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RESEARCH HIGHLIGHT

A simplified stent-bridging pancreaticogastrostomy during pancreaticoduodenectomy: How I do it

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Abstract

Background Pancreaticoduodenectomy (PD) remains the standard approach for benign or malignant disease in the pancreatic head and periampullary regions. Despite attempts of diverse pancreatic anastomosis, no reliable pancreatic anastomosis has been recommended.

Methods Between July 2023 to December 2023, a novel method of pancreaticogastrostomy (PG) using a stent bridging the remnant pancreas and the stomach were applied to drain the pancreatic juice into the gastric cavity in 12 consecutive open and laparoscopic cases. The surgical details and postoperative outcomes were analyzed to evaluate this method.

Results The mean operation time was 318 ± 51.60 min. The mean time for the stent-bridging PG was 25.90 ± 4.86 min. No incidence of grades B or C postoperative pancreatic fistula (POPF) or anastomotic failure was occurred during the median follow-up period of 10.20 ± 1.55 months.

Conclusion The stent-bridging PG had the advantages of safety, simplicity and promising efficacy by complete diversion of pancreatic juice and minimal manipulation of the pancreatic remnant under open or laparoscopic PD, proving its value as an alternative technique for mitigating the risk of POPF. By understanding the standardized procedures, surgeons can achieve consistent and reproducible results in complex pancreatic anastomosis. However, further evaluation with clinical trials is required to validate its real benefits.

Keywords Pancreaticoduodenectomy · Pancreatic anastomosis · Pancreaticogastrostomy · Postoperative pancreatic fistula · Stent-bridging

Introduction

Clinically relevant postoperative pancreatic fistula (POPF) remains the most dreadful complication following pancreaticoduodenectomy (PD), as it can lead to intraabdominal infection, hemorrhage, and ultimately life-threatening consequences [1]. The surgical community has engaged in intense debate over the past decades regarding the optimal reconstruction method to reduce the risk of POPF after PD. Despite various pancreatico-enteric anastomosis techniques, such as pancreaticojejunostomy (PJ) and pancreaticogastrostomy (PG), being employed to reduce the incidence and severity of POPF [2], there seems no consistently reliable method, and a simple, practical, and safe management protocol remains elusive [3]. Here we introduced a novel method of PG using a stent bridging the remnant pancreas and the stomach, so as to drain the pancreatic juice into the gastric cavity. We evaluated the feasibility, safety, and potential effectiveness of this approach in 12 consecutive open or laparoscopic cases.

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Methods

Patients

The stent-bridging PG was used in 12 consecutive open/laparoscopic cases for periampullary neoplasms from July 2023 to December 2023. Patients' demographics, intraoperative data, and the incidence of POPF as defined by the International Study Group of Pancreatic Surgery (ISGPS) [4], length of hospital stay, and radiographic findings were evaluated. The occurrence of major complications was evaluated with definition according to the system put forward by the ISGPF [5], or a Clavien-Dindo score of III or higher [6]. All procedures were performed by an experienced surgeon, who designed the technique (Q. L).

Surgical technique

All patients underwent subtotal stomach-preserving PD, followed by the reconstruction phase. Firstly, the bilioenteric anastomosis was performed approximately 3–5 cm distal to the blind end of the jejunum in a retrocolic fashion. Secondly, the gastrojejunostomy was performed approximately 65–70 cm distal to the hepaticojejunostomy in an antecolic fashion. Then, a Braun jejunojejunostomy (side-to-side anastomosis of afferent and efferent loops) 20 cm from gastrojejunostomy site was added to prevent bile reflux gastritis. No signs of regurgitation were observed postoperatively. Ultimately, the novel PG anastomosis technique, called "the stent-bridging PG" was performed. The key steps were detailed below:

Pancreas mobilization, pancreatic duct stenting and wrapping

Initially, the pancreatic stump was isolated for 2 cm to facilitate the construction of the PG anastomosis, after which the stomach was pulled up to expose posterior surface. A compatible polyethylene catheter (usually 6–10 Fr) with lateral orifices was positioned in the Wirsung duct, aiming to direct the pancreatic juice into the gastric lumen (Figs. 1a and 2a). For a small duct of 1 mm, we used an improved peridural catheter. We usually wrapped the stump of the gastroduodenal artery and pancreatic remnant using the falciform ligament and round ligament (Figs. 1b and 2b). At the beginning, the falciform ligament and round ligament were meticulously mobilized from the ventral abdominal wall and liver surface, and the peritoneum on one side of ligament was incised along the longitudinal axis. Then, both the GDA and the pancreatic stump were carefully inserted into the designated notch. The falciform ligament wrap was then secured in position using two to three single stitches. Continuous suture of the whole pancreatic stump was performed to achieve remnant hemostasis and secure the pancreatic duct stent (Figs. 1c and 2c). The main pancreatic duct and the stent were closely tied with nonabsorbable suture acrossing the pancreatic parenchyma, for the sake of prevention of stent dislodging, and side leakage of pancreatic juice.

