**Name of Journal:** *World Journal of Gastrointestinal Pharmacology and Therapeutics*

**Manuscript NO:** 54995

**Manuscript Type:** REVIEW

**Management of gastric outlet obstruction: Focusing on endoscopic approach**

Jeong SJ *et al*. Management of GOO

Su Jin Jeong, Jin Lee

**Su Jin Jeong**, **Jin Lee,** Division of Gastroenterology, Department of Internal Medicine, Inje University Haeundae Paik Hospital, Busan 48108, South Korea

**Author contributions:** All authors equally contributed to this paper with conception and design of the study, literature review and analysis, drafting and critical revision and editing, and final approval of the final version.

**Corresponding author:** **Jin Lee, MD, Assistant Professor,** Internal Medicine, Haeundae Paik Hospital, 875, Haeun-daero, Haeundae-gu, Busan 48108, South Korea. injemed76@naver.com

**Received:** February 27, 2020

**Revised:** May 14, 2020

**Accepted:** May 29, 2020

**Published online:** June 8, 2020

**Abstract**

Gastric outlet obstruction (GOO) is a medical condition characterized by epigastric pain and postprandial vomiting due to mechanical obstruction. The obstructions typically involved in GOO can be benign or malignant. Peptic ulcer disease is the most common cause of benign GOO, and malignant causes include gastric cancer, lymphoma, and gastrointestinal stromal tumor. With the eradication of *Helicobacter pylori (H. pylori)* and the use of proton pump inhibitors, the predominant causes have changed from benign to malignant diseases. Treatment of GOO depends on the underlying cause: Proton pump inhibitors, *H. pylori* eradication, endoscopic treatments including balloon dilatation or the placement of self-expandable stents, or surgery.

**Key words:** Gastric outlet obstruction; Balloon dilation; Metal stent

Jeong SJ, Lee J. Management of gastric outlet obstruction: Focusing on endoscopic approach. *World J Gastrointest Pharmacol Ther* 2020; 11(2): 0000-0000 URL: https://www.wjgnet.com/2150-5349/full/v11/i2/0000.htm DOI: <https://dx.doi.org/10.4292/wjgpt.v11.i2.0000>

**Core tip:** The causes of gastric outlet obstruction are generally divided into benign and malignant. With the eradication of *Helicobacter pylori* and the use of proton pump inhibitors, the predominant causes have changed from benign to malignant diseases. Treatment of gastric outlet obstruction (GOO) depends on the underlying cause: proton pump inhibitor, endoscopic techniques, or surgery. In this article, we review the etiology, diagnosis, and current treatment methods of GOO, especially endoscopic techniques.

**INTRODUCTION**

Gastric outlet obstruction (GOO) occurs when gastric emptying is mechanically inhibited by various diseases, most of which involve obstruction of the gastric pylorus or proximal duodenum due to intrinsic or extrinsic factors. The precise incidence of GOO is unknown. Although GOO due to peptic ulcers has been common in the past, the use of proton pump inhibitors and identification of *Helicobacter pylori (H. pylori)* have reduced the incidence of peptic ulcer disease, and malignant diseases have become the main cause of GOO in recent decades, with about 50%-80% of GOO being caused by cancer[1-5]. As the predominant cause of GOO shifts from benign to malignant diseases, treatment methods have also changed. In this article, we review the etiology, diagnosis, and current treatment methods of GOO, especially endoscopic techniques.

**ETIOLOGY**

***Benign gastric outlet obstruction***

Peptic ulcer disease is the most common cause of benign GOO, accounting for approximately 90% of cases[6]. Caustic ingestion, inflammatory diseases such as Crohn’s disease or tuberculosis, and non-steroidal anti-inflammatory drug-induced strictures may also result in GOO. Other rare benign causes are large gastric polyps, gallstone obstruction (Bouveret’s syndrome), annular pancreas, pancreatic pseudocyst, and bezoars (Table 1)[7]. Peptic ulcer disease was the leading cause of GOO in the past, with the use of proton pump inhibitors and identification of *H. pylori,* theincidence has declined significantly. Currently, GOO is the least common complication of peptic ulcer disease. Less than 5% of complicated duodenal ulcer disease and less than 1-2% of complicated gastric ulcer disease develop obstructive complications[8,9].

Corrosive injury caused by caustic ingestion, including acid or alkali substances, can result in GOO by antral or pyloric scarring[10,11]. The incidence rate of GOO by caustic ingestion varies from 20 to 60%[10-12]. In a study of 41 cases of acid ingestion, 44.4% developed GOO[10], and another study reported that 36.8% of the 31 alkali-ingestion patients developed GOO[11].

Inflammatory causes, such as Crohn’s disease or tuberculosis, also cause GOO. Crohn's disease mostly invades the distal gastrointestinal tract, and it rarely invades the upper gastrointestinal tract such as the stomach or duodenum alone. Clinically, severe gastroduodenal Crohn’s disease is rare, in which case it continuously invades the antrum, pylorus, and proximal duodenum[13]. Gastroduodenal tuberculosis is rare, occurring in only 0.3%-2.3% of patients with tuberculosis. GOO was identified in 61% of 23 patients with gastroduodenal tuberculosis which was confirmed by histopathological examination[14].

Nonsteroidal anti-inflammatory drugs (NSAIDs) can also cause GOO. NSAIDs reduce prostaglandin E2 to induce pyloric edema and scarring, and increase histamine release to increase gastric secretion, reduce mucosal absorption, and cause gastric motility disturbances, leading to GOO[15]. In a study of 10 cases of NSAID-induced GOO in 2011, the most common site of involvement was the duodenum, followed by the pylorus and duodenum, and then pylorus only[16]. Most strictures were short web-like in nature, and endoscopic balloon dilation was successful in 90% of cases.

***Malignant gastric outlet obstruction***

In recent decades, malignancy has been the most common cause of GOO. The most common causes are pancreatic and gastric cancer, but lymphomas, duodenal carcinoma, biliary tract carcinoma, ampullary carcinoma, and metastatic malignancies can also cause malignant GOO. In pancreatic cancer, 15%-20% of patients have been reported to develop GOO[17].

