Endoscopic management of malignant gastric outlet obstruction

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Abstract: Malignant gastric outlet obstruction (MGOO) is a late complication of advanced malignancies, mostly occurring due to gastrointestinal cancers or external compression outside the lumen. It causes nausea, vomiting, poor appetite, weight loss, and decreased quality of life. In the past, surgical bypass was the gold standard for the management of MGOO. However, the introduction of self-expandable metallic stent (SEMS) provides several advantages over surgical bypass, including earlier oral intake, rapid symptom relief, less invasiveness, and shorter hospital stays; therefore, it has replaced surgical bypass as the mainstream management approach in most situations. Although SEMS placement is a safe and effective way for palliation of MGOO, stent dysfunction with obstruction or migration limits the utilization and increases repeated intervention. Endoscopic ultrasound-guided gastroenterostomy with lumen-apposing metal stent has emerged as an alternative way to bypass the obstruction site and restore the oral intake of patients. Although a lower stent dysfunction rate was reported, further prospective studies are warranted to validate its effectiveness and safety.

Keywords: Gastric outlet obstruction; Gastroenterostomy; Stents

1. INTRODUCTION

Malignant gastric outlet obstruction (MGOO) is a condition commonly encountered in patients with advanced malignancies from gastrointestinal cancers or external compression outside the lumens (Fig. 1). The most common causes of MGOO are cancers of the stomach, duodenum, or from external compressions caused by pancreatic or biliary malignancies. Patients with MGOO usually have nausea, vomiting, and early satiety, resulting in poor appetite, weight loss, and poor quality of life. MGOO can appear as a preterminal stage for patients with inoperable malignancies; these patients would be referred for surgical bypass in the past. However, the introduction of self-expandable metallic stent (SEMS) as an alternative way for palliation has emerged as a mainstream method that might replace surgical bypass in most situations nowadays. This method has several advantages over surgical bypass such as a shorter hospital stay, rapid symptom relief, and earlier commencement of oral intake.[1–3] SEMS also improves the quality of life and possibly prolongs survival of patients with feeding ostomy. A prospective observational study compared the quality of life and survival of patients with MGOO palliated by an endoscopic stent, surgical bypass, percutaneous gastrostomy (PEG), or percutaneous jejunostomy (PEJ) and found no difference in survival between the stent and surgical bypass groups; however, worse survival was seen in the PEG and PEJ groups. Quality of life, as assessed by a questionnaire, also improved in both the endoscopic stent and surgical bypass groups.[4] In addition, it has been proven to be an effective and safe procedure to palliate patients with MGOO.

2. SELF-EXPANDABLE METALLIC STENTS

There are several brands of SEMS available for use. These metal stents are made of stainless steel or alloys, such as nitinol or elgiloy. Elgiloy is an alloy composed primarily of cobalt, nickel, and chromium. It is nonmagnetic with high yield strength and fatigue strength. It also generates a high radial force with less compliance. Nitinol is an alloy of nickel and titanium and has some properties, such as increased strength, low stiffness, increased flexibility, and shape memory (the ability to return to its original shape). It is helpful for stenting some regions with sharp angles. However, its radial force is lower than that of stents made with other metals.[5] In recent years, there has been an increase in the use of nitinol stents instead of stainless steel or elgiloy. According to a review article published by the American Society for Gastrointestinal Endoscopy, only one enteral stent (Wallstent; Boston Scientific, USA) was made from elgiloy.[6]

Unlike uncovered metal stents, there are metal stents covered with plastic or silicone membranes, which prevent the ingrowth of tissue or tumor as covered metal stents. Based on the degree of coverage, covered stents can be divided into partially covered and fully covered stents, which have their advantages and disadvantages. SEMS comes in various lengths and diameters, and proximal or distal flare ends to minimize migration risks. A brief introduction of common brands of SEMS available for use has been presented in Table 1.[6] Some of them provide covered stent options. As for the types of stents,

