Abdominal Radiology

Published online: 19 September 2017

Abdom Radiol (2018) 43:1464–1471
https://doi.org/10.1007/s00261-017-1313-2

Percutaneous gastric remnant gastrostomy following Roux-en-Y gastric bypass surgery: a single tertiary center's 13-year experience

Shehbaz Hasam Shaikh,[1] Justin Jay Stenz,[1] David W. McVinnie,[1] James J. Morrison,[1] Todd Getzen,[1] Arthur M. Carlin,[2] Farhaan R. Mir[1]

[1]Department of Radiology, Henry Ford Hospital, 2799 W. Grand Blvd, Detroit, MI 48202, USA
[2]Department of Surgery, Henry Ford Hospital, 2799 W. Grand Blvd, Detroit, MI 48202, USA

Abstract

Purpose: The purpose of the study is to evaluate the indications, techniques, and outcomes for percutaneous gastrostomy placement in the gastric remnant following Roux-en-Y gastric bypass (RYGB) in bariatric patients.
Materials and methods: Retrospective chart review and summary statistical analysis was performed on all RYGB patients that underwent attempted percutaneous remnant gastrostomy placement at our institution between April 2003 and November 2016.
Results: A total of 38 patients post-RYGB who underwent gastric remnant gastrostomy placement were identified, 32 women and 6 men, in which a total of 41 procedures were attempted. Technical success was achieved in 39 of the 41 cases (95%). Indications for the procedure were delayed gastric remnant emptying/biliopancreatic limb obstruction ($n = 8$), malnutrition related to RYGB ($n = 17$), nutritional support for conditions unrelated to RYGB ($n = 15$), and access for endoscopic retrograde cholangiopancreatography (ERCP, $n = 1$). Insufflation of the gastric remnant was performed via a clear window ($n = 35$), transhepatic ($n = 5$), and transjejunal ($n = 1$) routes. Five complications were encountered. The four major complications (9.8%) included early tube dislodgement with peritonitis, early tube dislodgement requiring repeat intervention, intractable pain, and upper gastrointestinal bleeding. A single minor complication occurred (2.4%), cellulitis.
Conclusion: Patients with a history of RYGB present a technical challenge for excluded gastric remnant gastrostomy placement. As the RYGB population increases and ages, obtaining and maintaining access to the gastric remnant is likely to become an important part of interventional radiology's role in the management of the bariatric patient.

Key words: Gastrostomy—Anastomosis Roux-en-Y—Gastric bypass—Bariatric surgery—Afferent loop obstruction

Laparoscopic Roux-en-Y gastric bypass (RYGB) is one of the most common bariatric surgical procedures performed in Michigan and throughout the United States [1–3]. RYGB has demonstrated significant success in promoting weight loss, leading to remission of medical comorbidities, and improving quality of life [4]. RYGB involves creating a small gastric pouch with a gastrojejunal anastomosis which thereby excludes a large portion of the stomach and duodenum (Fig. 1). By excluding a portion of the gastrointestinal system, weight loss is attained through multiple mechanisms including restricted consumption of food, reduced absorption of ingested nutrients, and modification of gastrointestinal hormones that effect satiety and hunger. Following RYGB, endoscopic access to the excluded gastric remnant and biliopancreatic limb is precluded due to altered anatomy, although balloon-assisted enteroscopy and endoscopic ultrasound may provide potential options for access [5, 6].

Complications relating to RYGB may necessitate the need for access to the gastric remnant and biliopancreatic limb for diagnostic evaluation or therapeutic purposes. Gastric remnant access for postoperative delayed gastric emptying/biliopancreatic obstruction and for malnutri-

Previous presentation: Portions of this manuscript were presented at the Society of Interventional Radiology (SIR) 2016 Annual Meeting; Vancouver, BC; April 2–7, 2016.

