fluoroscopic guidance were the most commonly utilized (7). Most gastroenterologists and radiologists placed plastic stents in patients under general anesthesia and patients were monitored in the hospital for 2–3 days. These plastic stents are semirigid with large external diameters (16 mm) but relatively small fixed internal diameters (12 mm). These stents therefore do not guarantee relief of dysphagia and are difficult to place in patients with angulated strictures. The placement of plastic stents also requires aggressive stricture dilation to accommodate their large external diameters leading to high esophageal perforation rates. The overall complication rate for plastic stent placement has been reported to be as high as 36% with a mortality of 2%–16%. The various reported complications include a perforation rate of 4%–11%, obstruction in 8%–10%, bleeding in 2%–5%, and migration in 22% (8–12). The use of general anesthesia and requirement for hospital admission for a few days also makes this treatment expensive. Because of the rather high complication rates and cost, this procedure has declined in popularity in many centers.

During the past 12 years, self-expanding metal stents (SEMS) have become available for the treatment of malignant dysphagia and have almost replaced plastic stents. The major advantage of SEMS is their very low complication rate and lower mortality rate. Various SEMS are available differing in composition, degree of shortening, radial force, and type of delivery system. Some are covered with a thin flexible silicone coating to prevent tumor ingrowth between the elements of the meshwork. Coated SEMS can also be
used to close tracheoesophageal fistulas. They are supplied in a tightly bound form on a delivery catheter which greatly reduces their predeployment diameter (3mm). They are positioned across the stricture and then deployed under endoscopic and fluoroscopic guidance without the need of predeployment dilation. Although the metal stents can expand to 18 mm, the actual size of the resultant lumen is unpredictable. Expansion depends on the degree of stricture and amount of tissue resistance. Once SEMS are placed they can not be repositioned. Malpositioning can be compensated for by placing an additional stent overlapping the first. Although the complication rates of SEMS are lower, serious complications have been reported, including perforation in 2%, obstruction in 20%, bleeding in 4%, migration in 5%, and chest pain in 2% (8–16). The main advantages of SEMS are their ease of insertion, avoidance of general anesthesia, minimal in hospital stay, larger luminal diameter and lower complication rates. Overall cost and survival seem to be comparable with both SEMS and plastic stents. Palliation of dysphagia and quality of life in uncomplicated cases are also similar in both groups.

led to esophageal perforation and the development of an aortoesophageal fistula.

**Bleeding**

Fatal upper gastrointestinal hemorrhage is the most dramatic complication of esophageal stent placement. Previous studies have shown life-threatening hemorrhage to occur in 4% of patients receiving SEMS and 6% of patients receiving plastic stents (8–16). Wang et al, showed a significant association between the anatomic location of the stent and the incidence of bleeding (14). Bleeding is more likely in patients whose stents extended to or above the level of the aortic arch. At the level of the arch, both the left subclavian artery and the aorta are in close contact with the posterior wall of the esophagus. In these cases pressure necrosis has generally

**Perforation**

Due to their large external diameters, predeployment dilation of the strictured esophagus is necessary in the placement of plastic stents. Tight strictures generally need serial dilations with either balloons or savories up to 16–20 mm. If esophageal dilation is too rapid or produces too large a diameter, the patient is at risk for perforation and death. Because of the small diameter of the delivery system (3 mm) for the SEMS, predeployment dilation can be generally avoided. Even when necessary for tight strictures dilation to a diameter of 10 mm is generally adequate. Predeployment dilation, greater rigidity (plastic and covered stents), higher expansile radial force, flared ends, and placement above the level of the aortic arch are all risk factors for perforation (14).

**Obstruction**

Recurrent dysphasia in a patient who has undergone
esophageal stent placement can occur in up to 50% of cases and is due to tumor ingrowth, overgrowth, or food impaction. Tumor ingrowth is a particular problem in uncovered SEMS due to the spaces between their struts. The extent of ingrowth is therefore a function of the rate of tumor growth and length of patient survival. Published reports of tumor ingrowth range from 6%–38% (8–16) with mean time elapsed from stent placement to obstruction being approximately three months. Tumor ingrowth occurs less frequently in 2%–4% of patients with covered SEMS when the membrane has not been disrupted (11,13,14). Tumor overgrowth, in contrast, occurs at the ends of both types of SEMS with published rates ranging from 4%–18% (8–16). Tumor ingrowth and overgrowth can be treated with either ablative therapies (laser, argon plasma coagulation, or photodynamic therapy) or by placement of additional stents. Food impaction is a common cause of recurrent dysphagia in patients receiving plastic esophageal stents occurring in 6% (8–12). Patients are therefore instructed to avoid large boluses of meat, bread, and leafy vegetables.