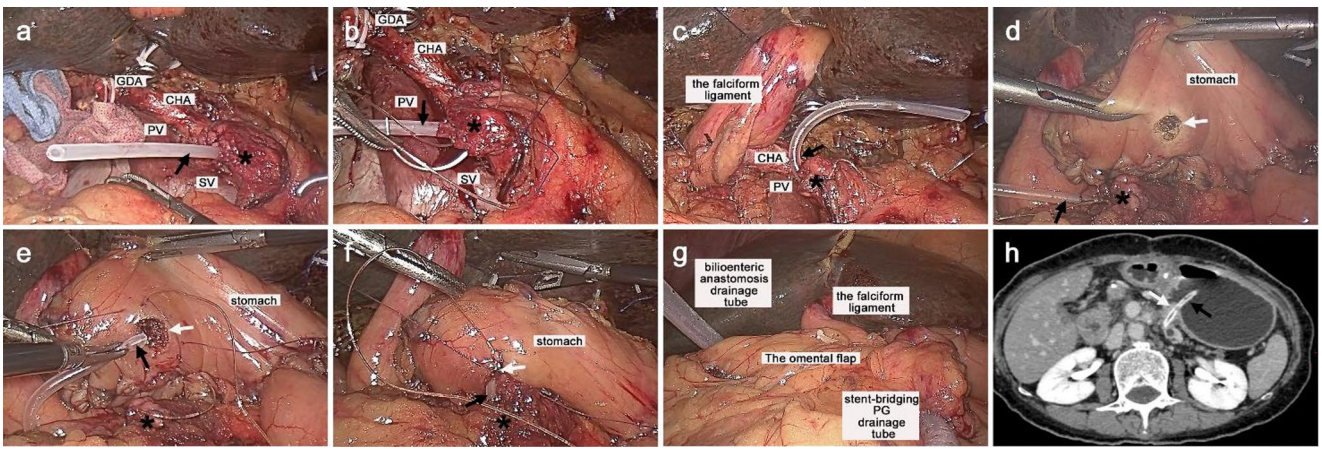

Fig. 1 Laparoscopic stent-bridging PG. **a** The Wirsung duct was cannulated with a compatible polyethylene catheter as stent (black arrow). **b** Continuous suture of the whole pancreatic stump (black asterisk) was performed. **c** The stump of the gastroduodenal artery and pancreatic stump were wrapped using the falciform ligament and round ligament. **d** A point-like full-layer hole by electrocoagulation (white arrow) matching the position of the Wirsung duct was made on the posterior wall of the stomach. **e** Only the compatible polyethylene catheter (black arrow) was inserted into the gastric lumen. **f** Two seromuscular purse-string sutures were applied around the incision for fixation and the gastric lumen was gently pulled closely adjacent to the pancreatic remnant. **g** The omental flap, along with portions of the preperitoneal fat, was localized and two easy-flow drains were placed in the proximity of the pancreatic and biliary anastomoses. **h** The postoperative CT scan confirmed optimal positioning and secure fixation of the stent, with no evidence of specific abnormalities around the anastomosis. Compatible polyethylene catheter (black arrow); pancreatic stump (black asterisk); point-like electrocoagulation (white arrow)

