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ORIGINAL ARTICLE

# Falciform ligament flap for the protection of the gastroduodenal artery stump after pancreaticoduodenectomy: A single center experience



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## KEYWORDS

Falciform ligament flap;  
Pancreaticoduodenectomy;  
Hemorrhage;  
Pancreatic fistula

## Summary

**Aim of the study:** Delayed hemorrhage, though rare, remains a significant source of morbidity and mortality after pancreaticoduodenectomy (PD). An important cause of this delayed hemorrhage is erosion or pseudoaneurysm formation of the gastroduodenal artery (GDA) by pancreatic enzymes and adjacent intra-abdominal sepsis. So protection of the GDA stump may avoid this devastating complication.

**Patients and methods:** This is a retrospective observational study. All patients, who underwent a PD between August 2007 and December 2014, were included in the study. We used pedicled falciform ligament flap to protect the GDA stump. After PD, pedicled falciform ligament flap was spread widely over the skeletonized hepatic artery including the GDA stump and was fixed to the surrounding retroperitoneal connective tissue. This procedure allowed complete separation of the GDA stump from the pancreatic stump.

**Results:** We performed 182 cases of PD during the study period. Although, 27 (15%) patients developed pancreatic fistula and six patients developed intra-abdominal abscess, no one experienced hemorrhage due to erosion or pseudoaneurysm formation of the GDA.

**Conclusion:** The present surgical option seems to be an effective measure for the prevention of erosion and pseudoaneurysm formation of the GDA after PD.

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## Introduction

The mortality after pancreaticoduodenectomy (PD) has decreased considerably over the past decade and is currently between 0% and 5% in high volume centers [1–5]. However, the morbidity remains stubbornly high, ranging from 20% to 40% [6–8]. Pancreatic fistula, intra-abdominal abscess, delayed gastric emptying, and hemorrhage are most common complications after PD. Although delayed gastric emptying is not a lethal complication, both pancreatic fistula and hemorrhage can lead to operation-related death.

Delayed hemorrhage after PD is a less frequent but devastating complication. An important cause of this delayed hemorrhage is erosion or pseudoaneurysm formation of the gastroduodenal artery (GDA) by the pancreatic enzymes or by local sepsis resulting from the pancreatic fistula. Several methods have been used to reduce the leak rate but no one can eliminate completely the pancreatic fistula. The incidence of pancreatic fistula after PD ranges from 9% to 29% [4,9]. So, one of the important surgical options for the prevention of delayed hemorrhage after PD is the protection of the skeletonized hepatic artery and GDA stump from the leaked pancreatic secretions and intra-abdominal infection. Inspired by the work of Abe et al. [10], we adopt his method of covering the skeletonized and divided vessels with falciform ligament flap (FLF) in all the cases of PD. Herein, we present our experience with the use of falciform ligament flap after PD for the protection of GDA stump.

## Patients and methods

This is a retrospective observational study. All the patients who underwent PD between 2007 August and December 2014 were included in our study. We routinely used falciform ligament flap to cover the GDA stump. All clinical, biochemical, and radiological data were retrospectively collected from our gastrointestinal surgery database. The specific parameters of patients that were analyzed included postoperative hemorrhage, the interval between PD and bleeding, the incidence of pancreatic fistula, intra-abdominal abscess, delayed gastric emptying, operating time, duration of hospital stay, intervention to combat complications and their outcome. Written informed consent was obtained from each patient and we follow the protocol of the ethical committee of our institution.

We performed the PD by a supraumbilical transverse or bilateral subcostal incision. Self-retaining Thompson retractor was routinely used. The falciform ligament (Fig. 1a and b) was mobilized by dividing it near the umbilicus and incising its anterior peritoneal reflections along the posterior rectus sheath and the undersurface of the diaphragm. The preperitoneal fat around the ligament was preserved as much as possible. The fine vessels between the ligament and liver parenchyma were ligated and divided. With this method we achieved the length of the flap about 15 cm (Fig. 1c and d). In cases of carcinoma, we routinely performed standard lymphadenectomy and removal of soft tissue to the right side of the first 3–4 cm of the superior mesenteric artery. GDA stump was routinely transfixed with 4-0 polypropylene sutures. After removal of the specimen, hemostasis was achieved meticulously. Bleeding from the pancreatic stump was controlled with 5-0 polypropylene sutures. We then brought the falciform ligament flap to the operative field and spread it widely on the exposed vessels near the pancreatic stump, like the common hepatic

artery, gastroduodenal artery stump, portal vein, superior mesenteric vein, and the inferior vena cava (Fig. 2). The flap was then fixed with 4-0 polypropylene sutures to the surrounding retroperitoneal connective tissue (Fig. 3). This procedure allowed complete separation of these vessels from the pancreatic stump. Reconstruction was done with end-to-side pancreaticojejunostomy with 4-0 polypropylene sutures, hepaticojejunostomy with 4-0 vicryl, and gastrojejunostomy on the same jejunal loop at approximately 50 cm distal to the hepaticojejunostomy site. Closed drain was placed adjacent to the pancreaticojejunal anastomosis. Final position of the flap (Fig. 4) was checked before closure of the abdomen.

Ocreotide was not used postoperatively. We did serum and drain fluid amylase estimation on postoperative day 3 and 5. Pancreatic fistulas were diagnosed when the amylase concentration of the drain fluid obtained on day 3 were more than three times the serum amylase concentration. Pancreatic fistulas were classified as grade A, B, and C according to the definition proposed by an international study group on pancreatic fistula [11].

## Results

One hundred and eighty-two patients were included in our study. There were 121 men and 61 women, with a mean age of 47.95 years (range, 30 years to 75 years). The mobilization of falciform ligament and covering of the GDA stump was successfully performed in all the cases. The mean operating time and blood loss were 383 minutes (range 280 to 510 minutes) and 400 mL (range 200 to 1200 mL), respectively.

Pancreatic fistula developed in 27 (15%) cases; 12 had grade A fistulas, 11 had grade B fistulas, and 4 had grade C fistulas. Bile leak occurred in 7 (4%) cases. Early hemorrhage developed in 2 cases. Pancreatic remnant was the source of bleeding in one case and in another case bleeding was from a small retroperitoneal vessel. All these cases, bleeding occurred within first 24 hours and were adequately treated by re-operation. One patient developed delayed hemorrhage due to multiple erosions of gastrojejunostomy stoma site. The patient was managed by pantoprazole infusion. But, no patient developed delayed hemorrhage due to erosion of adjacent vessels or pseudoaneurysm formation. Other complications included delayed gastric emptying in 14 (8%) cases (type A-8 cases, type B-4 cases, type C-2 cases), and intra-abdominal abscess in 6 (3%) cases. The mean duration of hospital stay was 14 (range 7 to 50) days. Seven patients (4%) died from their operations because of leak related sepsis.

## Discussion

Delayed hemorrhage after pancreaticoduodenectomy (PD) is a well recognized complication. Based on the timing of bleed, hemorrhagic complications after PD can be divided into early and delayed. Early hemorrhage usually occurs within first 24 hours. It is generally related to technical failure or by an underlying perioperative coagulopathy [12]. Early bleeding in the abdominal cavity is usually managed by immediate relaparotomy. However, in case of early bleeding in the gastrointestinal tract, endoscopy plays an important role in controlling bleeding from gastrojejunostomy site or, if accessible, at the enteroenteric anastomosis [13]. Although,

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