

RESEARCH ARTICLE

Pancreatico-Gastric Anastomosis with and without Sutures – Experimental Swine Model

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Objectives. The aim of our study is to identify a surgical technical that has the lowest rate of pancreatic fistulas in pancreatico-gastric anastomosis following duodenopancreatectomies. We studied pancreatico-gastric anastomosis performed with stitches compared to the ones performed without stitches. **Methods.** Our experimental model is based on ten piglets, which were divided into 2 groups. In the first group (n=5) the pancreatico-gastric anastomosis was done using double purse-string threads one passed through the gastric seromuscular layer and one through the gastric mucosa. In the second group (n=5) the pancreatico-gastric anastomosis was performed using sutures through the stomach and pancreas. **Results.** Postoperative amylasemia was higher in the second group. In the first group no pancreatico-gastric fistulas were observed, whereas pancreatic necrosis was observed only at a superficial level of the pancreatic stump. In the second group, two cases had developed fistulas, both bordered by large areas of coagulation necrosis accompanied by pancreatic duct hyperplasia. Duration of the anastomosis was shorter for the first group. **Conclusions.** In conclusion, the pancreatico-gastric anastomosis performed using two purse-string suture is a feasible, safe and fast process.

Keywords: duodenopancreatectomy, pancreatic fistula, pancreatico-gastric anastomosis, double purse string

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Introduction

Pancreatic resection techniques and ways to restore digestive continuity had numerous changes over time. In 1909 Kausch performed the first two stage duodenopancreatectomy for a patient with carcinoma of the ampulla of Vater.

The classic procedure described by Whipple in 1935 entailed a pancreatico-jejunal anastomosis upon completing the pancreatic resection. In 1946 Waugh and Clagett performed the first pancreatico-gastric anastomosis following a cephalic duodenopancreatectomy. Thus, both pancreatic anastomosis with the jejunum and the stomach have known continuous improvements over time.

Postoperative mortality after a cephalic duodenopancreatectomy decreased greatly in recent years [1,2,3,4]. However morbidity rate remained high, between 30 and 50% [5,6]. Of all the postoperative complications the pancreatic fistula is one of the most fearsome with a rate of 3 to 36% [7,8,9]. Although no differences were observed on the rate of pancreatic fistula according to the pancreatodigestiv reconstruction [10,11,12,13,14], some authors have shown that the pancreatico-gastric anastomosis is associated with less complications [14,15,16]. It has been demonstrated that pancreatic fistula rate is higher in cases with so called "soft pancreas" and in cases where the diameter of the Wirsung duct is reduced.

Lately, anastomotic technical variations aim to traumatize as little as possible the residual pancreatic stump. This paper presents an experimental study on a swine model of the pancreatico-gastric anastomosis without sutures compared to a pancreatico-gastric anastomosis with transfixiating threads passed through the pancreas.

Materials and methods

Animals

A batch of ten female piglets, weighing between 10 and 12 kg was obtained from the Eurohyb swine farm. The animals were kept and fed according to national guidelines for care. The experimental study was approved by the Ethics Committee of the University of Medicine and Pharmacy of Tîrgu Mureș.

Fasting was established 24 hours before surgery, fluid intake was allowed up until 12 hours preoperatively. Randomization of the two groups was done before anesthesia and surgery. Pre- and postoperative care was done in collaboration with a veterinary surgeon.

Anesthesia and surgery

For sedation we used Ketamine 10 mg/kg i.m. and Xylazine 3mg/kg i.m. Atropine 0.05 mg/kg i.v. was administered to reduce secretions. General anesthesia was obtained using 2.5% Isoflurane. Breathing and blood pressure were monitored and with the help of the pulse oximetry device placed in the ear oxygen saturation and heart rate were also monitored.

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Median laparotomy was performed that stretched from the xiphoid process to the umbilicus. The pancreas consists of three lobes: the duodenal lobe, the splenic lobe and the connecting lobe. By careful dissection the pancreatic lobes were revealed and separated at the junction between the duodenal lobe and splenic lobe, to the left of the portal vein.