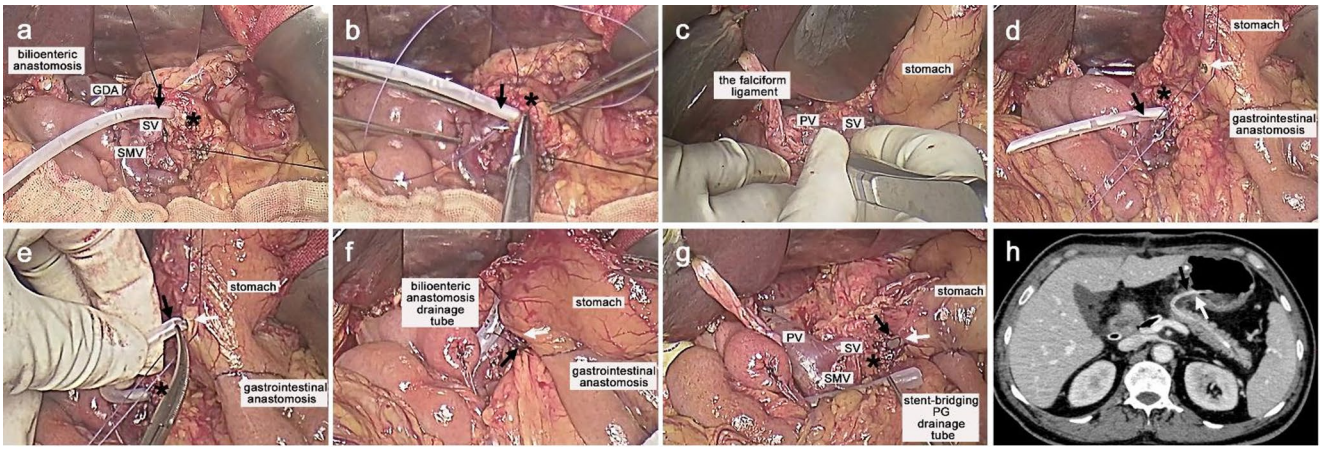

Fig. 2 Open stent-bridging PG follows a standardized procedure akin to a laparoscopic approach

Gastric incision, purse-string suture and stent-bridging

A full-layer hole approximately equivalent to the caliber of the pancreatic duct stenting catheter was made on the posterior wall of the stomach directly above the pancreatic stump to ensure a tight bridging. Two seromuscular purse-string sutures were applied around the incision for fixation. (Figures 1d and 2d) Then, the distal end of stent was inserted into the gastric lumen as an internal drainage (Figs. 1e and 2e). The stomach was pulled down to fixed closely adjacent to the pancreatic remnant. Ideally, the pancreatic stump and the gastric wall were drawn close allowing the gastric wall as a serosal envelope to protect the anastomosis (Figs. 1f and 2f). Subsequently, the two purse-string sutures were tightened with proper tension to prevent pancreatic stent occlusion, thus the procedure of the stent-bridging PG completed. As such, the thick gastric wall with excellent suture retention had a generous blood supply and was less likely than the jejunum to develop ischemic complications.

Peripancreatic localizing and drainage

Finally, the omental flap, along with portions of the preperitoneal fat, was utilized to localize the anastomotic site to completely drain the pancreatic fluid in case of pancreatic leakage. Two easy-flow drains were placed in the proximity of the pancreatic and biliary anastomoses. (Figures 1g and 2g)

Perioperative management

Perioperative management under the ERAS protocol was standardized. All patients received preoperative counselling, pre-rehabilitation, and enteral nutritional support. For elderly patients, especially those with malnutrition and frailty, a jejunostomy tube is typically placed intraoperatively to facilitate early initiation and adequate provision of enteral nutrition, thereby potentially reducing the length of hospital stay. For other patients, a nasojejunal tube is placed. After surgery, no prophylactic octreotide was used, and early tube removal were routinely administered including nasogastric and intra-abdominal drainage tubes. The nasogastric tube was removed within 3 days after surgery if gastrointestinal function is initially restored and the daily output was less than 200mL, and intra-abdominal tubes were removed if there was no measurable drain fluid or the amylase level was less than 3 times the upper limit of normal after postoperative day 3 [2, 5]. A nasojejunal or jejunostomy liquid diet was resumed gradually from postoperative day 1 in the absence of clinical concerns for delayed gastric emptying. Drain fluid amylase was measured on postoperative day 1, 3 and 5. We routinely perform a plain CT at 4th day and an enhanced CT at 7th day postoperatively. In addition to determining the location of the tube, attention must be paid to early postoperative complications such as signs of peripancreatic fluid collection, intra-abdominal infection, ascites, and hydrothorax. These factors are crucial in assessing the postoperative complications. Due to the specific nature and novelty of this technique, long-term follow-up is essential to ensure secure fixation of the stent and to prevent delayed complications, such as anastomotic failure. PG anastomotic failure may potentially require intervention, presenting as pancreatic ductal blockage, stent displacement or even gastric fistula on imaging and in clinical presentation.