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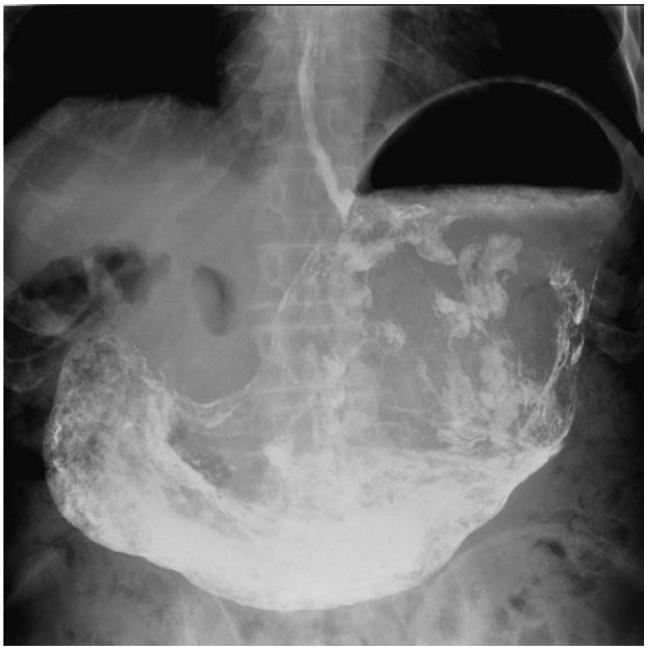

Fig. 1 The upper gastrointestinal series showed markedly distended stomach in a patient with malignant gastric outlet obstruction.

there is no consensus on the recommendations for stent selection. According to a recent meta-analysis,[7] these stents have similar technical and clinical success profiles. The covered stents are associated with higher migration rates but lower restenosis rates. The uncovered stents are associated with the opposite characteristics. However, overall adverse events are more frequent with covered stents. Generally, if patients have limited life expectancies or the stricture site is near the major papilla, uncovered stents may be more appropriate. The reason uncovered stents would be recommended in patients with limited life expectancies is the reduced need for reinterventions. Migration rates are higher for covered stent placement and may occur at any time point after stent deployment. It might raise the need for reintervention, such as endoscopic retrieval or surgical management. These patients might not be capable of enduring further interventions due to disease progression. However, for patients with benign strictures where stents are removed within weeks, fully covered stents are recommended. The rationale is that stent placement in benign stricture can be expected to result in gradual and sustained dilatation in the stenotic part without the need for repeated procedures. Fully covered stents can prevent tissue ingrowth and facilitate stent removal after several weeks.[8,9]

3. INDICATIONS AND CONTRAINDICATIONS OF STENT PLACEMENT

Patients with inoperable MGOO or those who are poor candidates for surgical bypass for either luminal cancers or extrinsic compression by neoplasms are indicated for SEMS placement.[10] SEMS placement for MGOO should be prohibited in patients with multifocal obstructions, common in patients with peritoneal carcinomatosis. However, peritoneal carcinomatosis is not an absolute contraindication for enteral stent placement, and selected patients are still suitable for stenting.[11] Contraindications include curable disease status, free bowel perforation, and any conditions that are not amenable for endoscopy.[10]

4. PREPROCEDURAL EVALUATION

4.1. Patient evaluation and preparation

Abdominal computed tomography (CT) and endoscopy must be performed before stenting to exclude candidates with contraindications and determine the site and length of the stricture. CT scans help to determine the obstruction level and determine if a multifocal obstruction is present, which is contraindicated for stent placement. Endoscopy examinations help to visualize the obstruction directly if CT scan results are unclear of the obstruction status. It is important to determine the site for stenting in patients with subtotal gastrectomy with Billroth II or Roux-en-Y anastomosis. Getting the "road map" before stenting via upper gastrointestinal or small bowel series is optional but can help rule out the presence of multifocal obstruction.

Patients with MGOO are at risk of aspiration because of retained gastric contents. The nasogastric tube drainage at least 24 hours before the procedure is recommended to evacuate gastric contents and minimize aspiration risks. Endotracheal intubation is warranted for patients with an increased risk of aspiration during the procedure.