Correspondence to: Shehbaz Hasam Shaikh; *email:* shs0808@gmail.com

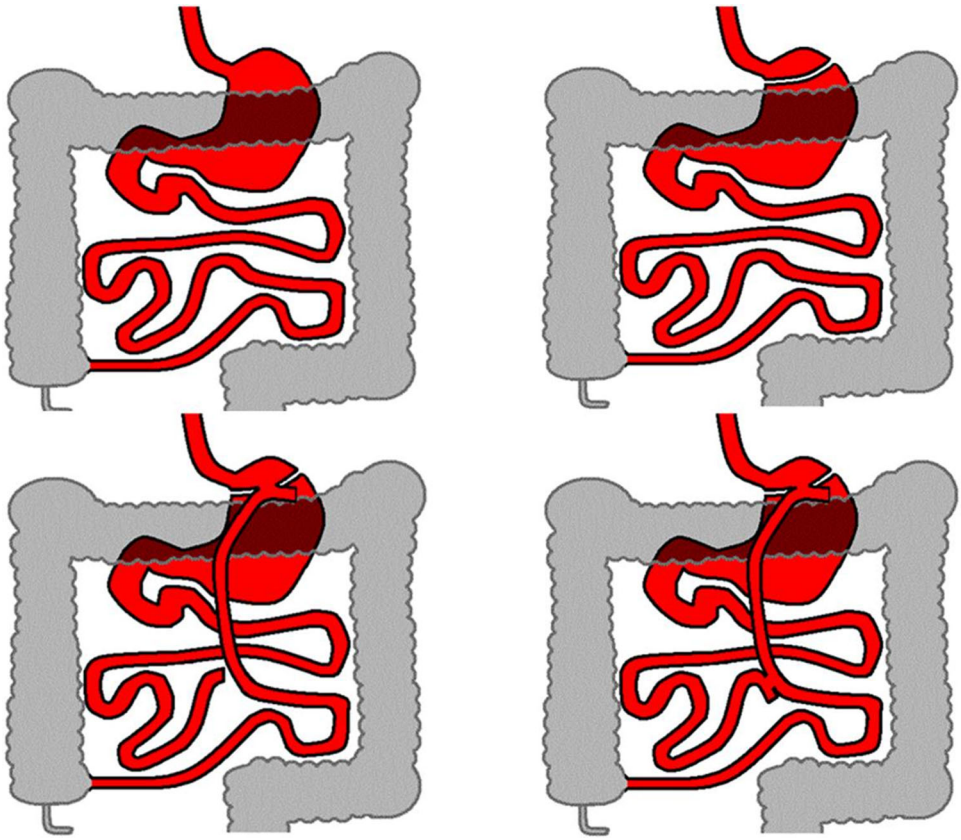

Fig. 1. Roux-en-Y Gastric Bypass Procedure. A small gastric pouch is created, followed by a gastrojejunostomy. A jejunojejunostomy is then performed and the Y-type enterostomy created.

tion related to RYGB have both been previously described [7, 8]. Nosher et al. described the placement of a venting gastrostomy in 8 patients who developed obstruction or ileus following RYGB. Additionally, Stein et al. reported their experience in placing computed tomography (CT)-guided gastrostomy tubes in the treatment of RYGB-related malnutrition. Gastrostomy placement for nutritional support in conditions unrelated to a patient's RYGB has not been previously reported in the literature. Additionally, long-term follow-up data for this patient population are not available. As the population of patients with RYGB grows and ages, we anticipate a commensurate increase in requests for gastrostomy tube placement in these patients. Here, we present our 13-year experience and success rates with percutaneous gastrostomy placement in patients with a history of RYGB.

Materials and methods

After institutional review board approval, a retrospective review of our institution's electronic medical record system and picture archiving and communications system was performed in an effort to identify all RYGB patients who underwent attempted percutaneous gastrostomy placement between April 2003 and November 2016. These procedures were performed using fluoroscopy, ultrasound with fluoroscopy, or CT. All patients who received an initial gastrostomy tube placement and had a history of RYGB were included. Data collection was performed in compliance with the Health Insurance Portability and Accountability Act and tabulated in spreadsheet format (Excel; Microsoft, Redmond, WA). Technical success was defined as placement of a functional gastrostomy tube into the excluded remnant lumen. Complications were classified as minor or major using the Society of Interventional Radiology Clinical Practice Guidelines [9]. The focus of this retrospective review was to document complications related to gastrostomy placement. Therefore, complications relating to subsequent tube malfunction or dislodgement not resulting in peritonitis were excluded.

