ABSTRACT

Objective: Pancreatic fistula remains the single most important cause of morbidity following Pancreatoduodenectomy (PD) and perhaps contributes most to increased mortality. Pancreatogastrostomy (PG) has been used by many surgeons in recent years because of its theoretical advantages over Pancreatojejunostomy (PJ). In this study, we analysed the outcome of modified binding PG technique following PD.

Methods and Material: 20 consecutive patients were studied from April 2013 to March 2015 all of whom underwent binding PG after PD, where a single purse-string suture was taken on the posterior wall of the stomach with additional four mucosal corner sutures thereby creating a Pancreato-gastric anastomosis.

Results: We prospectively analysed patient characteristics, perioperative outcomes and surgical results. In this average study age was 50.9 years with body mass index 21.5±2.6 kg/ m². All patients underwent standard PD and meant operative time was 377.5±44.14 minutes. The mean operative time taken to complete pancreatogastrostomy after complete mobilisation of the pancreatic stump was 9.2 minutes(range 7-11minutes). Mean hospital stay was 16.55±3.83 days (range, 8 to 21 days). Postoperative mortality was 5% (n=1) due to pneumonitis. Only two patients developed Grade A pancreatic fistula, which were managed conservatively. One patient had postoperative haemorrhage, and four patients developed delayed gastric emptying (DGE).

Conclusion: Results of our study are auspicious, proving that modified binding PG is a simple, fast and safe reconstruction procedure after PD. However, to determine its superiority over conventional PG, this procedure needs to be more comprehensively evaluated in a larger group of patients.

KEYWORDS: Pancreatodudenectomy, pancreatic fistula, pancreatogastrostomy

Introduction:

Pancreatodudenectomy ranks as one of the most complicated and technically demanding surgical procedures in surgical armamentarium. In most of the recent series, mortality has decreased substantially, but morbidity rate remains high (30-50%), even at high volume centres [1-2]. The critical step in pancreatic surgery is no more extended resection itself but reconstruction of the pancreateoenteric anastomosis. Postoperative pancreatic fistula (POPF) is one of the most feared complication after PD with an incidence ranging 5-30%[3]. Various reconstruction techniques have been evaluated with the aim to reduce the incidence of POPF, but none has been demonstrated to be superior compared
to others. Based on results of recent randomised clinical trials PG has been advocated as procedure associated with lower postoperative complications, mortality and pancreatic fistula rates than PJ[4-9]. Several PG anastomotic technique has been published: duct to mucosa anastomosis, binding PG using two purse-string sutures, or one binding purse-string with two transfixing mattress sutures, one continuous seromuscular suture and various other techniques with minor variations[9-13,p]. In this present study, we describe our reconstruction method with minor modification to previously described techniques of binding pancreatogastrostomy (BPG), consisting of full-thickness purse string suture in the posterior gastric wall and addition of 4 corner sutures placed between mucosa of posterior gastric wall and pancreas, which we now use as standard method for reconstruction after PD. Our preliminary results in twenty patients are presented.

Patients and methods:
This retrospective descriptive survey of anastomotic technique included 20 patients who underwent PD with binding PG between December 2013 to December 2015. The institutional ethical board approved the study. Patients demographics, the texture of pancreas, complications, hospital mortality, hospital stay, postoperative interventional procedures and re-explorations were prospectively documented.