4.2. Equipment

SEMS placement should be performed under the fluoroscopic guidance. The stent is deployed via through-the-scope, over-the-wire systems. The therapeutic scope should be equipped with a large working channel (>3.3 mm) to fit the 10Fr stent introducer system. The duodenoscope is an option to place stents and provides extra advantages for biliary SEMS placement in the concomitant strictures of the bile duct. Other items include guidewires, water-soluble contrast medium, biliary catheters, and balloon dilators. However, predeployment balloon dilation is generally not required for gastroduodenal stenting.

5. STEPS OF STENT PLACEMENT

5.1. Evaluation of stricture

While advancing the scope to the front of the stricture, the stricture is navigated with the guidewire to gain deep access to the

Table 1

Introduction of variable brands of common pyloric/duodenal stents

		Stent				Delivery system	
Manufacturer	**Brand name**	**Component**	**Diameter, mm**	**Length, cm**	**U, C, or PC/membrane**	**Diameter, F**	**Length, cm**
Boston Scientific	Wallstent	Elgiloy	20	6, 9	U	10	135, 230
	Wallflex	Nitinol	22	6, 9, 12	U	10	230
Endochoice	Bonastent	Nitinol	20	6, 8, 10, 12, 14, 16	U, PC/silicone	10	180, 230
Cook	Evolution	Nitinol	22	6, 9, 12	U	10	230
TaeWoong	Niti-S/ComVi	Nitinol	18,20,22,24	6, 8, 10, 12, 14, 15	U, C/silicone	10	180
MI.Tech	HANARO	Nitinol	18, 20, 22	U: 6-17 PC: 6-15	U, PC/silicone	10.2	230

C = covered; PC = partially covered; U = uncovered.

small intestine distal to it under fluoroscopic assistance. Then, a biliary catheter (balloon extractor or Sohendra dilator) is inserted over the wire, and a water-soluble contrast is injected to delineate the stricture. External radio-opaque markers could be used to indicate proximal and distal aspects of the stricture and guide stent placement.

5.2. Optimal positioning of the stent

Adequate stent positions and stent lengths across the stricture are crucial for optimal stenting. Variable degrees of foreshortening of stents after deployment occur in most SEMS. Endoscopists should have good knowledge of the properties of available SEMS in their own units. On average, SEMS will foreshorten by about 25% of stent lengths during the transition from constraint to full expansion. Thus, sufficient stent lengths across the stricture should be ensured even after foreshortening. In general, an additional 2 cm on both ends across the stricture with the "waist" at the middle of the stent is optimally positioned.

5.3. Stent deployment

After introducing the stent delivery system, simultaneous fluoroscopic and endoscopic guidance is needed for optimal stent placement. Once the sheath is withdrawn, the stent gradually expands. The distal and proximal ends of the stent should be monitored to ensure adequate lengths of the stent on each side with a stent "waist" at the middle of the stricture. Most SEMS are reconstrainable and allow for repositioning to the appropriate location if the stents do not fully expand.

5.4. Correction of stent position

If optimal stent placement is not achieved, it is still possible to manipulate immediately after placement. The stents could be grasped by forceps with gentle traction to move stents proximally or slightly push stents with an endoscope or controlled radial expansion balloons distally. If the stent does not cover the whole stricture, the second stent should be placed to overlap the previous stent to cover the stricture site.

Besides, the direction of the stent matters and affects the function. The wrong direction of the stent leads to stent malfunction and lowers clinical success but could be modified by changing the axis. Mangiavillano et al[12] used clips to adjust the stent axis by approximating the distance between the proximal end of the stent and stent body. Sasaki et al[13] applied detachable snares and clips to fold the proximal part of the stent and changed the stent axis. These methods might work to rescue, but the efficacy needs to be examined in further studies.