**DIAGNOSIS**

The diagnosis of gastric outlet obstruction is usually suggested by history and physical examination. Patients have suffered recurrent vomiting and show up electrolyte abnormalities including hypokalemia or hypochloremic metabolic alkalosis. The gastrin secretion due to gastric expansion increases serum gastrin levels (400-800 pg/mL range) and can be confused with Zollinger-Ellison syndrome[18]. Tests such as endoscopy, and barium study are helpful for diagnosis. Plain radiography may show a large gastric shadow. Contrast studies with barium or water-soluble contrast agents may show an enlarged stomach and provide clues as to the underlying disease. The absence of any contrast passage in the small intestine suggests a complete GOO. CT scan is helpful, especially for evaluating the mural thickness of the pylorus or gastric wall, lymph node enlargement, pancreatic or biliary tract, and retroperitoneum[9].

Endoscopy is the most useful examination to establish gastric outlet obstruction and obtain tissue specimens from obstructing areas for confirmation or exclusion of malignant GOO. Endoscopy should be performed after fasting for over 4 hours, and nasogastric tube suction is recommended before endoscopy to reduce the risk of aspiration.

**TREATMENT**

All patients with symptomatic GOO need to be hospitalized. Fluid resuscitation with normal saline and correction of electrolyte imbalance should be performed first. Nasogastric decompression should be initiated during hospitalization. This helps relieve discomfort and pain caused by gastric distension, clear the field during endoscopic procedure, and reduce the gastric capacity before surgery. In patients with benign gastric outlet obstruction due to acute peptic ulcer disease, patients showed improvement in symptoms due to reduced edema and spasm due to inflammation after 48-72 h with nasogastric decompression and proton pump inhibitors.

*H. pylori* eradication can be performed in patients with benign GOO with *H. pylori* infection. The prevalence of *H. pylori* in GOO varies from 33% to 90%[19]. Kate *et al*[20] reported a high prevalence of *H. pylori* infection in duodenal ulcers with GOO, even without active ulcers. Acute ulcers associated with *H. pylori* infection cause obstruction due to inflammation and edema, and antimicrobial treatment can help improve occlusion. Mohsina *et al*[21] summarized reports on the role of *H. pylori* in GOO.

If GOO is irreversible with medical therapy, definitive treatment is required based upon the underlying cause (Table 2). Until the development of endoscopic procedures, surgery was the only treatment for these patients. In the past, 80%-90% of ulcer related GOO patients underwent surgery[22], and the only treatment option for caustic GOO patients was surgery as well[12]. Recent reports suggest that endoscopic balloon dilation is an effective treatment option, as an alternative to surgery in the majority of peptic ulcer disease-related and caustic GOO patients[23-31]. In benign GOO, intraluminal stent insertion is a poor treatment option. There are no commercial stents available for benign GOO, and if uncovered stents are used, stent removal is impossible, and long-term patency is not guaranteed, and stent migration occurs frequently when covered stents are used. On the other hand, if curative surgery is not possible in malignant GOO, there are palliative options such as endoscopic placement of self-expanding metal stents (SEMS), and bypass surgery such as gastrojejunostomy. Surgical gastrojejunostomy for palliative purposes has a high mortality of up to 10%[32], and previous reports have shown that palliative SEMS insertion is more cost-effective, reduces the number of days of hospitalization, and improves symptoms rapidly[33,34]. Endoscopic SEMS insertion is widely performed in malignant GOO.

**ENDOSCOPIC MANAGEMENT**

***Endoscopic balloon dilation***

Benjamin *et al*[35,36] first reported the use of endoscopic balloon dilation (EBD) of the pylorus for the treatment of GOO using a through-the-scope 5-mm balloon with good clinical outcome. Subsequent reports have shown the safety and effectiveness of EBD for GOO management[23-31]. Dilations can be performed with endoscopy and using balloon dilators inserted through the working channel of the endoscope, or using balloons placed over a guidewire under fluoroscopic guidance. If adequate dilation is achieved, the clinical response is maintained in 70%-80% of patients[25,30]. Repeated recurrence of stricture after EBD may be an indication of surgery. If more than two sessions of dilations are required, they are highly associated with the probability of surgery[28].

EBD may also be effective for GOO caused by caustic injury or endoscopic submucosal pylorus dissection[37,38]. In a single-center study published by Kochhar *et al*[39] recently, EBD had a clinical success of 97.3% and no recurrence during a 98-month follow-up period. Perforation occurred in 2 of 111 patients. However, the mean number of sessions was 2-13 times in caustic GOO, while only 1-3 times in PUD-induced GOO[27,38]. GOO caused by other causes, such as Crohn's disease and tuberculosis, may also benefit with EBD[26,40].

EBD is generally a safe procedure, with complications of bleeding and perforation in diameters less than 15 mm rare. Perforation occurred more often when the diameter was over 15 mm[7,24,41,42]. Pain and minor bleeding are common during EBD procedures, but they are self-limited, whereas arterial bleeding is rarely reported[40].

***Intralesional steroids***

A combination of balloon dilation and intralesional steroid injection could be performed to inhibit stricture formation. Triamcinolone blocks the cross-linking of collagen and prevents scar contracture[43]. There are few reports on the treatment of pyloric strictures with intralesional steroids. Kochhar *et al*[44] and Lee *et al*[45] reported the efficacy of intralesional steroids.

***Endoscopic incision***

Endoscopic incision could be further performed after endoscopic balloon dilation in pyloric stenosis refractory to EBD. Boron *et al*[46] reported an electrosurgical incision using sphincterotomy, and Hagiwara *et al*[47] used a needle-knife radial electrosurgical incision in refractory anastomotic pyloric stenosis.