The proximal pancreatic stump was sutured. In the first group of five piglets we performed a pancreatico-gastric anastomosis between the distal pancreas and the posterior gastric wall with two purse string threads (Fig. 1 and Fig. 2), while in the other group of five piglets we carried out a pancreatico-gastric anastomosis with transfixiating threads through the posterior gastric wall and the pancreas (Fig. 3).

When using the double purse-string technique, an anterior gastrotomy approx. 5cm in length was done followed by a cross gastrotomy at the level of the posterior gastric wall about 2/3 the diameter of the pancreatic stump. We applied two purse string sutures: one on the seromuscular layer and another one on the mucosal layer both approximately 1 cm from the edge of the posterior gastrotomy (Fig. 1, 2), then placed two traction threads at the pancreatic stump. Due to the very low caliber of the Wirsung duct cannulation was abandoned. With the two traction threads passed through the posterior gastrectomy the pancreatic stump was gently pulled into the stomach, protruding about 2 cm above the gastric mucosa. The first purse

string to be tightened was the seromuscular one followed by the mucosal one. The next step was the closure of the stomach with separate non-resorbable threads followed by abdominal wall closure and skin suture.

In the other group of five piglet's the pancreatico-gastric anastomosis was performed with transfixiating threads passed through the posterior gastric wall and pancreas. The difference from the other technique is the fact that after the placing of the pancreatic stump inside the stomach, it is sutured to the posterior gastric wall using eight to ten threads that pass through the posterior gastric wall and the pancreas.

The average duration was 14 minutes for the double purse string anastomosis and 20 minutes for the transfixiating threads anastomosis.

Postoperative care

Postoperatively piglets were locked in individual cages and monitored. They were administered prophylactically Linco-Spectin 15mg/kg i.m. for the first three days after surgery. For the first two days the animals received only water followed by a normal diet.

Parameters studied

In collaboration with the veterinarian the piglets were monitored daily about their general condition, appetite, appearance of postoperative wound and bowel movement.



Fig. 1. External purse string



Fig. 3. Transfixing threads technique



Fig. 2. Internal purse string



Fig. 4. Purse string technique – necropsy aspect

On the tenth post operative day blood was collected and the amylase level was measured to determine if a pancreatic reaction occurred.

Necropsy

The animals were euthanised on the tenth day using a commercial euthanasia solution, after previously receiving ketamine and xylazine and a necropsy was performed. The aim was to detect possible anastomotic fistula, intraperitoneal abscesses, location and extent of the areas of adhesion, pancreatitis lesions and macroscopic aspects of the anastomosis (Fig. 4 and Fig. 5). The pancreas and posterior gastric wall were removed and after a macroscopic inspection of the anastomosis the surgical specimens were fixed in buffered formaldehyde and embedded in paraffin (paraffin-embedded Tissues). For each case five paraffin-embedded blocks were carried out and studied. Three-five μm paraffin sections were used dyed with hematoxylin-eosin.

The following parameters have been taken into account: presence / absence of pancreatico-gastric fistulas, the type and extent of necrosis, tissue regeneration signs (granulation tissue, fibrosis), and histological changes of gastric and pancreatic wall.

Result

Clinic pathological aspects

All pigs survived after surgery. A transient lethargy which disappeared after 1-2 days was noted with no differences between the two groups.

A single pig in the second group showed a minimal wound infection.

Serum amylase level on the 7th postoperative day, prior to euthanasia was above normal for two piglets in the sec-



Fig. 5. Transfixing threads – necropsy aspect

ond group (2130 U/L and 2315 U/L, normal value: <2000 U/L).

Changes highlighted post-euthanasia

All piglets were found to have adhesions between loops of small bowel and the anastomosis. Microscopically we found steatonecrosis ranging from 1-3 mm in size at the level of the pancreatic parenchyma, independent of the technique used.