6. OUTCOMES

6.1. Technical and clinic success

Technical success is defined as successful stent placement and deployment across the stricture. Clinical success is defined as the improvement of oral intake and symptom relief. A meta-analysis of 32 case series including 606 patients with MGOO who received metallic stents reported technical success in 97% of patients, and 87% of patients with clinical success could resume a soft diet at least.[14] Another systemic review with 19 prospective studies, including 1281 patients, reported that the pooled technical success and clinical success rates were 97.3% and 85.7%, respectively.[15] Although these studies were heterogeneous with different stents and causes of MGOO, the technical success rates were still high. Little difference exists in the technical aspects of the placement of various stents. Technical failure was mainly due to the inability to gain access through the obstruction, such as the complicated anatomy, severe stenosis, or acute angulation of bowel loops. In addition, variable sites of the stricture can alter the technical success rate. Stent placement in the duodenal stricture was more complicated than in the prepyloric region because of the loop formation of stent delivery systems in the distended stomach and the curved configuration of the duodenum. The stricture at the anastomotic site was also challenging for stent placement because of the altered anatomy.[16]

Successful stent placement does not always accompany clinical success. Even though the obstruction is recannulated by stents, some patients fail to resume oral intake. There are several possible explanations for this result. First, the stomach is extremely dilated due to prolonged obstruction, and the muscle of the gastric wall is weakened, failing to empty gastric contents efficiently. Second, the nerves responsible for gastric emptying might be infiltrated by the tumor or damaged by the chemoradiation. Lastly, there is the possibility of partial distal multifocal obstruction in patients with peritoneal carcinomatosis.[17] For patients with MGOO, it is important to improve the symptoms and restore oral intake as a treatment goal. Gastric outlet obstruction scoring system (GOOSS) is developed to evaluate the improvement of oral intake before and after stent placement. The GOOSS score is assigned on a 4-point scale with 0 for no oral intake, 1 for liquids only, 2 for soft solids only, and 3 for low-residue or full diet.[18,19] Clinical success is often defined by the improvement of GOOSS scores in most studies.[14]

6.2. Complications

6.2.1. Stent obstruction

Generally, the average stent patency is approximately 3 to 4 months. Some studies showed that the median stent patency ranged from 68 to 307 days.[20–25] Stent obstruction is the most common complication of enteral SEMS placement, which shortens stent patency. The incidence ranged from 8% to 25.4%, and the pooled analysis showed an obstruction rate of 12.6%.[15,19,21–23,26–29] The most common cause of obstruction is disease progression, and other causes may include food impaction or stent collapse. Disease progression might result in tumor overgrowth at both ends of the stent or tumor ingrowth through the interstices of the stent. If reobstruction occurs, the common method of rescue is to place the second stent in a coaxial, stent-in-stent fashion (Fig. 2); stent-in-stent technique indicates that the second stent will be deployed inside the first stent and restore the lumen. Some studies have proven the effectiveness for the management of the first stent dysfunction.[30,31] This technique for rescuing stent dysfunction is indicated for stent obstruction not only by tumor ingrowth but also in tumor overgrowth, fracture, or extrinsic compression. However, argon plasma coagulation (APC) is an alternative option that involves ablating the tumor tissue. For food impaction of a stent, endoscopic removal should be performed.

6.2.2. Stent migration

Stent migration occurred in 0% to 19.4% of patients,[19,22,23,26,27,32] and it might occur at any time after stent deployment. The migration rate varies depending on the type of stent. The migration rate is higher in covered stents and lower in uncovered stents. A meta-analysis that included 13 prospective and retrospective studies with 1624 patients showed that covered SEMS was associated with higher migration risks (relative risk, 4.28; 95% confidence interval, 2.89-6.34) than uncovered SEMS.[7] If stent migration occurs, it can be managed by observation, endoscopic retrieval, or surgical intervention. If the stent migrates proximally to the stricture, endoscopic retrieval could be performed initially. Then, the second stent should be placed to rescue the obstruction. If it migrates distally, surgical intervention should be considered because the migrated stent is not necessarily