***Endoscopic placement of self-expanding metal stents***

SEMS insertion is used as a palliative treatment for malignant GOO and is used in cases of malignant gastrointestinal obstruction that cannot be surgically treated. The goal of SEMS insertion is to relieve obstruction symptoms. To evaluate the degree of symptom relief, the GOO score, which evaluates the severity of symptoms defined as satiety, nausea, and early vomiting, scoring based on the patient’s oral intake level[48].

Generally, the technical and clinical success rates are reported to be 89%-98% and 86%-89%, respectively, which is very good in terms of short-term success rates[49-52]. SEMS insertions should be considered in patients with a short life expectancy (less than 2-6 mo)[53]. In addition, there should be no other occlusion site in the distal part of the stent insertion site, and the presence of free perforation or peritonitis are contraindications to endoscopic stent placement[54].

In malignant GOOs, biliary obstruction is often coexistent. Placement of the biliary metal stent should be considered before insertion of the duodenal stent. Since the endoscopic approach to the biliary tract is very limited after the duodenal stent is inserted, the percutaneous transhepatic approach is usually required[54].

**Covered versus uncovered SEMS:** Uncovered stents are widely used for the treatment of malignant GOO. It is less likely to migrate and more flexible, but the tumor can grow into the stent and result in stent obstruction. Covered stents are increasingly used in Europe because they provide the advantage of low tumor growth. However, they are more prone to migration and less flexible than uncovered stents[55,56]. According to Kim *et al*[57] stent migration rate was much higher in covered stents than in uncovered stents (28% *vs* 3%) within 8 weeks of stent insertion.

According to a systematic review by Yang *et al*[58], there were no significant differences in technical or clinical success rate, long-term patency, or complications in three meta-analyses, in which comparison of efficacy and safety between covered or uncovered SEMS for malignant GOO were assessed.

Currently uncovered SEMS, rather than fully or partially covered stents, have been shown to be a standard treatment for managing malignant GOO, with low migration rates and better bile outflow[55,56,59]. Tumor ingrowth/overgrowth has been reported in 17.2% of patients receiving bare metal stents and in 6.9% of patients with covered stents[60,61]. This stent obstruction can be managed with a stent-in-stent technique, and stent occlusion rate was reported to be 10%-34% after the secondary SEMS insertion[62,63]. The development of stents to compensate for the shortcomings of the existing stents continues, and recent new covered stents with anti-migration designs have been suggested to be superior in terms of stent patency and complications[64].

**SEMS *vs* surgery:** The comparison of the effects and safety of surgical methods and endoscopic stents as palliative treatment for malignant GOO have been presented in various studies. Compared to surgery, the advantages of endoscopic stents are; shorter procedure time, less time to ingestion, and shorter hospitalization periods, but repeated procedures are often required due to frequent stent failures[65-67]. According to one systematic study, patients treated with enteral stents showed shorter hospitalization periods (average 12 d) and faster oral intake (average 7 d) than those treated with gastrojejunostomy, and there was no significant difference in mortality, overall complications, and survival rates[68]. Most studies have shown that there is no difference between both treatments in technical or clinical success rate of the procedure, but one meta-analysis reported that the success rate was higher in stent placement patients[69,70]. There was no difference in the frequency of mild and severe complications in the early stage of complications after SEMS insertion or surgery, but it is known that the time of severe complications in the late stage is relatively earlier and more common in stent patients[71]. Nevertheless, there was no difference in stent insertion or surgery-related mortality[72]. In larger randomized trials with longer follow-up, late complications including recurrent obstruction and need for reoperation were more common in SEMS than gastrojejunostomy, which confirms the previous retrospective study, which reported that gastrojejunostomy surgery has more benefits and is associated with a longer life expectancy[70,73,74].

***Endoscopic ultrasound-guided gastroenterostomy***

Endoscopic ultrasound-guided gastroenterostomy (EUS-GE) using lumen-apposing metal stents has emerged as a safe and effective alternative method. EUS-GE can allow sustained palliation of surgical bypass while maintaining a minimally invasive endoscopic approach[75,76]. EUS-GE was first described by Binmoeller *et al*[77] in 2012, and has shown significant efficacy in palliating malignant GOO in patients who are suitable for surgical bypass[78]. In EUS-GE, a bypass is created by inserting a lumen-apposing metal stent from the stomach to the small bowel distal to the obstruction under EUS and fluoroscopic guidance.

EUS-GE can be used for palliative management of malignant GOO and can be a treatment option for benign GOO. Two recent case studies showed high technical (90%-92%) and clinical (85%-92%) success rates, with a variable percentage of adverse events (0-11.5%)[79,80]. Tyberg *et al*[79] showed there were fewer side effects (12% *vs* 41%) and similar technical success (88% *vs* 100%) with EUS-GE compared to surgical laparoscopic gastrojejunostomy. A retrospective study in 2020 by James *et al*[81] reported EUS-GE as a bridge therapy for definitive treatment of benign gastric outlet obstruction. EUS-GE was performed in 22 patients with benign GOO, and 83.3% of patients were prevented from surgery. Lumen-apposing metal stents was maintained for a mean of 8.5 mo until GOO was resolved, and the low recurrence rate of GOO (5.6%) has been reported after lumen-apposing metal stents removal. Future prospective, large-scale, randomized studies comparing surgical gastroenterostomy and EUS-GE are needed.

**SURGERY**

Surgery is the preferred method of treatment in patients with refractory GOO, or for whom endoscopic treatment has not been indicated. In the past, open gastrojejunostomy was widely performed, but recently laparoscopic gastrojejunostomy has become the main treatment. The laparoscopic surgical approach is more effective than open surgery for rapid postoperative recovery and is associated with a shorter hospital stay[82].

**CONCLUSION**

With the eradication of *H. pylori* and the use of proton pump inhibitors, the predominant causes of GOO have changed from benign to malignant diseases. Treatment of GOO depends on the underlying cause, and multiple treatment methods exist, including both endoscopic and surgical approaches. Therefore, determining the appropriate treatment for individual patients is important for treatment success and prognosis.