Technique

Gastric remnant gastrostomy placement was performed utilizing several imaging guidance techniques including fluoroscopy, ultrasound with fluoroscopy, or CT. Gaseous distension of the stomach is typically required to assess the stomach for safe access and then to complete the procedure. For RYGB patients, gastric remnant access for gaseous distension is achieved via small gage needle (20 or 22G Chiba Biopsy Needle, Cook Medical, Bloomington, IN). Intragastric location of the needle is confirmed with contrast injection. When the gastric remnant already contains gas, or is fluid-distended,

Table 1. Patients presenting with delayed gastric remnant emptying/biliopancreatic limb obstruction

Case no.	Age	Sex	Surgery to gastrostomy (days)	Indication	Image guidance	Access	Technical success	Complications	Access maintained (days)	Outcomes
1	61	F	9	Vomiting and gastric remnant dilatation	Fluoro	Clear window	Success	None	3	Persistent symptoms, OR for lysis of adhesions
2	54	F	19	Vomiting, intolerance to diet, and gastric remnant dilatation	Fluoro	Clear window	Success	None	78	Symptoms resolved
3	49	M	6	Gastric remnant dilatation with slow regain of bowel function	Fluoro	Clear window	Success	None	30	Symptoms resolved
4	50	F	7	Vomiting and gastric remnant dilatation	Fluoro	Clear window	Success	None	20	Symptoms resolved
5	51	F	11	Fever, increased white blood cell count, and distended remnant	CT	Clear window	Success	None	40	Symptoms resolved
6	57	F	3	Intolerance to diet and remnant dilatation	US + Fluoro	Clear window	Success	None	20	Symptoms resolved
7	59	F	6	Vomiting and gastric remnant dilatation	CT	Clear window	Success	None	44	Symptoms resolved
8	44	F	329	Acute gastric pain with remnant dilatation	CT	Clear window	Success	None	34	Return of symptoms, OR for lysis of adhesions

CT computed tomography; *F* female; Fluoro, fluoroscopy; *M* male; *OR* operating room; *US* ultrasound

needle access to the gastric remnant is achieved using fluoroscopic guidance alone. If the gastric remnant is not discernible with fluoroscopy, needle access is achieved using ultrasound with fluoroscopy or CT guidance. Once gastric remnant access is achieved, air is injected to distend the gastric lumen either directly via the needle, or the needle can be exchanged over a wire for the 4F inner cannula from a Neff set (Cook Medical). When access is established using fluoroscopy or ultrasound with fluoroscopy, the procedure is completed with fluoroscopic guidance. When access is achieved with CT, the procedure is completed with CT guidance. At exam completion, the inflation needle (or Neff set cannula) is removed.

Once the gastric remnant is gas distended, a suitable access window (i.e., no intervening bowel or liver) is chosen. Care is taken to select a site that is at least 1–2 cm away from the costal margin or xyphoid process. Two small (5-mm) skin incisions are made at the chosen access site a few millimeters apart. Through the first incision, the 17G needle from a suture anchor set (Cope Gastrointestinal Suture Anchor Set, Cook Medical) is passed into the stomach. A gastric suture anchor is deployed into the stomach via the needle. Through the same incision, the needle is again passed into the stomach and a second suture anchor is deployed. The anchor sutures are pulled snugly, approximating the anterior stomach to the abdominal wall, and the anchor sutures are then tied together and the knot is buried deep to the skin surface. Through a second small incision, the 17G needle is again passed into the stomach, this time as close as possible (ideally between) to the two anchors. A guidewire is inserted (Amplatz Ultra Stiff Wire Guide, Cook Medical), the tract is sequentially dilated, and a 14F pigtail-retained gastrostomy tube (Wills-Oglesby, Cook Medical) is placed. This is the standard tube used at our institution because of operator familiarity and ease of placement. Pigtail-retained gastrostomy tubes are placed for both decompression and tube feedings. Gastric decompression can commence immediately, while tube feeding is started after 24 h. The tubes are exchanged as needed when damaged, occluded, leaking, or dislodged. Tube follow-up is typically performed by the referring surgical service.