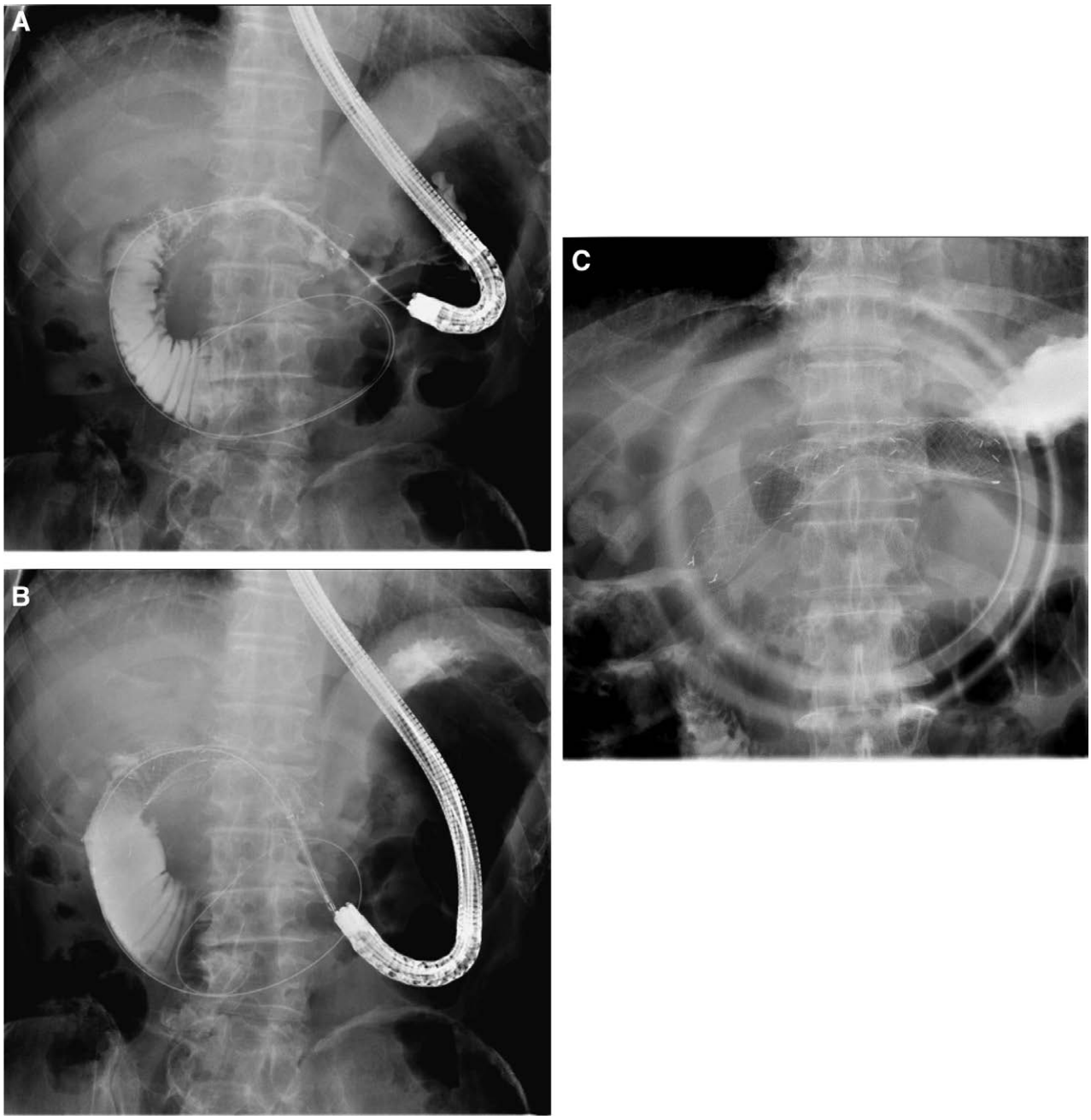

Fig. 2 A, The image showed the luminal narrowing enhanced by contrast within the previous stent. B, After cannulation with guidewire, the second stent was introduced within the first stent. C, While deploying stent, the second stent expanded gradually in a coaxial, "stent-in-stent" fashion.

retrievable by enteroscopy. However, simple observation is still an option because of the high risks of surgery in some fragile patients.