**REFERENCES**

1 **Johnson CD**. Gastric outlet obstruction malignant until proved otherwise. *Am J Gastroenterol* 1995; **90**: 1740 [PMID: 7572886]

2 **Khullar SK**, DiSario JA. Gastric outlet obstruction. *Gastrointest Endosc Clin N Am* 1996; **6**: 585-603 [PMID: 8803569 DOI: 10.1016/S1052-5157(18)30356-8]

3 **Johnson CD**, Ellis H. Gastric outlet obstruction now predicts malignancy. *Br J Surg* 1990; **77**: 1023-1024 [PMID: 2207566 DOI: 10.1002/bjs.1800770923]

4 **Chowdhury A**, Dhali GK, Banerjee PK. Etiology of gastric outlet obstruction. *Am J Gastroenterol* 1996; **91**: 1679 [PMID: 8759707]

5 **Shone DN**, Nikoomanesh P, Smith-Meek MM, Bender JS. Malignancy is the most common cause of gastric outlet obstruction in the era of H2 blockers. *Am J Gastroenterol* 1995; **90**: 1769-1770 [PMID: 7572891]

6 **Tringali A**, Giannetti A, Adler DG. Endoscopic management of gastric outlet obstruction disease. *Ann Gastroenterol* 2019; **32**: 330-337 [PMID: 31263354 DOI: 10.20524/aog.2019.0390]

7 **Kochhar R**, Kochhar S. Endoscopic balloon dilation for benign gastric outlet obstruction in adults. *World J Gastrointest Endosc* 2010; **2**: 29-35 [PMID: 21160676 DOI: 10.4253/wjge.v2.i1.29]

8 **Paimela H**, Tuompo PK, Peräkyl T, Saario I, Höckerstedt K, Kivilaakso E. Peptic ulcer surgery during the H2-receptor antagonist era: a population-based epidemiological study of ulcer surgery in Helsinki from 1972 to 1987. *Br J Surg* 1991; **78**: 28-31 [PMID: 1671826 DOI: 10.1002/bjs.1800780110]

9 **Ferzoco SJ,** Soybel D. Gastric outlet obstruction, perforation and other complications of gastroduodenal ulcer. In: . Gastric outlet obstruction, perforation and other complications of gastroduodenal ulcer. Therapy of digestive disorders: Elsevier Inc., 2006: 357-372 [DOI: 10.1016/b978-1-4160-0317-5.50028-5]

10 **Zargar SA**, Kochhar R, Nagi B, Mehta S, Mehta SK. Ingestion of corrosive acids. Spectrum of injury to upper gastrointestinal tract and natural history. *Gastroenterology* 1989; **97**: 702-707 [PMID: 2753330 DOI: 10.1016/0016-5085(89)90641-0]

11 **Zargar SA**, Kochhar R, Nagi B, Mehta S, Mehta SK. Ingestion of strong corrosive alkalis: spectrum of injury to upper gastrointestinal tract and natural history. *Am J Gastroenterol* 1992; **87**: 337-341 [PMID: 1539568]

12 **Chaudhary A**, Puri AS, Dhar P, Reddy P, Sachdev A, Lahoti D, Kumar N, Broor SL. Elective surgery for corrosive-induced gastric injury. *World J Surg* 1996; **20**: 703-6; discussion 706 [PMID: 8662156 DOI: 10.1007/s002689900107]

13 **Nugent FW**, Roy MA. Duodenal Crohn's disease: an analysis of 89 cases. *Am J Gastroenterol* 1989; **84**: 249-254 [PMID: 2919581]

14 **Miner PB**, Harri JE, McPhee MS. Intermittent gastric outlet obstruction from a pedunculated gastric polyp. *Gastrointest Endosc* 1982; **28**: 219-220 [PMID: 7129059 DOI: 10.1016/s0016-5107(82)73075-5]

15 **Goldman G**, Tiomny E, Kahn PJ, Somjen D, Halpern Z, Gilat T, Wiznitzer T. Prostaglandin E2 in pyloric stenosis. *Arch Surg* 1989; **124**: 724-726 [PMID: 2730327 DOI: 10.1001/archsurg.1989.01410060096020]

16 **Noor MT**, Dixit P, Kochhar R, Nagi B, Dutta U, Singh K, Poornachandra KS. NSAIDs-Related Pyloroduodenal Obstruction and Its Endoscopic Management. *Diagn Ther Endosc* 2011; **2011**: 967957 [PMID: 21747657 DOI: 10.1155/2011/967957]

17 **Lopera JE**, Brazzini A, Gonzales A, Castaneda-Zuniga WR. Gastroduodenal stent placement: current status. *Radiographics* 2004; **24**: 1561-1573 [PMID: 15537965 DOI: 10.1148/rg.246045033]

18 **Appasani S**, Kochhar S, Nagi B, Gupta V, Kochhar R. Benign gastric outlet obstruction--spectrum and management. *Trop Gastroenterol* 2011; **32**: 259-266 [PMID: 22696905]

19 **Gisbert JP**, Pajares JM. Review article: Helicobacter pylori infection and gastric outlet obstruction - prevalence of the infection and role of antimicrobial treatment. *Aliment Pharmacol Ther* 2002; **16**: 1203-1208 [PMID: 12144568 DOI: 10.1046/j.1365-2036.2002.01275.x]

20 **Kate V**, Ananthakrishnan N, Badrinath S, Amarnath SK, Ratnakar C. Helicobacter pylori infection in duodenal ulcer with gastric outlet obstruction. *Trop Gastroenterol* 1998; **19**: 75-77 [PMID: 9752759]

21 **Mohsina S**, Muthusami A, Shankar G, Sureshkumar S, Kate V. Helicobacter pylori eradication in complicated peptic ulcer: Beneficial in most? *Int J Adv Med Health Res* 2016; **3**: 58 [DOI: 10.4103/2349-4220.195947]

22 **Weiland D**, Dunn DH, Humphrey EW, Schwartz ML. Gastric outlet obstruction in peptic ulcer disease: an indication for surgery. *Am J Surg* 1982; **143**: 90-93 [PMID: 7053661 DOI: 10.1016/0002-9610(82)90135-0]