Results

A total of 38 patients post-RYGB who underwent gastric remnant gastrostomy placement were identified, 32 women and 6 men, in which a total of 41 procedures were attempted. The mean age was 51.2 years (range 29–75 years). Insufflation of the gastric remnant was performed via a clear window ($n = 35$), transhepatic ($n = 5$), and transjejunal ($n = 1$) routes. Indications for the procedure were delayed gastric remnant emptying/biliopancreatic limb obstruction ($n = 8$), malnutri-

Table 2. Patients presenting with malnutrition directly related to RYGB

Case no.	Age	Sex	Time access maintained (days)	Indication	Image guidance	Insufflation access	Technical success	Complications
9	30	F	77	Gastroesophageal fistula/leak needing supplemental nutrition	US + Fluoro	Clear window	Success	None
10	35	F	122	Gastrojejunal anastomotic ulcer with chronic emesis, intolerance to oral diet	US + Fluoro	Clear window	Success	None
11	29	F	65	Noncompliant with nutritional supplements, diarrhea, abdominal discomfort	CT	Clear window	Success	None
12	41	F	101	Gastrojejunal anastomotic ulceration with intolerance to oral intake, abdominal pain, vomiting	CT	Transhepatic	Success	None
13	41	F	156	Intolerance to oral diet, chronic nausea, vomiting, abdominal pain, severe vitamin deficiency, and hypoalbuminemia	CT	Clear window	Success	None
14	46	F	239	Nausea and vomiting; suspected dehydration as etiology.	CT	Clear window	Success	None
15	48	F	8	Chronic abdominal pain, nausea, vomiting, and malnutrition	CT	Clear window	Success	None
16	48	F	92	Had to go through new puncture to get access	CT	Clear window	Success	None
17	49	F	202	Weight loss, nausea, and vomiting	US + Fluoro	Clear window	Success	None
18	43	F	134	Recurrent nausea and vomiting	CT	Clear window	Success	None
19	51	F	LTFU	Chronic diarrhea with 30 lb weight loss in 1-2 months	CT	Clear window	Success	LTFU
20	47	F	85	Decreased caloric intake due to diet restrictions from hyperoxaluria management and stresses in life	CT	Clear window	Success	None
21	62	F	58	Dysphagia with weight loss and jejunum-remnant fistula	CT	Clear window	Success	None
22	58	F	29	Neostomach obstructed	CT	Clear window	Success	None
23	56	F	40	Vomiting, nausea, epigastric pain, Marlex mesh band eroded into the gastric pouch	CT	Clear window	Success	Unrelenting pain
24	52	F	57	Abdominal pain, nausea, and vomiting with EGD showing multiple gastric ulcers and poor nutritional status	CT	Clear window	Success	None
25	55	F	Tube still present	Protein–calorie malnutrition	US + Fluoro	Clear window	Success	None

CT computed tomography; *EGD* esophagogastroduodenoscopy; *F* female; Fluoro, fluoroscopy; *LTFU* lost to follow-up; *M* male; *RYGB* Roux-en-Y gastric bypass; *US* ultrasound

Table 3. Patients presenting for nutritional support for conditions unrelated to RYGB

Case no.	Age	Sex	Time access maintained (days)	Indication	Image guidance	Insufflation access	Technical success	Complications
26	68	M	45	Respiratory failure after cervical fusion	CT	Clear window	Success	None
27	33	F	24	Respiratory failure, sepsis, and pneumonia	CT	Clear window	Success	Gastrointestinal bleed
28	41	F	N/A	Hemorrhagic stroke	CT	Clear window	Failed	N/A
29	57	M	LTFU	Respiratory failure s/p excision of cervicomedullary ependymoma	CT	Transhepatic	Success	None
30	62	M	353	Malnutrition 2/2 colon cancer	CT	Clear window	Success	None
31	53	F	4	Respiratory failure requiring tracheostomy	CT	Clear window	Success	Extragastric feeds
32	68	F	71	Respiratory failure requiring tracheostomy	CT	Transjejunal	Success	None
33	65	F	Hospice	Malnutrition 2/2 neuroendocrine tumor	CT	Clear window	Success	None
34	61	M	N/A	Dysphagia with aspiration	US + Fluoro and CT	Clear window	Failed	N/A
35	52	F	91	Altered mental status with dysphagia and aspiration	US + Fluoro	Transhepatic	Success	None
36	44	F	Tube still present	Encephalopathy with dysphagia and aspiration	US + Fluoro	Transhepatic	Success	None
37	71	F	Hospice	Thyroid carcinoma and unable to tolerate oral diet	US + Fluoro	Clear window	Success	None
38	42	F	Tube still present	Respiratory failure requiring tracheostomy	US + Fluoro	Transhepatic	Success	None
39	75	F	39	Malnutrition after surgery for small bowel obstruction with postoperative malnutrition	US + Fluoro	Clear window	Success	None
40	48	M	LTFU	Respiratory failure 2/2 ischemic stroke	CT	Clear window	Success	None