6.2.3. Stent fracture

Stent fracture is a rare complication. Although some studies have reported that stent fracture is a cause of reobstruction, few have elucidated the possible mechanism. In a systemic review with pooled analysis, the incidence rate was about 0.5% (7 of 1281).[15] However, in one study with 71 patients who compared two stent brands, the stent fracture rate was 13.3% (4 of 30) in one brand of a stent, which was significantly higher than the other brand (0%, 0 of 41).[20] Despite the small sample size of the retrospective study, the possible explanation of stent fracture might be related to the weaving method of a stent. (Fig. 3)

6.2.4. Perforation

Perforation is a possibly fatal complication, and emergent surgical intervention is often required. Perforation might occur before, during, or after stent placement. These include advances in the guidewire, catheter, or scope across the stricture, pushing the undeployed stent across the stricture, and balloon dilatation of the stricture. Delayed perforation might occur due to erosion of the intestinal wall by the stents.[33] Overall, the perforation incidence is uncommon, up to 1.9% in some studies.[21,27,34]

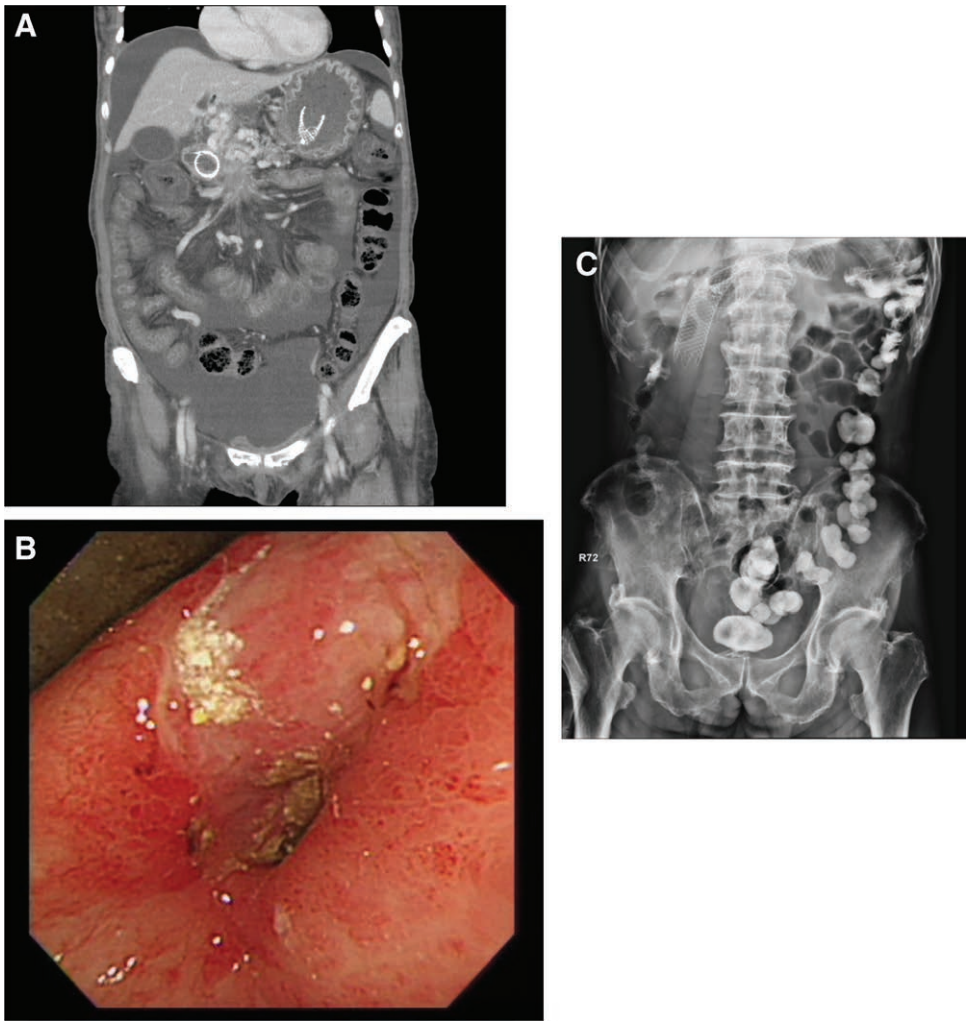

Fig. 3 A, The computed tomography image showed fractured stent in a patient with gastric cancer whose obstruction level was at antrum. The part of fractured stent was seen at fundus. B, The endoscopy showed the obstruction site at antrum, but no retained stent was seen. C, After removing the part of fractured stent, the second stent was placed smoothly to palliate the gastric outlet obstruction. The follow-up abdominal X-ray showed the second stent was with optimal expansion.