23 **Lau JY**, Chung SC, Sung JJ, Chan AC, Ng EK, Suen RC, Li AK. Through-the-scope balloon dilation for pyloric stenosis: long-term results. *Gastrointest Endosc* 1996; **43**: 98-101 [PMID: 8635729 DOI: 10.1016/s0016-5107(06)80107-0]

24 **Boylan JJ**, Gradzka MI. Long-term results of endoscopic balloon dilatation for gastric outlet obstruction. *Dig Dis Sci* 1999; **44**: 1883-1886 [PMID: 10505729 DOI: 10.1023/a:1018807125952]

25 **Solt J**, Bajor J, Szabó M, Horváth OP. Long-term results of balloon catheter dilation for benign gastric outlet stenosis. *Endoscopy* 2003; **35**: 490-495 [PMID: 12783346 DOI: 10.1055/s-2003-39664]

26 **Misra SP**, Dwivedi M. Long-term follow-up of patients undergoing ballon dilation for benign pyloric stenoses. *Endoscopy* 1996; **28**: 552-554 [PMID: 8911802 DOI: 10.1055/s-2007-1005553]

27 **Kochhar R**, Sethy PK, Nagi B, Wig JD. Endoscopic balloon dilatation of benign gastric outlet obstruction. *J Gastroenterol Hepatol* 2004; **19**: 418-422 [PMID: 15012779 DOI: 10.1111/j.1440-1746.2003.03283.x]

28 **Perng CL**, Lin HJ, Lo WC, Lai CR, Guo WS, Lee SD. Characteristics of patients with benign gastric outlet obstruction requiring surgery after endoscopic balloon dilation. *Am J Gastroenterol* 1996; **91**: 987-990 [PMID: 8633593]

29 **Cherian PT**, Cherian S, Singh P. Long-term follow-up of patients with gastric outlet obstruction related to peptic ulcer disease treated with endoscopic balloon dilatation and drug therapy. *Gastrointest Endosc* 2007; **66**: 491-497 [PMID: 17640640 DOI: 10.1016/j.gie.2006.11.016]

30 **Kozarek RA**, Botoman VA, Patterson DJ. Long-term follow-up in patients who have undergone balloon dilation for gastric outlet obstruction. *Gastrointest Endosc* 1990; **36**: 558-561 [PMID: 2279642 DOI: 10.1016/s0016-5107(90)71163-7]

31 **Kuwada SK**, Alexander GL. Long-term outcome of endoscopic dilation of nonmalignant pyloric stenosis. *Gastrointest Endosc* 1995; **41**: 15-17 [PMID: 7698619 DOI: 10.1016/s0016-5107(95)70270-9]

32 **Weaver DW**, Wiencek RG, Bouwman DL, Walt AJ. Gastrojejunostomy: is it helpful for patients with pancreatic cancer? *Surgery* 1987; **102**: 608-613 [PMID: 2443991]

33 **Chandrasegaram MD**, Eslick GD, Mansfield CO, Liem H, Richardson M, Ahmed S, Cox MR. Endoscopic stenting versus operative gastrojejunostomy for malignant gastric outlet obstruction. *Surg Endosc* 2012; **26**: 323-329 [PMID: 21898024 DOI: 10.1007/s00464-011-1870-3]

34 **Jeurnink SM**, Polinder S, Steyerberg EW, Kuipers EJ, Siersema PD. Cost comparison of gastrojejunostomy versus duodenal stent placement for malignant gastric outlet obstruction. *J Gastroenterol* 2010; **45**: 537-543 [PMID: 20033227 DOI: 10.1007/s00535-009-0181-0]

35 **Benjamin SB**. Ballon dilation of the pylorus: therapy for gastric outlet obstruction. *Gastrointest Endosc* 1982; **28**: 253-255 [DOI: 10.1016/s0016-5107(82)73105-0]

36 **Benjamin SB**, Glass RL, Cattau EL Jr, Miller WB. Preliminary experience with balloon dilation of the pylorus. *Gastrointest Endosc* 1984; **30**: 93-95 [PMID: 6714610 DOI: 10.1016/s0016-5107(84)72329-7]

37 **Coda S**, Oda I, Gotoda T, Yokoi C, Kikuchi T, Ono H. Risk factors for cardiac and pyloric stenosis after endoscopic submucosal dissection, and efficacy of endoscopic balloon dilation treatment. *Endoscopy* 2009; **41**: 421-426 [PMID: 19418396 DOI: 10.1055/s-0029-1214642]

38 **Kochhar R**, Dutta U, Sethy PK, Singh G, Sinha SK, Nagi B, Wig JD, Singh K. Endoscopic balloon dilation in caustic-induced chronic gastric outlet obstruction. *Gastrointest Endosc* 2009; **69**: 800-805 [PMID: 19136104 DOI: 10.1016/j.gie.2008.05.056]

39 **Kochhar R**, Malik S, Reddy YR, Mallick B, Dhaka N, Gupta P, Sinha SK, Manrai M, Kochhar S, Wig JD, Gupta V. Endoscopic balloon dilatation is an effective management strategy for caustic-induced gastric outlet obstruction: a 15-year single center experience. *Endosc Int Open* 2019; **7**: E53-E61 [PMID: 30648140 DOI: 10.1055/a-0655-2057]

40 **Kim JH**, Shin JH, Di ZH, Ko GY, Yoon HK, Sung KB, Song HY. Benign duodenal strictures: treatment by means of fluoroscopically guided balloon dilation. *J Vasc Interv Radiol* 2005; **16**: 543-548 [PMID: 15802456 DOI: 10.1097/01.RVI.0000150033.13928.D4]

41 **DiSario JA**, Fennerty MB, Tietze CC, Hutson WR, Burt RW. Endoscopic balloon dilation for ulcer-induced gastric outlet obstruction. *Am J Gastroenterol* 1994; **89**: 868-871 [PMID: 8198096]