CT computed tomography; *F* female; Fluoro, fluoroscopy; *M* male; *LTFU* lost to follow-up; *N/A* not applicable; *US* ultrasound

Fig. 2. A 53-year-old woman with worsening leukocytosis 4 days after placement of a percutaneous gastrostomy tube. Axial contrast-enhanced computed tomography with water soluble contrast administered through the gastrostomy tube demonstrates an extraluminal gastrostomy tube, free air, and perihepatic water soluble contrast material.

tion related to RYGB ($n = 17$), nutritional support for conditions unrelated to RYGB ($n = 15$), and access for endoscopic retrograde cholangiopancreatography (ERCP, $n = 1$). Overall, the procedure was technically successful in 39 of the 41 cases (95%). Case numbers 2 and 21 are the same patient who presented in the early postoperative period with delayed gastric emptying and then again several years later with malnutrition related to RYGB. Cases 15, 16, and 17 are the same patient whose initial tube was placed for malnutrition related to RYGB, but because of early dislodgement (at 8 days), a separate insertion procedure was required. Then, nearly a year following removal of her initial tube, she again required gastric remnant gastrostomy for malnutrition related to RYGB.

Gastrostomy placement for decompression in the setting of delayed gastric remnant emptying/biliopancreatic limb obstruction was technically successful in all eight cases (Table 1). Seven cases presented in the early postoperative period at a mean of 8.7 days (range 3–19 days) from time of surgery, while one case presented nearly a year after RYGB (329 days). Fluoroscopy ($n = 4$), ultrasound with fluoroscopy ($n = 1$), and CT ($n = 3$) were used for image guidance. Six of the eight cases were managed conservatively following placement, and the tubes were removed by the surgical service when the patient's condition improved. Cases 1 and 8 had persistence of symptoms that prompted surgery for lysis of adhesions, at which time the tube was