Migration

Previous studies have reported stent migration as the major complication of esophageal stent placement. Plastic and covered metal stents migrate more readily than bare stents because of decreased friction and fixation of the devise to the esophageal wall. Fixation is improved in covered stents with prongs or barbs. Many authors have shown that stent placement across the gastroesophageal junction, with the distal end lying free in the stomach, increases the risk of migration (8,11,12,14,15). The use of uncovered stents in this situation appears to decrease the risk of migration as mucosal ingrowth through the mesh seems to heightens the stents incorporation into the esophageal wall. Other situations, such as large exophytic lesions or significant dilation of the esophagus proximal to the tumor, that prevent the stent from lying closely adjacent to the wall will prevent fixation and promote migration. Chemoradiation therapy leading to rapid tumor shrinkage has also been shown to compromise fixation and promote migration (17).

Figure 3. A SEMS with migration into the biliary tree above the malignant stricture.

GASTRODUODENAL STENTS

Gastric outlet obstruction is most commonly caused by malignancy arising either from the gastric antrum or from extrinsic compression or invasion from pancreatic carcinoma. Only approximately 40% and 10% of patients with gastric and pancreatic cancer respectively have curable disease at presentation. Palliative treatment has been traditionally surgical with a gastroenterostomy. However, the results of gastric bypass surgery are poor and carry a high mortality rate in patients with vomiting and duodenal compression at the time of surgery. Enteral feeding through a percutaneous jejunostomy does not prevent recurrent vomiting, limiting the patient’s quality of life. Recently, however, gastroduodenal stenting has been deemed as an effective and safe alternative in patients deemed unfit for surgery.

Song et al, first reported the placement of an esophageal Z stent through a surgical gastrostomy site for palliative treatment of a gastric outlet stenosis in 1993 (18). The original delivery system of the Z-stents were large making it not possible for direct placement through an endoscope channel. The deliv-
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**Table 1**

Complication Rates of Various Endoluminal Stents

<table>
<thead>
<tr>
<th></th>
<th>Mortality</th>
<th>Migration</th>
<th>Perforation</th>
<th>Bleeding</th>
<th>Obstruction</th>
<th>Pain</th>
<th>Tumor growth impaction</th>
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<tbody>
<tr>
<td><strong>Esophageal</strong></td>
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<td>plastic</td>
<td>2%–16%</td>
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<td>metal</td>
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<td>0%–18%</td>
<td>0%–8%</td>
<td>0%–10%</td>
<td>6%–38%</td>
<td>0%–14%</td>
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<td>plastic</td>
<td>0%–2%</td>
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<td>0%–2%</td>
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<td>30%–60%</td>
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<td>metal (n=19)</td>
<td>0%–1%</td>
<td>0%–3%</td>
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Biliary stents for benign and malignant disease has offered a valid alternative to surgery. Many authors have shown that this modality achieves comparable therapeutic results and improved quality of life (26). The placement of stents reestablishes the flow of bile into the duodenum and ameliorates the symptoms of biliary obstruction (anorexia, pruritus, and jaundice). There also seems to be no difference in patient survival between endoscopic and surgical drainage.

Stents used in the biliary system are made of either plastic or metal. Although quite effective, numerous adverse events of biliary stent placement have been described in the literature including, obstruction, migration, perforation, cholangitis, and hemobilia. We will discuss the two most common complications, obstruction and migration.

**BILIARY STENTS**

Most patients with malignant biliary obstruction have advanced disease at time of diagnosis, with only few being candidates for curative resection. Soehendra et al, first described the use of biliary stents for palliation in patients with malignant obstruction in 1979 (25). Since then, endoscopic insertion of plastic and metal-biliary stents for benign and malignant disease has offered a valid alternative to surgery. Many authors have shown that this modality achieves comparable therapeutic results and improved quality of life (26). The placement of stents reestablishes the flow of bile into the duodenum and ameliorates the symptoms of biliary obstruction (anorexia, pruritus, and jaundice). There also seems to be no difference in patient survival between endoscopic and surgical drainage.

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**Obstruction**

The most common problem associated with biliary stent placement is occlusion occurring in up to 60% of cases. This is caused by tumor ingrowth/overgrowth or clogging with resultant cholangitis or recurrent obstructive jaundice. The lumen of plastic stents often (continued on page 52)
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become obstructed by the formation of a biofilm composed of bacteria and mucin within 1–3 months of placement (27). Numerous efforts have been made in an attempt to improve stent patency including the use of aspirin, antibiotics, and bile salts, as well as different stent designs and materials with little success. Metal stents expand to larger diameters and therefore can maintain biliary decompression longer than plastic stents. The mean duration of patency being approximately nine months (28).

Migration
Dislocation and migration of biliary stents proximally and distally occurs in 10% and generally causes no major problems. Johanson et al, found proximal migration with the use of short (<5 cm) stents, large diameter stents, and malignant lesions (29). Proximal migration can lead to failure of biliary drainage, or more seriously, hepatic abscess formation. Distal dislocation was associated with biliary stent use for benign strictures (29). With distal migration, the stent generally passes with the feces or remains in a loop of bowel without causing symptoms. There have been reported cases however, of distally migrated stents causing perforation. In our review, there have been 19 such reported cases with a majority occurring in the duodenum. This being the result of the stent tip eroding through the duodenal wall either opposite the papilla or within a periampullary diverticulum. Less frequently, a perforation occurs as a result of stent migration into the distal luminal GI tract. These cases have involved stents impacting within incarcerated small bowel and parastomal hernia sacs, at the ileocecal valve, and within colonic diverticuli.