In the first group, microscopic changes were similar in all 5 cases. The gastric mucosa showed patches of necrosis, granulation tissue in the submucosa and the muscularis propria in the vicinity of the pancreas showed minimum coagulation necrosis, extended areas of fibrosis that embedded pancreatic ducts and suture threads surrounded by giant foreign body reaction cells. Steatonecrosis was not accompanied by hemorrhage (Fig. 6).

In both pigs from the second group with increased amylasemia we observed macroscopically areas of 10-20 mm in diameter of steatonecrosis, pancreatic bleeding and peri-pancreatic bleeding (acute pancreatitis).

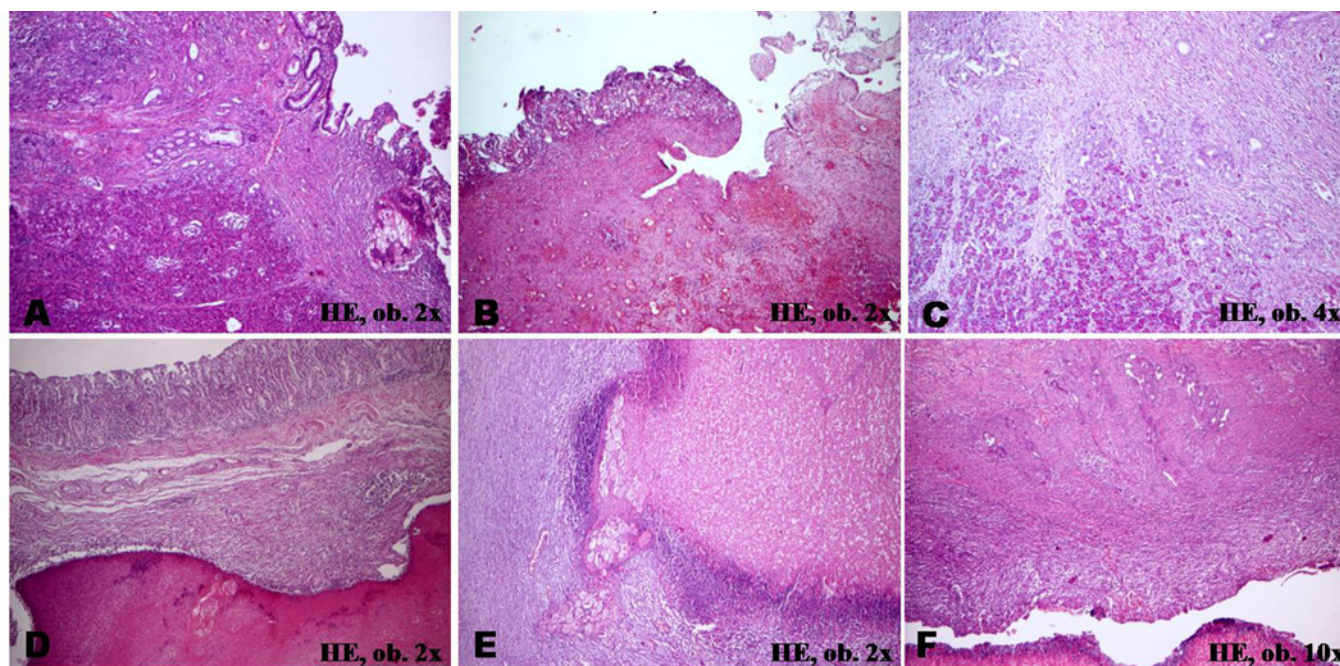


Fig. 6. Histological appearance of the pancreas and the stomach wall, depending on the type of surgery. In animals in which two purse string sutures were used (A-C): patches of necrosis of the gastric mucosa (A, B), granulation tissue in the submucosa (B) and peripancreatic fibrosis with proliferation of ducts (C). In the second group (D-F) extended patches of necrosis (D, E) are noticed and microscopic fistulas fenced by fibrous tissue that embeds pancreatic ducts (F).