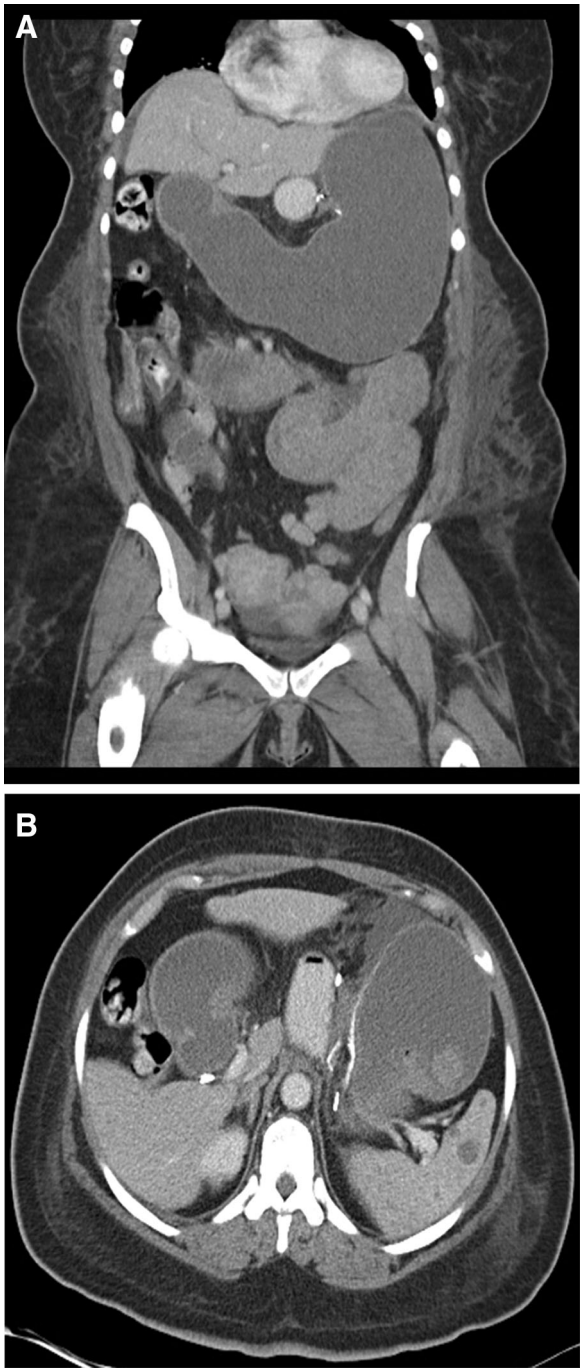

Fig. 3. A 51-year-old woman with fever and leukocytosis 11 days after Roux-en-Y gastric bypass. Axial and coronal contrast-enhanced computed tomography demonstrates a markedly dilated gastric remnant with increased fluid adjacent to the staple line, concerning for leak/impending rupture.

removed. Tube removal occurred after a mean of 33.6 days (range 3–78 days) in this subgroup.

Gastrostomy placement for RYGB-related malnutrition was technically successful in all 17 cases (Table 2). These patients presented months to years after surgery with chronic emesis or chronic abdominal pain causing anorexia. CT ($n = 13$) and ultrasound with fluoroscopy ($n = 4$) were used for image guidance. One patient was lost to follow-up and one patient still has a tube at this time. In the remaining 15 cases, tube removal occurred after a mean 97.7 days (range 8–239 days). Tube removal was performed after adequate oral intake was maintained.

Gastrostomy placement for nutritional support for conditions unrelated to RYGB was technically successful in 13 of 15 cases (Table 3). Case 28 was unsuccessful despite adequate insufflation due to lack of a clear access window for tube placement. Case 34 was unsuccessful due to an inability to access the gastric remnant for insufflation. Indications included ventilator-dependent respiratory failure, neurologic conditions precluding oral intake, and malnutrition secondary to malignancy. CT ($n = 9$) and ultrasound with fluoroscopy ($n = 6$) were used for imaging guidance, with case 34 failing both ultrasound with fluoroscopy and CT. Two patients were lost to follow-up, two entered into hospice care, and two cases still had the tube in place at the time of writing. For the remainder, tube removal occurred after a mean 90 days (range 4–353 days).

Gastrostomy placement to provide access for ERCP evaluation of biliary ductal dilatation occurred in one case and was performed with ultrasound with fluoroscopy guidance. A 14F gastrostomy tube was initially placed, followed by upsizing to 18F and then 24F at 2 and 4 weeks, respectively. At the time of ERCP, general surgery performed dilation of the track to 16 mm (equivalent to 48F) in the endoscopy suite. The patient developed acute pancreatitis following ERCP and the tube was removed at 149 days.

Five complications were encountered: 4 classified as ‘Major’ (9.8%) and 1 classified as ‘Minor’ (2.4%) following the Society of Interventional Radiology guidelines. The most significant major complication was early tube dislodgement in one patient with resultant intraperitoneal feeds requiring laparotomy (Fig. 2). On retrospective review, it is believed that there was a failure of gastropexy that prompted tube dislodgement and leak. Malnourished patients have reduced healing and may be at an increased risk for gastropexy failure. Upper gastrointestinal bleeding, which occurred in one patient 2 weeks following tube placement, may have been related to the procedure or may have been related to stress ulceration associated with the intercurrent illness. Early tube dislodgement requiring repeat intervention occurred in one patient. Case 23 developed intractable pain following the procedure. The gastrostomy tube was placed high in the abdomen, slightly lateral to the xyphoid process in an attempt by the interventionalist to avoid crossing a Marlex mesh-wrapped gastric pouch. Case 41 developed cellulitis approximately 1.5 months following ERCP, which resolved with antibiotics. There were no procedure-related deaths.

Discussion

Gastrostomy tubes placed by interventional radiology help to avoid the risks of surgery and general anesthesia. Radiologic gastrostomy placement in conventional anatomy is associated with a relatively low major complication rate of 5.9% [10]. Although percutaneous gastrostomy placement in RYGB anatomy is more technically challenging than cases with conventional anatomy, a significant increase in the overall rate of major complication was not encountered in our series (7.3%). No additional factors that increase risk or new risks were identified.