COLONIC STENTS
Colorectal cancer is the third leading cause of cancer death in the United States. Although most patients are unaware of its presence at the time of diagnosis, a small percentage (10%–30%) of colon cancer patients may experience obstructive symptoms during their illness. It is this subset of patients, however, that make up a vast majority of colonic emergencies (85%) due to acute malignant obstruction of the colon (30). This situation is a surgical emergency that historically has carried a poor prognosis with mortality rates up to 20% and post-operative morbidity in one third. The procedures of choice in this setting; decompressive colostomy of colonic resection are associated with high morbidity and mortality for various reasons. These patients are generally quite ill, dehydrated with electrolyte abnormalities and have dilated, unprepared bowels. Surgery in this setting leads to stoma formation in 70% of patients. Unfortunately, a significant number of patients (40%) in whom delayed anastomosis is intended are left with a permanent stoma and the long term complications and the quality of life issues associated with them (30). Endolumenal stenting offers a way to decompress the large bowel, avoids emergency surgery with stoma formation and allows preoperative mechanical bowel preparation followed by a one-stage resection.

Acute colorectal obstruction caused by malignant neoplasm can be effectively dealt with by the placement of SEMS across the lesion. The use of SEMS to relieve colonic obstruction was first reported by Dohmoto in 1991 (31). Since then many authors have reported on the efficacy and safety of SEMS in the treatment of acute colonic obstruction. The average success rate for stent placement is 92% with clinical decompression occurring in 88% of patients (32). The application of SEMS in these circumstances relieves obstructing symptoms and allows for adequate preoperative workup and bowel preparation for an elective one-stage resection.

Stenting with flexible metallic endoprostheses is generally quite safe. There are, however, several complications attributable to the use of SEMS in the colon that have been reported and include: perforation, bleeding, stent migration and obstruction, pain, and tenesmus.

Perforation
The most serious complication of colonic stenting is perforation. This can lead to spillage of fecal material or tumor cells into the peritoneum or retroperitoneum. The overall perforation rate in the literature reviewed (29 studies) is 4% (32). It was observed in these studies that a majority of the perforations took place when pretreatment dilation was performed. The perforation
rate among patients receiving dilation (105 pts) was 10% as opposed to a rate of only 2% in patients not receiving pretreatment dilation (493 pts) (32). In some of these cases perforation occurred with guide wire manipulation or stent catheter insertion.

**Bleeding**

Postprocedural hemorrhage is usually minor and without significant sequela. Bleeding is generally a result of the sharp ends of the stent irritating the friable tumor tissue. In a few cases, stent-induced pressure necrosis has lead to arterial erosion and significant blood loss. Even in this setting, conservative management is generally all that is necessary (33).

**Migration**

Stent migration occurs in 10% (32). Migration occurs either within the first 3 days or after many weeks (34–36). A majority of stent migrations are asymptomatic and found incidentally (37,38). Less frequently, migrated stents can cause the reoccurrence of obstructive symptoms. Dislodged stents generally migrate distally and are passed per rectum without the need for retrieval (33). Many methods described in regards to removing migrated stents are dependant on the type of stent being retrieved (i.e. Wallstent®, Z-stent®, Ultraflex®) (33,36). Key factors that seem to promote migration include preexisting laser debulking, poststenting chemotherapy or radiation therapy, and use in benign strictures (33,37,38).

**Obstruction**

The overall reobstruction rate after successful colonic stent placement is 10%. A majority of these cases occurring in patients receiving stenting for palliative care as opposed to the "bridge to surgery" patients. The causes of reobstruction include tumor ingrowth/overgrowth (62%), fecal impaction (25%), and stent migration (13%) (32). Tumor ingrowth or overgrowth generally occurs within 8–12 weeks of the procedure and can be treated with: laser ablation, photodynamic therapy, argon plasma coagulation, or the placement of an additional stent.

**Pain**

Mild abdominal pain is commonly experienced for up to 3–5 days after colonic stent placement (39). Care must be taken when addressing low-lying rectal lesions. Severe tenesmus can be a result of stent-induced irritation of the nerve endings near the dentate line.

**CONCLUSION**

Great advances have been made in the industry of endovascular/luminal stenting since Sir Henry Souttar's original design of a spring made of gold plated German silver held in the esophagus by the roughness of its exterior and a proximal lip in 1924. Gianturco revolutionized the field with the development of a self-expanding metallic stent in 1985. Many authors have since written on the effectiveness of endoluminal stenting for obstruction due to a cancer in the esophagus, duodenum, biliary system and colon. Self-expanding stents in this setting are now FDA approved and offer a valid alternative to surgery for palliative care. Most gastroenterologists and surgeons are performing these procedures in an outpatient setting. The placement of stents are however associated with potential complications namely: perforation, obstruction, migration, and bleeding. By practicing good technique and taking the appropriate precautions these complication rates can be kept quite low.

**References**

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