6.2.5. Bleeding

Because of the fragile mucosa of tumor tissue, bleeding is often encountered during stent placement. Most bleeding episodes are self-limited and usually managed by conservative or endoscopic treatments. The significant bleeding rate is approximately 1%.[14,16,34]

6.2.6. Cholangitis

Cholangitis or biliary obstruction incidence after stent placement has been reported, ranging from 1% to 6%.[14,16,34] The biliary complication is presumably caused by the duodenal stent across the major papilla, which obstructs the orifice and this might limit the covered stent use in the stricture located in the second portion of the duodenum. Instead, the uncovered stent is preferred in this situation, or concomitant stent use with the placement of the biliary stent before the covered duodenal stent should be considered.

6.2.7. Abdominal pain

Abdominal pain is a minor and common complication after stent placement. It usually lasts for 1 to 3 days and resolves spontaneously. Pain control with analgesic medications is seldom needed.

6.3. Predictors of resumption of oral intake and stent patency

Several studies have attempted to identify the predictors of resumption of oral intake and stent patency. Regarding these issues, both patient and stent factors should be considered. As for patient factors, advanced stage of the disease, poor performance status, peritoneal carcinomatosis, ascites, and GOO scores <3 at day 7 after stent placement were reported to be associated with poor clinical success and oral intake.[20,35–37] However, with regard to factors relating to the stents, only few studies have shown that the degree of stent expansion mattered. Hori et al[38] reported that stent expansion ≤30% at day 0 was associated with poor GOO score improvement. Ye et al[39] reported that stent expansion ≥75% at day 1 correlated with longer stent patency.

7. DOUBLE STENTINGS FOR COMBINED MALIGNANT BILIARY AND DUODENAL OBSTRUCTION

Patients with periampullary malignancies often develop combined malignant biliary and duodenal obstructions. Biliary obstruction may precede duodenal obstruction, concurrently

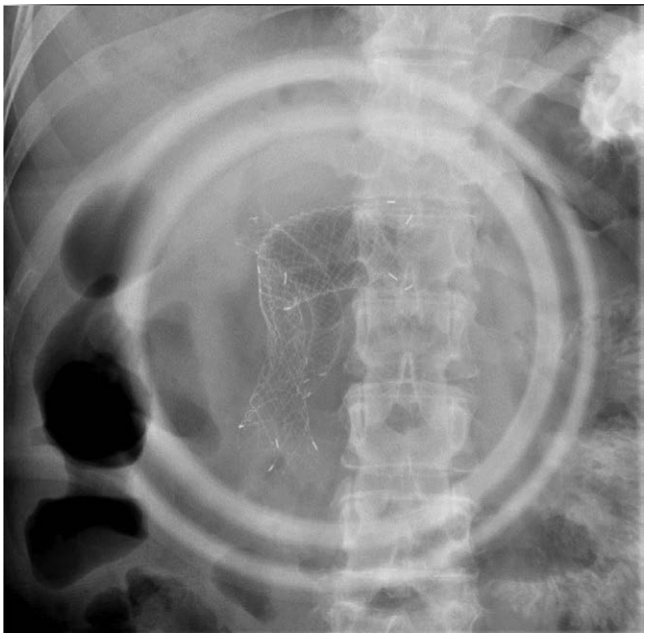

Fig. 4 The image showed combined biliary and duodenal obstructions with "double stenting". After placing the biliary metal stent, the duodenal metal stent was then placed smoothly.

occur, or follow that, although biliary obstruction preceding duodenal obstruction is still the most common in patients with periampullary malignancies.[40] In the past, hepaticojejunostomy and gastrojejunostomy would be performed for the management of obstruction. However, patients with combined obstructions usually have advanced disease stages with limited life expectancies and are not candidates for further surgeries. Currently, mainstream management has been replaced by "double stenting" for combined biliary and duodenal obstructions. (Fig. 4) These combined bilioduodenal strictures are classified according to the anatomical location of the duodenal stricture in relation to the papilla and the sequence of obstruction (Table 2).[40]