Results

The demographics and operative outcomes were listed in Table 1. Of the 12 continuous cases undergoing the stent-bridging PG procedures, all experienced uneventful recovery

Table 1 Patient's characteristics and postoperative complications

Variables	The stent-bridging PG ($N=12$)
Gender (male/female)	6:6
Age (years)	60.60 ± 15.38
Pathological types	
Pancreatic head carcinoma	6
Duodenal papillary carcinoma	3
Distal cholangiocarcinoma	3
Main pancreatic duct diameter (mm)	3.00 ± 1.25
Pancreatic texture (hard/soft)	7:5
Portal vein resection/reconstruction	4
Postoperative pancreatic fistula	
Biochemical leak	3
Clinically relevant Grade B/C POPF	0
Anastomotic failure	0
Follow-up (mo)	10.20 ± 1.55

and no incidence of grades B or C POPF was occurred. No major complications defined by the ISGPF criteria [5], or classified as Clavien-Dindo grade III or higher [6], were observed. During the follow-up, the stent was closely monitored, and no intervention was performed during the median follow-up period of 10.20 ± 1.55 months. The postoperative CT scan confirmed optimal positioning and secure fixation of the stent, with no evidence of fluid around the anastomosis, peripancreatic exudation or pancreatic duct dilatation. In 1 patient, the stent was found to fall off spontaneously without secondary pancreatitis, which was the only stent-related event.

Discussion

PD is a complex surgical procedure associated with high morbidity and mortality rates. The pancreatic anastomosis has widely been regarded as the 'Achilles heel' of PD, and the optimal methodology for reconstruction remains an area requiring further investigation. In general, adherence to the principles of anastomotic reconstruction and the execution of a safe, reliable, and reproducible anastomosis with a low clinically significant POPF rate remained critical for achieving optimal outcomes [7].

From a pathophysiological perspective, the elevated intraluminal pressure within the jejunal loop, coupled with the detrimental impact of activated pancreatic enzymes on an immature anastomosis during conventional digestive tract reconstruction, may progressively result in severe POPF due to autodigestion [8]. Thus, the stent-bridging PG could effectively achieve complete diversion of pancreatic juice, thereby preventing the accumulation of pancreatic leakage and the activation of pancreatic enzymes within the jejunal lumen, which subsequently disrupted the pathophysiologic cascade of events [9]. It was also hypothesized that POPF may result from inadvertent penetration of a pancreatic duct or laceration of the fragile pancreatic parenchyma during suturing or knot-tying procedures [10]. Thus, duct-to-mucosa anastomosis presented challenges when dealing with a soft, friable, and fatty pancreas with a small duct. Meanwhile, the invagination technique revealed no significant superiority in decreasing the risk of POPF owing to the ischemia of pancreatic stump or pancreatic duct occlusion. As such, the stent-bridging PG might eliminate potential risks of parenchymal fracture secondary to knot-tying or excessive manipulation of the pancreatic remnant. Furthermore, it was unnecessary to conduct a distal gastric stump opening or an anterior gastrostomy.

Overall, the stent-bridging PG procedure greatly simplifies the reconstruction procedure while maintaining safety and stability, either under open or laparoscopic PD. In spite of extensive research on the risk factors for POPF, which has yielded seemingly contradictory and complex findings regarding anastomotic techniques and operative duration, prior risk models have demonstrated limited efficacy and may lead to inaccurate estimations [11]. No anastomotic failure has been observed during long-term follow-up. In our view, PG anastomotic failure refers to pancreatic ductal blockage, stent dislocation, or even gastric fistula on imaging, which may require clinical intervention. We believed that the simplified construction of the pancreatic anastomosis might enhance therapeutic efficacy by reducing operative time and minimizing intraoperative trauma, particularly in cases involving friable pancreatic tissue.

Due to the intricate nature of the procedure, the ongoing debate surrounding surgeons' experience in clinical trials and dissemination was impeded by learning curves and suboptimal early outcomes [12]. The stent-bridging PG simplified the anastomosis, thereby enhancing ease of performance and replicability as a stable process, particularly during the initial learning phase.

Conclusion

The novel approach of the stent-bridging PG preliminarily proved its potential as a standardized method under open or laparoscopic PD. It may reduce risks of POPF by completely diverting pancreatic juice, preventing the accumulation of pancreatic leakage and the activation of pancreatic enzymes, and disrupting the pathophysiologic cascade of events. Compared with conventional duct-to-mucosa anastomosis, the stent-bridging PG reduced manipulation of the pancreatic remnant and associated potential risks. Notably, the stent-bridging PG simplified the anastomosis, thereby

enhancing ease of widespread implementation. By adhering to these standardized protocols, surgeons can simplify surgical procedures, including those for complex pancreatic conditions. This systematic approach not only ensured surgical outcomes and safety but also enhanced consistency and reproducibility of results.

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Author contributions Q. L. and L. D. contributed to the conception and final approval of the study. Y. S. and Z. W. contributed to analysis and manuscript preparation. K. L. and L. C. and J. W. contributed to acquisition and interpretation of data. All authors read and approved the manuscript.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Ethical approval This study was reviewed and approved by the Ethics Committee of Guang'anmen Hospital (approval no. 2023-022-KY-01), and informed consent was obtained from all individual participants included in the study.

Competing interests The authors declare no competing interests.

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