In one of them a perianastomotic abscess about 10 mm in diameter was noted macroscopically and a minimum anastomotic blocked fistula (Fig. 7). The second piglet showed, microscopically, a pancreatico-gastric fistula surrounded by granulation tissue and foreign body type cells without cell atypia (Fig. 1). The other three animals in the second group had extended steatonecrosis, bleeding areas, but no fistulas were observed.

Discussions

The cephalic duodenopancreatectomy original technique described by Whipple has suffered over the years in excess of 60 amendments. Most of these changes relate to how the continuity is restored after the actual resection. Currently there are still controversies about the pancreatico-digestiv anastomosis. The reconstruction processes consist of pancreatico-jejunal and pancreatico-gastric anastomosis [17,18,19,20]. All these changes, associated with increased postoperative care quality have contributed to the decrease in postoperative mortality [2,21,22,23]. It has been demonstrated that pancreatic fistula occurs more frequently with soft consistency pancreas (the so called „soft pancreas”) associated with an increased secretion of pancreatic juice through a small diameter Wirsung duct [23,24].

In the recent years a number of surgical techniques have been developed that reduce or avoid the use of threads passed through the pancreas, both in a pancreatico-gastric anastomosis and in a pancreatico-jejunal anastomosis. Although a number of studies have found differences on the rate of pancreatic fistula occurrence in the two variants of reconstruction, [11,25,26] there are a number of advantages belonging to the pancreatico-gastric anastomosis: pancreatic enzymes released in the stomach are inactive due to the absence of intestinal enterokinasis; pancreatic secretions can be aspirated through a nasogastric tube thus decreasing the tension at the level of the anastomosis and last but not least any bleeding can be handled through upper endoscopy.

Peng et al describes a similar surgical technique to the one we used, but performs a seromuscular excision of the posterior gastric wall corresponding in size to the distal pancreatic stump forming a mucosal sleeve for the pancreatic stump [27]. Zhu et al describes a procedure similar to that of Peng, but the application of the two purse string threads is done from a posterior gastric approach [10].

Bartsch performs an anastomosis by applying a purse string through the entire posterior gastric wall and two transfixing mattress sutures through both the pancreatic stump and the posterior gastric wall [16].

Given the fact that over tightening can easily cut the pancreatic tissue and the fact that the threads themselves can produce lesions that can lead to a fistula we deemed it necessary to compare the two methods.

From a clinical point of view there was a minimal postoperative wound supuration at a piglet in the second group. Amylasemia measured seven days postoperatively

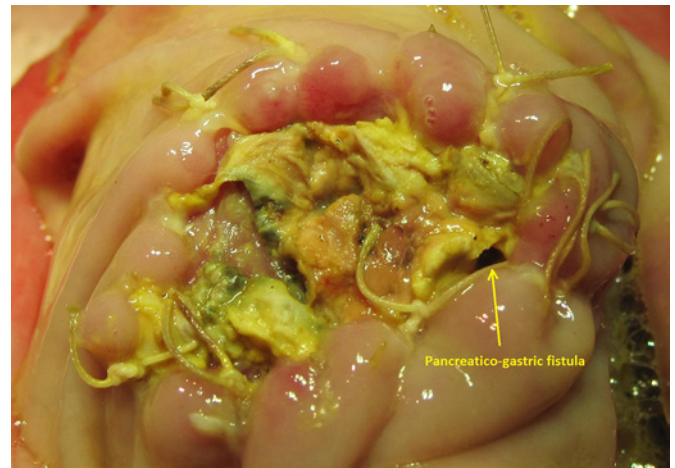


Fig. 7. Pancreatico-gastric fistula- necropsy aspect

was above normal in two cases in the second group. The median time required to perform the double purse string anastomosis was 14 minutes whilst the transfixing threads techniques required 20 minutes on average to carry out.

The macroscopic exploration of the anastomosis after euthanasia revealed a small discontinuity between the gastric mucosa and pancreatic stump at a piglet in the second group with increased amylasemia. Under the microscope, at another piglet, a pancreatico-gastric fistula was found surrounded by granulation tissue.