Surgical technique:
After PD, any bleeding from the cut surface of the pancreatic stump was stopped by bipolar electrical coagulation or fine suture ligation and then the pancreatic remnant was mobilised to provide minimum 3 to 5 cm stump for burying into the stomach without undue tension. The distal pancreatic stump was transfixated at its cranial and caudal end with two 3/0 polypropylene suture. A polyethylene 5 cm feeding tube, 5.0 or 7.5 French was introduced into main pancreatic duct depending on its diameter to ensure its patency. A 5-cm longitudinal incision was created in the anterior gastric wall proximal to the antrum. Transverse full thickness incision was made on the posterior wall of the stomach with a length of at the most 2/3d the diameter of the pancreatic stump, to ensure tight adherence of the gastric wall to the pancreatic remnant after completion of binding. The appropriate position of the incision was selected so that the stomach can be pushed over the pancreatic stump without tension. A full thickness purse-string suture was taken with polypropylene 2-0 on the posterior wall around the incision. The posterior stomach wall was then pushed over the pancreatic remnant. This manoeuvre was performed very gently to ensure tight wrapping of the posterior gastric wall around the pancreatic remnant and to avoid laceration of the pancreas. Ideally, the pancreatic remnant should protrude above the posterior gastric wall by 2-3 cm. The purse-string suture was then tightened. The feeding tube in the pancreatic duct was removed after ensuring patency of duct. Afterwards 4 point sutures of 4-0 polypropylene were placed between the mucosa of the posterior gastric wall and the pancreas. Finally the pancreatic remnant was checked for any minor bleeding. A nasogastric tube was positioned just above the PG. Bilioenteric reconstruction was done with the jejunal limb as an end to side hepaticojejunostomy followed by the side to side gastrojejunostomy with anterior gastrostomy site and then feeding jejunostomy.

All patients were treated by a standardised protocol including inj. Octreotide 100µg before the pancreatic transaction, 100µg s/c 8 hourly for next five days and proton pump inhibitors as prophylaxis against stress and marginal ulceration. The output from operatively placed drain was recorded daily and amylase level estimated on day three to five. The volume and the amylase activity of the drainage fluid was measured on postoperative day 3,4 and 5. The drain was removed when amylase level 3 times below normal serum amylase level was achieved without any suspicious contents irrespective of volume. As we were assessing particular technique of pancreatic-enteric anastomosis, the primary endpoint was pancreatic fistula rate. Other issues evaluated were an intraabdominal complication, i.e. biliary digestive tract fistula, intraabdominal collection, intraabdominal or digestive tract haemorrhage. Pancreatic, biliary fistula and post pancreatectomy haemorrhage was defined as per definition by ISGPS. Delayed gastric emptying was defined as being present when the postoperative nasogastric tube was required for more than ten days, or patient is unable to tolerate standard oral feed on or after ten days.

Results:
The study consisted of 20 consecutive patients undergoing PD with this new technique. The technique was developed and performed in all patients by the senior author (RG). Data of patients operated on were collected in a prospectively maintained database and were retrospectively reviewed for this study. There were 11 male and nine female patients, with an average age of 50.9 years (range, 32 to 74 years) and their average body mass index was 21.5±2.6 kg/m² (range, 18.8 - 23.6 kg/m²). Nineteen patients were operated for carcinoma pancreas and one patient for a traumatic pancreateoduodenal laceration. All PDs were

Abbreviations
PD = Pancreateoduodenectomy
POPF = Postoperative pancreatic fistula
PG = Pancreatogastrostomy
PJ = Pancreatejunostomy
POD = Post operative day

Figure 1: purse string suture in the post.
Whipple procedure. Of the 20 patients, nine patients had a soft pancreatic texture, and 11 patients had a firm pancreatic texture. Sixteen patients had main pancreatic duct diameter >3 mm and four patients had diameter <3 mm. The mean operative time for the complete procedure was 377.5 ± 44.14 minutes (range, 240 to 435 minutes). The mean operative time taken to complete pancreatogastrostomy after complete mobilisation of the pancreatic stump (from incision of gastric wall to completion of mucosal corner suture) was 9.2 minutes (range 7-11 minutes). Mean hospital stay was 16.55 ± 3.83 days (range, 8 to 21 days). The mean time of drain removal was 8.26 ± 2.1 days. The mean time to start orally was 8.73 ± 2.13 days. Two patients underwent re-exploration in the postoperative period. One patient operated for delayed intraluminal haemorrhage on POD 7. Operative findings revealed arterial bleeding present in the pancreatic stump and were managed with gastrotomy with ligation of bleeding artery and patient made an uneventful recovery. Another patient who was known case of ischaemic heart disease was re-explored on POD2 for persistent hypotension and tachycardia. On exploration was found to have multiple gangrenous patches in the caecum and ascending colon, probably secondary to the thromboembolic phenomenon and required right hemicolec- tomy. However patient expired on POD 9 due to pneumonia and respiratory failure. The most frequent complication in our study was delayed gastric emptying that occurred in 4 patients. POPF occurred in two patients both in soft texture pancreas. According to ISGP fistula definition, both patients had Grade A pancreatic fistula and were managed conservatively. All drains were eventually removed by POD7. All patients were followed up in an outpatient clinic with periodic physical examination, endoscopy and CT/MRI if indicated. What Median follow up was 18 months (range 12-30 months). Fourteen of 20 patients who underwent an endoscopic evaluation at 6 and 12 months showed healthy pancreatic stump.