42 **Lam YH**, Lau JY, Fung TM, Ng EK, Wong SK, Sung JJ, Chung SS. Endoscopic balloon dilation for benign gastric outlet obstruction with or without Helicobacter pylori infection. *Gastrointest Endosc* 2004; **60**: 229-233 [PMID: 15278050 DOI: 10.1016/s0016-5107(04)01569-x]

43 **Ketchum LD**, Smith J, Robinson DW, Masters FW. The treatment of hypertrophic scar, keloid and scar contracture by triamcinolone acetonide. *Plast Reconstr Surg* 1966; **38**: 209-218 [PMID: 5919604 DOI: 10.1097/00006534-196609000-00005]

44 **Kochhar R**, Sriram PV, Ray JD, Kumar S, Nagi B, Singh K. Intralesional steroid injections for corrosive induced pyloric stenosis. *Endoscopy* 1998; **30**: 734-736 [PMID: 9865568 DOI: 10.1055/s-2007-1001400]

45 **Lee M**, Kubik CM, Polhamus CD, Brady CE 3rd, Kadakia SC. Preliminary experience with endoscopic intralesional steroid injection therapy for refractory upper gastrointestinal strictures. *Gastrointest Endosc* 1995; **41**: 598-601 [PMID: 7672557 DOI: 10.1016/s0016-5107(95)70199-0]

46 **Boron B**, Gross KR. Successful dilatation of pyloric stricture resistant to balloon dilatation with electrocautery using a sphinctertome. *J Clin Gastroenterol* 1996; **23**: 239-241 [PMID: 8899513 DOI: 10.1097/00004836-199610000-00020]

47 **Hagiwara A**, Sonoyama Y, Togawa T, Yamasaki J, Sakakura C, Yamagishi H. Combined use of electrosurgical incisions and balloon dilatation for the treatment of refractory postoperative pyloric stenosis. *Gastrointest Endosc* 2001; **53**: 504-508 [PMID: 11275897 DOI: 10.1067/mge.2001.113281]

48 **Adler DG**, Baron TH. Endoscopic palliation of malignant gastric outlet obstruction using self-expanding metal stents: experience in 36 patients. *Am J Gastroenterol* 2002; **97**: 72-78 [PMID: 11808972 DOI: 10.1111/j.1572-0241.2002.05423.x]

49 **van den Berg MW**, Haijtink S, Fockens P, Vleggaar FP, Dijkgraaf MG, Siersema PD, van Hooft JE. First data on the Evolution duodenal stent for palliation of malignant gastric outlet obstruction (DUOLUTION study): a prospective multicenter study. *Endoscopy* 2013; **45**: 174-181 [PMID: 23348890 DOI: 10.1055/s-0032-1326077]

50 **Dormann A**, Meisner S, Verin N, Wenk Lang A. Self-expanding metal stents for gastroduodenal malignancies: systematic review of their clinical effectiveness. *Endoscopy* 2004; **36**: 543-550 [PMID: 15202052 DOI: 10.1055/s-2004-814434]

51 **Mansoor H**, Yusuf MA. Outcomes of endoscopic pyloric stenting in malignant gastric outlet obstruction: a retrospective study. *BMC Res Notes* 2013; **6**: 280 [PMID: 23870091 DOI: 10.1186/1756-0500-6-280]

52 **Lee JE**, Lee K, Hong YS, Kim ER, Lee H, Min BH. Impact of Carcinomatosis on Clinical Outcomes after Self-Expandable Metallic Stent Placement for Malignant Gastric Outlet Obstruction. *PLoS One* 2015; **10**: e0140648 [PMID: 26465920 DOI: 10.1371/journal.pone.0140648]

53 **Jeurnink SM**, Steyerberg EW, van Hooft JE, van Eijck CH, Schwartz MP, Vleggaar FP, Kuipers EJ, Siersema PD; Dutch SUSTENT Study Group. Surgical gastrojejunostomy or endoscopic stent placement for the palliation of malignant gastric outlet obstruction (SUSTENT study): a multicenter randomized trial. *Gastrointest Endosc* 2010; **71**: 490-499 [PMID: 20003966 DOI: 10.1016/j.gie.2009.09.042]

54 **Baron TH**, Harewood GC. Enteral self-expandable stents. *Gastrointest Endosc* 2003; **58**: 421-433 [PMID: 14528223 DOI: 10.1067/s0016-5107(03)00023-3]

55 **Woo SM**, Kim DH, Lee WJ, Park KW, Park SJ, Han SS, Kim TH, Koh YH, Kim HB, Hong EK. Comparison of uncovered and covered stents for the treatment of malignant duodenal obstruction caused by pancreaticobiliary cancer. *Surg Endosc* 2013; **27**: 2031-2039 [PMID: 23288317 DOI: 10.1007/s00464-012-2705-6]

56 **van den Berg MW**, Walter D, Vleggaar FP, Siersema PD, Fockens P, van Hooft JE. High proximal migration rate of a partially covered "big cup" duodenal stent in patients with malignant gastric outlet obstruction. *Endoscopy* 2014; **46**: 158-161 [PMID: 24338240 DOI: 10.1055/s-0033-1359023]

57 **Kim CG**, Choi IJ, Lee JY, Cho SJ, Park SR, Lee JH, Ryu KW, Kim YW, Park YI. Covered versus uncovered self-expandable metallic stents for palliation of malignant pyloric obstruction in gastric cancer patients: a randomized, prospective study. *Gastrointest Endosc* 2010; **72**: 25-32 [PMID: 20381802 DOI: 10.1016/j.gie.2010.01.039]

58 **Yang Z**, Wu Q, Wang F, Ye X, Qi X, Fan D. A systematic review and meta-analysis of randomized trials and prospective studies comparing covered and bare self-expandable metal stents for the treatment of malignant obstruction in the digestive tract. *Int J Med Sci* 2013; **10**: 825-835 [PMID: 23794946 DOI: 10.7150/ijms.5969]