In the first group, steatonecrosis was minimal and necrosis was only present in small areas whilst in the second group both steatonecrosis and coagulation necrosis were more obvious alongside the presence of small hemorrhagic areas.

The results obtained in this experiment advocates the use of pancreatico-gastric anastomosis with two purse strings which proved to be easier and faster to perform. The association of pancreatitis in two animals of the second group and the absence of bleeding in the first group also advocates for increased risk of pancreatic fistula when using transfixante threads.

Conclusions

Data from this study show that the double purse string pancreatico-gastric anastomosis is a safe, fast and simple treatment option involving minimal pancreatic modifications. Avoiding the use of sutures passed through the pancreas reduces the risk of acute pancreatitis. Further studies can confirm our results and the feasibility of this procedure.

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References

- Allema JH, Reinders ME, van Gulik TM, Koelmay MJ, Van Leeuwen DJ, de Wilt LT, et al. Prognostic factors for survival after pancreaticoduodenectomy for patients with carcinoma of the pancreatic head region. *Cancer*, 1995;75:2069-2076.
- Cameron JL, Pitt HA, Yeo CJ, Lillemoe KD, Kaufman HS, Coleman J. One hundred and forty-five consecutive pancreaticoduodenectomies without mortality. *Ann Surg*, 1993;217:430-435.
- Miedema BW, Sarr MG, van Heerden JA, Nagorney DM, McIlrath DC, Ilstrup D. Complications following pancreaticoduodenectomy: current management. *Arch Surg*, 1992;127:945-949.
- Haddad LBP, Scatton O, Randone B, Andraus W, Massault P, Dousset B, Soubrane O. Pancreatic fistula after pancreaticoduodenectomy: the conservative treatment of choice. *HPB (Oxford)*, 2009;11:203-209.
- Butturini G, Daskalaki D, Molinari E, Scopelliti F, Casarotto A, Bassi C. Pancreatic fistula: definition and current problems. *J Hepatobiliary Pancreat Surg*. 2008;15: 247-251.
- Akamatsu, N., Sugawara, Y., Komagome, M., Shin, N., Cho, N., Ishida, T., Ozawa, F. and Hashimoto, D. Risk factors for postoperative pancreatic fistula after pancreaticoduodenectomy: the significance of the ratio of the main pancreatic duct to the pancreas body as a predictor of leakage. *Journal of Hepato-Biliary-Panc*, 2010;17:322-328.
- Falconi M, Pederzoli P. The relevance of gastrointestinal fistulae in clinical practice: a review. *Gut*, 2001; 49 (Suppl 4): iv2-iv10.
- Yeo CJ, Cameron JL, Sohn TA et al. Six hundred fifty consecutive pancreaticoduodenectomies in the 1990s: pathology, complications, and outcomes. *Ann Surg*, 1997;226:248- 260.
- Bachelier P, Oussoultzoglou E, Rosso E, Scurtu R, Lucescu I, Oshita A, Jaeck D. Pancreatogastrostomy as a Salvage Procedure to Treat Severe Postoperative Pancreatic Fistula After Pancreatoduodenectomy. *Arch Surg*, 2008;143:966-970.
- Zhu F, Wang M, Wang X, Tian R, Shi C, Xu M, Shen M, Han J, Luo N, Qin R. Modified Technique of Pancreatogastrostomy for Soft Pancreas with Two Continuous Hemstitch Sutures: A Single-Center Prospective Study. *J Gastrointest Surg*, 2013;17:1306-1311.
- Bassi C, Falconi M, Molinari E, Salvia R, Butturini G, Sartori N, Mantovani W, Pederzoli P: Reconstruction by pancreaticojejunostomy versus pancreaticogastrostomy following pancreatectomy: results of a comparative study. *Ann Surg*, 2005;242:767-771.