### Table 1 Peroperative surgical findings

| Variable                          | value       |
|-----------------------------------|-------------|
| Operative time (min) (mean±SD)    | 377.5 ± 44.14 |
| Time to complete BPG (minutes)    | 9.2         |
| Transfusion (unit) (Mean±SD)      | 1.35 ± 0.81  |
| Type of surgery (No. of patients) | Classical = 20 (100%) |
|                                  | PPPD = 0    |
| Tumor size (cm) (mean±SD)         | 3.58 ± 1.73  |
| Pancreatic duct diameter >3 mm    | 16 (80%)    |
| Pancreatic duct diameter >3 mm    | 4 (20%)     |
| Venorrhaphy (SMV/PV)              | 10%         |
| Texture of pancreas               | Soft = 9 (45%) |
|                                  | Hard/fibrotic = 11 (55%) |

### Discussion:

The pancreateoenteric anastomosis is entirely different from commonly done enteroenteric anastomosis between two hollow vis- cera such as gastrojejounostomy (GJ), jejunojejounostomy or colo-
proximity of pancreas to the posterior wall of stomach hence
physiological and technical advantages of performing PG over
PJ in more than a dozen retrospective studies which almost
the pancreatic stump. The findings of PG have been compared
anastomosis. PG anastomosis is easily accessible endoscopi-
for continuous emptying of the stomach thus less tension on the
anastomotic healing. Nasogastric decompression provides
less tension on the anastomosis, excellent blood supply and
further consequences in case of minor leaks. Also, alkaline pan-
enzymes seems to prevent autodigestion of the anastomosis and
trypsin and the subsequent activation of other proteolytic
in the stomach which is required for conversion of trypsinogen
to trypsin and the subsequent activation of other proteolytic
enzymes to enzymes enterokinase
vates pancreatic enzymes. Further, lack of enzyme enterokinase
other reasons, more than 80 technical variations of pancreatoenteric
anastomosis have been described, and no firm conclusion can
be drawn about the safest technique. First reported in 1946,
PG has been established as a secure method of anastomosis as
an alternative to the standard PJ. There are various theoretical,
physiological and technical advantages of performing PG over
PJ[14,15]. A physiologic advantage is that gastric acid inactiv-
ates pancreatic enzymes. Further, lack of enzyme enterokinase
in the stomach which is required for conversion of trypsinogen
to trypsin and the subsequent activation of other proteolytic
enzymes seems to prevent autodigestion of the anastomosis and
further consequences in case of minor leaks. Also, alkaline pan-
creatic secretions may aid in preventing marginal ulceration. The
proximity of pancreas to the posterior wall of stomach hence
less tension on the anastomosis, excellent blood supply and
thickness of stomach wall holding sutures well are favourable
to anastomotic healing. Nasogastric decompression provides
for continuous emptying of the stomach thus less tension on the
PG anastomosis, a benefit not possible with a pancreaticojejunual
anastomosis. PG anastomosis is easily accessible endoscopi-
cally and so can be evaluated later for long-term outcome of the
pancreatic stump. The findings of PG have been compared
to PJ in more than a dozen retrospective studies which almost
invariably have demonstrated the superiority of PG. A recent
meta-analysis has reported that average pancreatic fistula rate
was significantly lower (3.7%) after PG than PJ (16.5%) with
a significant difference in mortality of 3% after PG compared
with 9% after PJ and lower intra-abdominal complications than
PJ[16-17].