59 **Hamada T**, Hakuta R, Takahara N, Sasaki T, Nakai Y, Isayama H, Koike K. Covered versus uncovered metal stents for malignant gastric outlet obstruction: Systematic review and meta-analysis. *Dig Endosc* 2017; **29**: 259-271 [PMID: 27997723 DOI: 10.1111/den.12786]

60 **Song HY**, Shin JH, Yoon CJ, Lee GH, Kim TW, Lee SK, Yook JH, Kim BS. A dual expandable nitinol stent: experience in 102 patients with malignant gastroduodenal strictures. *J Vasc Interv Radiol* 2004; **15**: 1443-1449 [PMID: 15590803 DOI: 10.1097/01.RVI.0000142594.31221.AF]

61 **Jang JK**, Song HY, Kim JH, Song M, Park JH, Kim EY. Tumor overgrowth after expandable metallic stent placement: experience in 583 patients with malignant gastroduodenal obstruction. *AJR Am J Roentgenol* 2011; **196**: W831-W836 [PMID: 21606277 DOI: 10.2214/AJR.10.5861]

62 **Sasaki T**, Isayama H, Nakai Y, Takahara N, Hamada T, Mizuno S, Mohri D, Yagioka H, Kogure H, Arizumi T, Togawa O, Matsubara S, Ito Y, Yamamoto N, Sasahira N, Hirano K, Toda N, Tada M, Koike K. Clinical outcomes of secondary gastroduodenal self-expandable metallic stent placement by stent-in-stent technique for malignant gastric outlet obstruction. *Dig Endosc* 2015; **27**: 37-43 [PMID: 24995858 DOI: 10.1111/den.12321]

63 **Kim CG**, Choi IJ, Lee JY, Cho SJ, Kim SJ, Kim MJ, Park SR, Park YL. Outcomes of second self-expandable metallic stent insertion for malignant gastric outlet obstruction. *Surg Endosc* 2014; **28**: 281-288 [PMID: 24026566 DOI: 10.1007/s00464-013-3185-z]

64 **Lee H**, Min BH, Lee JH, Shin CM, Kim Y, Chung H, Lee SH. Covered metallic stents with an anti-migration design vs. uncovered stents for the palliation of malignant gastric outlet obstruction: a multicenter, randomized trial. *Am J Gastroenterol* 2015; **110**: 1440-1449 [PMID: 26372507 DOI: 10.1038/ajg.2015.286]

65 **Del Piano M**, Ballarè M, Montino F, Todesco A, Orsello M, Magnani C, Garello E. Endoscopy or surgery for malignant GI outlet obstruction? *Gastrointest Endosc* 2005; **61**: 421-426 [PMID: 15758914 DOI: 10.1016/s0016-5107(04)02757-9]

66 **Khashab M**, Alawad AS, Shin EJ, Kim K, Bourdel N, Singh VK, Lennon AM, Hutfless S, Sharaiha RZ, Amateau S, Okolo PI, Makary MA, Wolfgang C, Canto MI, Kalloo AN. Enteral stenting versus gastrojejunostomy for palliation of malignant gastric outlet obstruction. *Surg Endosc* 2013; **27**: 2068-2075 [PMID: 23299137 DOI: 10.1007/s00464-012-2712-7]

67 **Roy A**, Kim M, Christein J, Varadarajulu S. Stenting versus gastrojejunostomy for management of malignant gastric outlet obstruction: comparison of clinical outcomes and costs. *Surg Endosc* 2012; **26**: 3114-3119 [PMID: 22549377 DOI: 10.1007/s00464-012-2301-9]

68 **Ly J**, O'Grady G, Mittal A, Plank L, Windsor JA. A systematic review of methods to palliate malignant gastric outlet obstruction. *Surg Endosc* 2010; **24**: 290-297 [PMID: 19551436 DOI: 10.1007/s00464-009-0577-1]

69 **Hosono S**, Ohtani H, Arimoto Y, Kanamiya Y. Endoscopic stenting versus surgical gastroenterostomy for palliation of malignant gastroduodenal obstruction: a meta-analysis. *J Gastroenterol* 2007; **42**: 283-290 [PMID: 17464457 DOI: 10.1007/s00535-006-2003-y]

70 **Jeurnink SM**, van Eijck CH, Steyerberg EW, Kuipers EJ, Siersema PD. Stent versus gastrojejunostomy for the palliation of gastric outlet obstruction: a systematic review. *BMC Gastroenterol* 2007; **7**: 18 [PMID: 17559659 DOI: 10.1186/1471-230X-7-18]

71 **No JH**, Kim SW, Lim CH, Kim JS, Cho YK, Park JM, Lee IS, Choi MG, Choi KY. Long-term outcome of palliative therapy for gastric outlet obstruction caused by unresectable gastric cancer in patients with good performance status: endoscopic stenting versus surgery. *Gastrointest Endosc* 2013; **78**: 55-62 [PMID: 23522025 DOI: 10.1016/j.gie.2013.01.041]

72 **Zheng B**, Wang X, Ma B, Tian J, Jiang L, Yang K. Endoscopic stenting versus gastrojejunostomy for palliation of malignant gastric outlet obstruction. *Dig Endosc* 2012; **24**: 71-78 [PMID: 22348830 DOI: 10.1111/j.1443-1661.2011.01186.x]

73 **Jeurnink SM**, Steyerberg EW, Hof Gv, van Eijck CH, Kuipers EJ, Siersema PD. Gastrojejunostomy versus stent placement in patients with malignant gastric outlet obstruction: a comparison in 95 patients. *J Surg Oncol* 2007; **96**: 389-396 [PMID: 17474082 DOI: 10.1002/jso.20828]

74 **Jang S**, Stevens T, Lopez R, Bhatt A, Vargo JJ. Superiority of Gastrojejunostomy Over Endoscopic Stenting for Palliation of Malignant Gastric Outlet Obstruction. *Clin Gastroenterol Hepatol* 2019; **17**: 1295-1302.e1 [PMID: 30391433 DOI: 10.1016/j.cgh.2018.10.042]