The treatment strategies and success rates of combined endoscopic stentings also vary based on the different types of stricture. Biliary endoscopic stenting would be more challenging in type II bilioduodenal stricture due to the involvement of the papilla and the difficulty in obtaining a good position for biliary access. On the contrary, stentings are relatively easier for type I and type III strictures. Thus, the technical success rate of type II stricture is the lowest among all three types.[40,41] Apart from the stricture location, the presence of an indwelling duodenal stent also affects the success rate of biliary management.[42]

For patients with type I stricture, biliary SEMS placement should be performed before duodenal stent placement if possible. If the major papilla is not accessible due to the duodenal stricture, either balloon dilatation or duodenal stent placement before biliary stenting should be considered. For patients with type III stricture, double stenting is relatively simple, regardless of whether biliary stenting or duodenal stenting precedes each other. However, the risk of duodenobiliary reflux by food or intestinal juice is high and might lead to cholangitis. In the management of both types of stricture, endoscopists should keep in mind that they should avoid deploying duodenal stents with overlapping papilla openings. For patients with type II stricture where duodenal stents across the papilla, endoscopic retrograde cholangiopancreatography with biliary cannulation is challenging because it should be performed through the interstices of duodenal stents. In this situation, biliary cannulation can be facilitated by balloon dilatation of the interstices of duodenal stents, the mesh removal with rat tooth forceps, or the creation of fenestration of duodenal stents by APC.[40,43] After successful biliary cannulation, biliary stenting can be placed through the interstices of duodenal stents.

Table 2

Classifications of combined bilioduodenal strictures according to the location and the sequence of obstruction[34]

Type	The location of obstruction
Type I	Stenosis occurs at the level of the duodenal bulb or upper duodenal genu, but without involvement of the papilla
Type II	Stenosis affects the second part of the duodenum, with involvement of the papilla
Type III	Stenosis involves the third part of the duodenum, distal to and without involvement of the papilla
Grade	**The sequence of obstruction**
Group 1	Biliary obstruction precede duodenal obstruction
Group 2	Concurrent biliary and duodenal obstruction
Group 3	Duodenal obstruction precede biliary obstruction

8. STENTING AT SURGICAL ANASTOMOSIS SITE OF GASTROJEJUNOSTOMY

While the tumor recurs at the anastomosis site of gastrojejunostomy, the obstruction could be at the afferent limb, the efferent limb, or both. The technical and clinical success rates of stentings at either one limb or both limbs are similar to those of patients with MGOO with naive anatomies.[44,45]

9. ENDOSCOPIC ULTRASOUND-GUIDED GASTROENTEROSTOMY WITH LUMEN-APPOSING METAL STENT

Although enteral stents have already made significant progress, stent malfunctions, including restenosis and migration, remain unsolved. Some specifically designed stents have been developed to minimize these drawbacks. Lumen-apposing metal stent (LAMS) is a dumbbell-shaped, fully covered with wide flanges at each end, which reduces the risk of migration. The stent was originally designed for pancreatic fluid collection drainage, but since then has been utilized in various kinds of situations for off-label use. With the assistance of EUS, it has been applied to the EUS-guided gallbladder drainage, EUS-guided choledochoduodenostomy, EUS-guided gastroenterostomy, and stenting for gastrointestinal strictures.[46,47] One study retrospectively enrolled 100 patients to compare both EUS-guided gastroenterostomy using LAMS and enteral stent placement in palliation of MGOO (22 with EUS-GE and 78 with enteral stent placement). The results showed a higher initial clinical success rate (95.8% vs 76.3%, p = 0.042) and a lower rate of stent failure requiring repeat intervention (8.3% vs 32%, p = 0.021) in the EUS-GE group than in the enteral stent group.[48] Despite its retrospective nature, the study suggested the effectiveness of EUS-GE for palliation of MGOO in the future.

In conclusion, SEMS placement has been proven as a safe and effective method for palliation of MGOO and has replaced surgical bypass as mainstream management. Even with high technical and clinical success rates, frequent stent dysfunctions, including stent obstruction and migration, which require repeated interventions, have not been solved. The emergence of EUS-guided gastroenterostomy with LAMS shows promising results with lower stent failure rates compared with enteral stent placement. However, further studies are warranted to ensure efficacy and safety.

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