We encountered a group of bariatric patients requiring long-term enteral feeding for nutritional support for conditions unrelated to RYGB. Indications included ventilator-dependent respiratory failure, neurologic conditions precluding oral intake, and malnutrition secondary to a malignancy. Similar to patients treated for RYGB-related malnutrition, feeding through the gastric remnant was preferred. The gastric pouch is extremely small, typically around 30 ml just below the esophagus, and connected to the jejunum. Placing a gastrostomy tube here is contraindicated for several reasons: risk of leak, inability to bring gastric pouch up to the abdominal wall, inability to bolus feed and risk of aspiration, and no benefit in terms of absorption (gastric remnant feeds flows into duodenum and proximal small intestine that is bypassed with full absorption potential). To the best of our knowledge, no previous report has described the role and safety of gastric remnant gastrostomy for nutritional support during management of conditions unrelated to a patient's RYGB.

Delayed gastric remnant emptying and biliopancreatic limb obstruction may develop in the early (days to weeks) or late postsurgical period. In the early postsurgical period, this complication may arise from ileus or mechanical obstruction secondary to adhesions, internal hernia, or hemorrhage or edema at the enteroenterostomy. If left untreated, the resultant high intraluminal pressures may result in ischemia, anastomotic/staple line disruption with leak, or perforation (Fig. 3). Anastomotic or staple line leaks are one of the most serious complications following RYGB with a mortality rate approaching 50% [11–13]. Findings of delayed gastric remnant emptying and biliopancreatic limb obstruction on radiographs and CT scans include distention of the remnant stomach and biliopancreatic limb with occasional air fluid levels [14, 15].

RYGB-related malnutrition develops later in the postsurgical period (months to years) and may be a consequence of chronic abdominal pain causing anorexia, chronic emesis, stomal stenosis, or stomal ulceration. Stomal stenosis typically occurs at the gastrojejunal anastomosis with an estimated incidence of 4%–27%, while marginal ulcers at the anastomosis can occur in up to 16% of patients [16]. Enteral feeding through the excluded remnant is the preferred route for treating protein–calorie and vitamin deficiencies until oral intake is tolerated.

Remnant gastrostomy placement for access to allow for a transgastric ERCP has been described in the literature previously [17]. Tekola et al. described the placement of a surgical gastrostomy tube and performance of ERCP through the healed, mature gastrostomy tract. Additionally, gastrostomy placement may also allow for transgastric endoscopic evaluation of RYGB postoperative bleeding or stress ulceration. Although not observed in our patient cohort, remnant gastrostomy placement may be applicable for venting in the setting of malignant gastric outlet or bowel obstruction.

The type of imaging guidance utilized is dependent on pre-procedural imaging and operator experience. In cases of delayed gastric remnant emptying/biliopancreatic limb obstruction, pre-procedural imaging typically demonstrates a dilated gastric remnant, which may allow simple access using fluoroscopy alone. In cases where there is under-distension of the gastric remnant, access using ultrasound with fluoroscopy or CT is employed. Early in our series, a dedicated CT unit was not available to the vascular and interventional radiology division for procedures, and cases were typically performed using fluoroscopy or ultrasound with fluoroscopy. When our division gained access to a dedicated scanner for procedures, most cases were performed using CT.

Our study is limited by retrospective design and a small patient cohort from a single institution. Other limitations include potential lack of notification of complications although we have a large health system with several hospitals and an interconnected electronic medical record. However, we believe that percutaneous gastric remnant gastrostomy placement is a safe and reliable procedure in patients with a history of RYGB. Indications for placement included delayed gastric remnant emptying/biliopancreatic obstruction, malnutrition related to RYGB, nutritional support for conditions unrelated to RYGB, and access to allow for transgastric ERCP. As the RYGB population increases and ages, obtaining and maintaining access to the gastric remnant is likely to become an important part of interventional radiology's role in the management of the bariatric patient.

Compliance with ethical standards

Conflicts of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required.