75 **Perez-Miranda M**, Tyberg A, Poletto D, Toscano E, Gaidhane M, Desai AP, Kumta NA, Fayad L, Nieto J, Barthet M, Shah R, Brauer BC, Sharaiha RZ, Kahaleh M. EUS-guided Gastrojejunostomy Versus Laparoscopic Gastrojejunostomy: An International Collaborative Study. *J Clin Gastroenterol* 2017; **51**: 896-899 [PMID: 28697151 DOI: 10.1097/MCG.0000000000000887]

76 **Khashab MA**, Bukhari M, Baron TH, Nieto J, El Zein M, Chen YI, Chavez YH, Ngamruengphong S, Alawad AS, Kumbhari V, Itoi T. International multicenter comparative trial of endoscopic ultrasonography-guided gastroenterostomy versus surgical gastrojejunostomy for the treatment of malignant gastric outlet obstruction. *Endosc Int Open* 2017; **5**: E275-E281 [PMID: 28382326 DOI: 10.1055/s-0043-101695]

77 **Binmoeller KF**, Shah JN. Endoscopic ultrasound-guided gastroenterostomy using novel tools designed for transluminal therapy: a porcine study. *Endoscopy* 2012; **44**: 499-503 [PMID: 22531985 DOI: 10.1055/s-0032-1309382]

78 **Ge PS**, Young JY, Dong W, Thompson CC. EUS-guided gastroenterostomy versus enteral stent placement for palliation of malignant gastric outlet obstruction. *Surg Endosc* 2019; **33**: 3404-3411 [PMID: 30725254 DOI: 10.1007/s00464-018-06636-3]

79 **Tyberg A**, Perez-Miranda M, Sanchez-Ocaña R, Peñas I, de la Serna C, Shah J, Binmoeller K, Gaidhane M, Grimm I, Baron T, Kahaleh M. Endoscopic ultrasound-guided gastrojejunostomy with a lumen-apposing metal stent: a multicenter, international experience. *Endosc Int Open* 2016; **4**: E276-E281 [PMID: 27004243 DOI: 10.1055/s-0042-101789]

80 **Khashab MA**, Kumbhari V, Grimm IS, Ngamruengphong S, Aguila G, El Zein M, Kalloo AN, Baron TH. EUS-guided gastroenterostomy: the first U.S. clinical experience (with video). *Gastrointest Endosc* 2015; **82**: 932-938 [PMID: 26215646 DOI: 10.1016/j.gie.2015.06.017]

81 **James TW**, Greenberg S, Grimm IS, Baron TH. EUS-guided gastroenteric anastomosis as a bridge to definitive treatment in benign gastric outlet obstruction. *Gastrointest Endosc* 2020; **91**: 537-542 [PMID: 31759034 DOI: 10.1016/j.gie.2019.11.017]

82 **Al-Rashedy M**, Dadibhai M, Shareif A, Khandelwal MI, Ballester P, Abid G, McCloy RF, Ammori BJ. Laparoscopic gastric bypass for gastric outlet obstruction is associated with smoother, faster recovery and shorter hospital stay compared with open surgery. *J Hepatobiliary Pancreat Surg* 2005; **12**: 474-478 [PMID: 16365822 DOI: 10.1007/s00534-005-1013-0]

**Footnotes**

**Conflict-of-interest statement:** Authors declare no conflict of interests for this article.

**Open-Access:** This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution NonCommercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: http://creativecommons.org/licenses/by-nc/4.0/

**Manuscript source:** Invited Manuscript

**Peer-review started:** February 27, 2020

**First decision:** April 22, 2020

**Article in press:** May 29, 2020

**Specialty type:** Gastroenterology and hepatology

**Country/Territory of origin:** South Korea

**Peer-review report’s scientific quality classification**

Grade A (Excellent): 0

Grade B (Very good): 0

Grade C (Good): C, C

Grade D (Fair): 0

Grade E (Poor): 0

**P-Reviewer:** de Melo FF, Ng QX **S-Editor:** Wang J **L-Editor:** A **E-Editor:** Qi LL

**Table 1 Causes of gastric outlet obstruction**

|  |  |
| --- | --- |
| **Benign** | **Malignant** |
| Peptic ulcer disease | Gastric cancer |
| Caustic ingestion | Gastric lymphoma |
| NSAID induced stricture | Pancreas cancer |
| Bouveret syndrome | Duodenal cancer |
| Hypertrophic pyloric stenosis | Cholangiocarcinoma |
| Iatrogenic | Gallbladder cancer |
| Post-surgical scar or anastomosis stricture | Metastatic cancer |
| Endoscopic submucosal dissection |  |
| Endoscopic mucosal resection |  |
| Inflammatory causes |  |
| Crohn’s disease |  |
| Pancreatitis |  |
| Inflammatory polyps |  |
| Infectious causes |  |
| Tuberculosis gastroenteritis |  |
| CMV gastroenteritis |  |
| Infiltrative causes |  |
| Eosinophilic gastroenteritis |  |
| Amyloidosis |  |

NSAID: Nonsteroidal anti-inflammatory drugs; CMV: Cytomegalovirus.

**Table 2 Treatment of gastric outlet obstruction based upon the underlying cause**

|  |  |
| --- | --- |
| **Underlying cause** | **Treatment** |
| Benign |
| Peptic ulcer disease | PPI ± HPE (1st option)  | EBD or surgery (2nd option) |
| Crohn disease | Corticosteroid (1st option) | EBD or surgery (2nd option) |
| Caustic ingestion | EBD or surgery |
| Bouveret syndrome | Surgery or endoscopic removal |
| Large gastric polyp | Endoscopic resection |
| Malignant |
| Palliative | Endoscopic stent (covered or uncovered) |
| EUS-guided gastroenterostomy |
| Surgical resection, surgical bypass (gastrojejunostomy) |
| Radiation therapy |
| Curative | Surgery |
| Chemotherapy (for lymphoma) |

PPI: Proton pump inhibitor; HPE: Helicobacter pylori eradication; EBD: Endoscopic balloon dilatation; EUS: Endoscopic ultrasound.