- Niedergethmann M, Dusch N, Widyaningsih R, Weiss C, Kienle P, Post S: Risk-adapted anastomosis for partial pancreaticoduodenectomy reduces the risk of pancreatic fistula: a pilot study. *World J Surg*, 2010;34:1579-1586.
- Fernandez-Cruz L, Cosa R, Blanco L, Lopez-Boado MA, Astudillo E: Pancreatogastrostomy with gastric partition after pylorus-preserving pancreaticoduodenectomy versus conventional pancreaticojejunostomy: a prospective randomized study. *Ann Surg*, 2008;248:930-938.
- Aranha GV, Hodul P, Golts E, Oh D, Pickleman J, Creech S. A comparison of pancreaticogastrostomy and pancreaticojejunostomy following pancreaticoduodenectomy. *Journal of Gastrointestinal Surgery*, 2003;7:672-682.
- Bassi C, Falconi M, Molinari E, et al. Reconstruction by pancreaticojejunostomy versus pancreaticogastrostomy following pancreatectomy: results of a comparative study. *Annals of Surgery*, 2005;242:767-773.
- Bartsch DK, Langer P, Kanngiesser V, Fendrich V, Dietzel K: A simple and safe anastomosis for pancreatogastrostomy using one binding purse-string and two transfixing mattress sutures. *Int J Surg Oncol*, 2012;718637.
- Adams DB: The pancreatic anastomosis: the danger of a leak, which anastomotic technique is better? *J Gastrointest Surg*, 2009;13:1182-1183.
- Bassi C, Falconi M, Molinari E, Mantovani W, Butturini G, Gumbs AA, Salvia R, Pederzoli P: Duct-to-mucosa versus endto-side pancreaticojejunostomy reconstruction after pancreaticoduodenectomy: results of a prospective randomized trial. *Surgery*, 2003; 134:766-771.
- Berger AC, Howard TJ, Kennedy EP, Sauter PK, Bower-Cherry M, Dutkevitch S, Hyslop T, Schmidt CM, Rosato EL, Lavu H, et al: Does type of pancreaticojejunostomy after pancreaticoduodenectomy decrease rate of pancreatic fistula? A randomized, prospective, dualinstitution trial. *J Am Coll Surg*, 2009;208:738-747.
- Cameron JL, Riall TS, Coleman J, Belcher KA: One thousand consecutive pancreaticoduodenectomies. *Ann Surg*, 2006;244:10-15.
- Su CH, Shyr YM, Lui WY, P'eng FK. Factors affecting morbidity, mortality and survival after pancreaticoduodenectomy for carcinoma of the ampulla of Vater. *Hepatogastroenterology*, 1999; 46:1973-1979.
- Pellegrini CA, Heck CF, Raper S, Way LW. An analysis of the reduced morbidity and mortality rates after pancreati-coduodenectomy. *Arch Surg*, 1989;124:778-781.
- Ming-Dong Bai, Liang-Qun Rong, Lian-Chen Wang, Hai Xu, Rui-Fang Fan, Pei Wang, Xiao-Peng Chen, Liu-Bin Shi, and Shu-You Peng. Experimental study on operative methods of pancreaticojejunostomy with reference to anastomotic patency and postoperative pancreatic exocrine function. *World J Gastroenterol*, 2008; 14:441-447.
- Hamanaka Y, Nishihara K, Hamasaki T, Kawabata A, Yamamoto S, Tsurumi M, Ueno T, Suzuki T. Pancreatic juice output after pancreaticoduodenectomy in relation to pancreatic consistency, duct size, and leakage. *Surgery*, 1996;119:281-287.
- Yeo CJ, et al. A prospective randomized trial of pancreaticogastrostomy versus pancreaticojejunostomy after pancreaticoduodenectomy. *Ann Surg*, 1995;222:580-592.
- Duffas JP, et al. A controlled randomized multicenter trial of pancreatogastrostomy or pancreaticojejunostomy after pancreaticoduodenectomy. *Am J Surg*, 2005;189:720-729.
- Peng SY, et al. A pancreas suture-less type II binding pancreaticogastrostomy. *Zhonghua wai ke za zhi [Chinese journal of surgery]*, 2009; 47:1764-1766.