References

1. Tice JA, Karliner L, Walsh J, Petersen AJ, Feldman MD (2008) Gastric banding or bypass? A systematic review comparing the two most popular bariatric procedures. Am J Med 121:885–893. doi:10.1016/j.amjmed.2008.05.036
2. Reames BN, Finks JF, Bacal D, Carlin AM, Dimick JB (2014) Changes in bariatric surgery procedure use in Michigan, 2006–2013. JAMA 312:959–961. doi:10.1001/jama.2014.7651
3. Ponce J, Nguyen NT, Hutter M, Sudan R, Morton JM (2015) American Society for Metabolic and Bariatric Surgery estimation of bariatric surgery procedures in the United States, 2011–2014. Surg Obes Relat Dis 11:1199–1200. doi:10.1016/j.soard.2015.08.496
4. Carlin AM, Zeni TM, English WJ, et al. (2013) The comparative effectiveness of sleeve gastrectomy, gastric bypass, and adjustable gastric banding procedures for the treatment of morbid obesity. Ann Surg 257:791–797. doi:10.1097/SLA.0b013e3182879ded
5. Kurzynske FC, Romagnuolo J, Brock AS (2015) Success of single-balloon enteroscopy in patients with surgically altered anatomy. Gastrointest Endosc 82:319–324. doi:10.1016/j.gie.2015.01.017
6. Attam R, Leslie D, Freeman M, Ikramuddin S, Andrade R (2011) EUS-assisted, fluoroscopically guided gastrostomy tube placement in patients with Roux-en-Y gastric bypass: a novel technique for access to the gastric remnant. Gastrointest Endosc 74:677–682. doi:10.1016/j.gie.2011.05.018
7. Nosher JL, Bodner LJ, Girgis WS, et al. (2004) Percutaneous gastrostomy for treating dilatation of the bypassed stomach after bariatric surgery for morbid obesity. AJR Am J Roentgenol 183:1431–1435. doi:10.2214/ajr.183.5.1831431
8. Stein EG, Cynamon J, Katzman MJ, et al. (2007) Percutaneous gastrostomy of the excluded gastric segment after Roux-en-Y gastric bypass surgery. J Vasc Interv Radiol 18:914–919. doi:10.1016/j.jvir.2007.03.001
9. Sacks D, McClenny TE, Cardella JF, Lewis CA (2003) Society of interventional radiology clinical practice guidelines. J Vasc Interv Radiol 14:S199–S202
10. Wollman B, D'Agostino HB, Walus-Wigle JR, Easter DW, Beale A (1995) Radiologic, endoscopic, and surgical gastrostomy: an institutional evaluation and meta-analysis of the literature. Radiology 197:699–704. doi:10.1148/radiology.197.3.7480742
11. Griffith PS, Birch DW, Sharma AM, Karmali S (2012) Managing complications associated with laparoscopic Roux-en-Y gastric bypass for morbid obesity. Can J Surg 55:329–336. doi:10.1503/cjs.002011
12. Ballesta C, Berindoague R, Cabrera M, Palau M, Gonzales M (2008) Management of anastomotic leaks after laparoscopic Roux-en-Y gastric bypass. Obes Surg 18:623–630. doi:10.1007/s11695-007-9297-6
13. Papasavas PK, Caushaj PF, McCormick JT, et al. (2003) Laparoscopic management of complications following laparoscopic Roux-en-Y gastric bypass for morbid obesity. Surg Endosc 17:610–614. doi:10.1007/s00464-002-8826-6
14. Scheirey CD, Scholz FJ, Shah PC, et al. (2006) Radiology of the laparoscopic Roux-en-Y gastric bypass procedure: conceptualization and precise interpretation of results. Radiographics 26:1355–1371. doi:10.1148/rg.265055123
15. Merkle EM, Hallowell PT, Crouse C, Nakamoto DA, Stellato TA (2005) Roux-en-Y gastric bypass for clinically severe obesity: normal appearance and spectrum of complications at imaging. Radiology 234:674–683. doi:10.1148/radiol.2343030333
16. Hernandez J, Boza C (2016) Novel treatments for complications after bariatric surgery. Ann Surg Innov Res 10:3. doi:10.1186/s13022-015-0021-2
17. Tekola B, Wang AY, Ramanath M, et al. (2011) Percutaneous gastrostomy tube placement to perform transgastrostomy endoscopic retrograde cholangiopancreaticography in patients with Roux-en-Y anatomy. Dig Dis Sci 56:3364–3369. doi:10.1007/s10620-011-1743-6