Ohigashi and Peng have described new modified techniques
describing the theoretical advantages of binding and transfixing
modifications[18,19]. Bartsch reported another new technique
for PG, which combines one binding purse-string and two trans-
fixing mattress sutures between the pancreatic stump and the
posterior gastric wall. These transfixing sutures techniques still
require transpancreas sutures. Every suture carries the risk for
pancreatic laceration resulting in pancreatic leakage, especially
in a fragile and soft pancreatic remnant[20]. Peng et al. in-
troduced four types of binding PG using binding purse-string
without transpancreatic sutures. In Types, I and II the sutures
were placed in the mucosal layer through an opening in the ante-
rior gastric wall or the sealed distal gastric stump. However, this
technique was not comfortable for surgeons and prolonged the
operation time. Types III and IV were designed to avoid opening
the anterior gastric wall or the sealed distal gastric stump,
and, instead, the binding anastomosis was performed behind
the posterior stomach wall directly. However, this was neither
an easy nor was a safe procedure to place the inner suture.

The ideal pancreatic reconstruction should be easy to per-
form, reproducible and characterised by the lowest possible leak
rate. Kostov et al. described a new technique for pancreato-
gastrostomy using one continuous seromuscular circular suture
without transpancreatic sutures for PG[21]. In our view, this
sero-
muscular approach in the stomach does not guarantee adequate
hemostasis from the highly vascular gastric mucosa. We started
doing binding PG with a full thickness purse-string suture on the
posterior gastric wall that ensures the proper haemostasis from the
posterior gastric wall. To minimise the pancreatic laceration
during suturing with a needle or tightening of the suture thread,
we introduced 4 points fine suture with the pancreatic capsule
and gastric mucosa only. The approach of binding PG in our tech-
nique via the gastrotomy in the anterior gastric wall provides an
excellent field of vision, enabled us to inspect bleeding points in
the pancreatic stump after completion of the anastomosis and
consequently much easier GJ anastomosis with anterior gas-
troscopy site. The pancreatic stump is sufficiently invaginated
into the gastric lumen, and this guarantees adequate drainage of
the pancreatic juice secreted from the accessory pancreatic
ducts on the cross-section planes. The main pancreatic duct was
cannulated using a short internal stent during the anastomosis
to ensure that purse string is not too tight enough to obliterate
the duct. Additional mucosal sutures are taken at the corners
between the capsule of pancreatic stump and gastric wall secure
the stump firmly within the stomach. Binding PG can be safely
done in all pancreatic stumps irrespective of the diameter of duct
or texture of pancreatic parenchyma. The percentage of pancre-
atic leak varies from 0-16%, and mortality varies from 0-12.3%
in various RCTs and observational studies. Although small in
numbers, the pancreatic leak of 10%(grade A only) and mortal-
ity of 5% in the present study is comparable to world literature.
Postoperative haemorrhage developed in one patient only(5%),
similar incidence has been described by others in literature.

| Postoperative complications | Number of patients | % |
|-----------------------------|-------------------|---|
| Mortality                   | 1                 | 5%|
| Pancreatic fistulas         | 2                 | 10%|
| Grade A                     | 2                 | 10%|
| Grade B                     | 0                 | 0% |
| Grade C                     | 0                 | 0% |
| DGE                         | 4                 | 20%|
| Postoperative hemorrhage    | 1                 | 5% |
| Reoperation                 | 2                 | 10%|
| Bile Leak                   | 0                 | 0% |
| Surgical Site Infection     | 0                 | 0% |
| Intra abdominal bleed       | 0                 | 0% |
| Intra abdominal collection  | 0                 | 0% |
| Gastric leak                | 0                 | 0% |
| Post operative pancreatitis | 0                 | 0% |
| Other systemic complications| 0                 | 0% |
Conclusion:
We believe that this technique is simple, secure, and reproducible and should be part of the pancreatic surgeon armamentarium. The main advantage of our technique is the easy placement of single full-thickness perfect hemostatic purse string suture through anterior gastrostomy incision under vision, no need for gastric wall resection, no deep pancreatic parenchymal sutures and mucosal approximation with corner sutures. It has several advantages over the conventional PG. The results of this novel technique are comparable to other studies concerning mortality and morbidity. To determine its superiority over the traditional procedures, this operative technique needs to be more comprehensively evaluated in a larger group of patients for statistical significance in future.

Competing Interests
The authors declare no conflict of interest.

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