

Use of isolated Roux loop for pancreaticojejunostomy reconstruction after pancreaticoduodenectomy

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Abstract

AIM: To evaluate the efficacy of the isolated Roux loop technique in decreasing the frequency of pancreaticojejunal anastomosis failure.

METHODS: We retrospectively reviewed 88 consecutive patients who underwent pancreaticoduodenectomy (standard or pylorus-preserving). Single jejunal loop was used in 42 patients (SL group) while isolated Roux loop was used in 46 patients (RL group). Demographic characteristics (age, gender) and perioperative results (major/minor complications, mortality, hospital stay) were compared between the two groups.

RESULTS: Mortality was almost equal in both groups and overall mortality was 2.27%. Leak rate from the pancreaticojejunal anastomosis and hospital stay were lower in the RL group without significant difference. Morbidity was 39.1% in the RL group, insignificantly higher

than the SL group. Operative time was almost 30 min longer in the RL group.

CONCLUSION: The isolated Roux loop, although an equally safe alternative, does not present advantages over the traditional use of a single jejunal loop. Randomized controlled studies are required to further clarify its efficacy.

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Key words: Pancreaticojejunal anastomosis; Isolated Roux loop; Whipple pancreaticoduodenectomy; Pancreatic leak

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INTRODUCTION

Pancreaticoduodenectomy (PD) is the procedure of choice for the treatment of peri-ampullary and pancreatic head malignancies and was first described by Allen Whipple *et al*^[1] back in the 1930s. Early enthusiasm concerning the procedure was followed by skepticism because of the associated high morbidity and mortality rates^[2]. However,

advances in operative techniques and perioperative patient care have resulted in lower hospital mortality and longer survival, making the procedure relatively safe in expert hands^[3,4].

Despite recent favorable outcomes, leakage from the pancreaticojejunal anastomosis is still considered a significant source of morbidity and associated mortality. Various methods of surgical management of the pancreatic remnant have been proposed to address this serious problem. The rationale of creating an isolated Roux loop for the drainage of the pancreatic stump was initially introduced by Machado *et al*^[5] in 1976. They proposed that this isolated Roux loop can prevent the activation of pancreatic fluid by the intestinal contents and bile, and therefore protect the pancreaticojejunal anastomosis from erosion.

The aim of this study was to assess the outcome of the pancreaticojejunal anastomosis formed with an isolated Roux loop compared to the standard single loop technique.

MATERIALS AND METHODS

Study design

We retrospectively studied all patients who underwent PD for malignancy in our department from 1994 to 2006. The medical records of 88 consecutive patients were reviewed. All PDs were performed by two experienced pancreatic surgeons. There have been two distinct periods in our study during which the management of the pancreatic remnant was different. In period I (1994 to 1999) the pancreatic stump was anastomosed sequentially to the single jejunal loop (followed by hepaticojejunal and gastrojejunal anastomoses) used for the reconstruction of all anastomoses (Group SL). During period II (2000 to 2006) an isolated Roux loop (Group RL) was used for the pancreatic reconstruction. Informed consent for the surgical procedures was obtained from each patient.

Preoperative assessment

Preoperative diagnostic workup during the early period of study included abdominal computerized tomography scan with oral/intravenous contrast, endoscopic retrograde cholangiopancreatography, percutaneous transhepatic cholangiography and mesenteric angiography in selected patients. The advent of magnetic resonance imaging and magnetic resonance cholangio-pancreatography in the late 1990s provided an excellent adjunct to diagnosis and a safe alternative for biliary-pancreatic evaluation.

Surgical approach

Standard Whipple type operation was performed in 63 patients while the remaining 25 patients underwent a pylorus-preserving PD (PPPD) according to Traverso *et al*^[6]. In the majority of cases an end-to-side, duct-to-mucosa pancreaticojejunal anastomosis with transanastomotic stent was preferred. Only in cases where the pancreatic remnant was considered to be very friable was invagination of pancreatic stump into the jejunal loop preferred.

Table 1 Demographic characteristics of the patients and type of operation for the two different groups

	Single loop group (SL)	Isolated Roux loop group (RL)	Total
Patients (n)	42	46	88
Age	60.9 ± 11.5	64.4 ± 9.5	62.7 ± 10.5
Gender			
Men/women	23/19	29/17	52/36
Type of operation			
Standard Whipple	25	38	63
Traverso-Longmire	17	8	25

Data collection

Patient data concerning postoperative complications, mortality and hospital stay were evaluated and compared between the two groups. Pancreatic anastomotic failure was initially as described according to the Heidelberg and Johns Hopkins groups as the drainage of more than 50 mL of fluid in 24 h, with an amylase content of more than 3 times the serum amylase activity for more than 10 d after operation^[7,8]. In order to adopt a more universally uniform definition we used the ISGPF (International Study Group on Pancreatic Fistula) proposal which is based on the high amylase content of the drain fluid on or after the third postoperative day^[9].

Statistical analysis

Statistical analysis was performed by using the Statistical Package for Social Sciences 13.0 for Windows (SPSS Inc., Chicago, IL). Demographic, operative data and postoperative outcome were collected retrospectively. Continuous variables were compared by using Mann-Whitney *U* test and categorical variables were compared by using the χ^2 or Fisher's exact test, depending on the frequency distribution. $P < 0.05$ was considered statistically significant.

RESULTS

Between 1994 and 2004, 88 patients underwent PD for malignancy. The underlying disease was pancreatic head carcinoma ($n = 59$), ampullary carcinoma ($n = 13$), cholangiocarcinoma ($n = 8$), duodenal carcinoma ($n = 6$) and two rare cases of ampullary carcinoid. The male to female ratio was 52:36. The patients' mean age was 62.7 ± 10.5 years (range 33-78). Period I (1994 to 1999-single loop group) included 42 patients, while period II (2000 to 2004-isolated Roux loop group) included 46 patients. The demographic data of these patients are shown in Table 1.

Perioperative outcomes

Postoperative complications are demonstrated in Table 2. Mean operative time for the RL group was 366.1 min (range 270-520), which was significantly longer ($P = 0.046$) than the operative time of 338.8 min (range 240-470) recorded in the SL group. No major intraoperative compli-

Table 2 Major and minor complications in both groups *n* (%)

	Single loop group (SL) <i>n</i> = 42	Isolated Roux loop group (RL) <i>n</i> = 46	<i>P</i>
Major complications			
PJ anastomosis failure	3 (7.1)	2 (4.3)	NS
Hemorrhage	1 (2.3)	1 (2.2)	NS
Minor complications			
Wound infection	2 (4.8)	3 (6.5)	
Pulmonary infection	2 (4.8)	4 (8.7)	
Delayed gastric emptying	4 (9.5)	7 (15.2)	
Subhepatic fluid collection	-	1 (2.2)	
Cardiac failure	1 (2.3)	-	
Morbidity	13 (30.9)	18 (39.1)	NS
Mortality	1 (2.3)	1 (2.2)	NS
Operative time (min)	338.8 ± 52.7	366.1 ± 60.1	< 0.05
Hospital stay (d)	19.5 ± 10.1	14.6 ± 5.5	NS

PJ: Pancreaticojejunal; NS: Non-significant.

cation occurred in patients of either group. Two patients died in the early postoperative period (overall mortality; 2.27%). Mortality did not differ significantly between the two groups ($P = 1.0$). One fatality occurred in a patient of the SL group (mortality; 2.3%) who presented with postoperative pancreatic leak and subsequent massive gastrointestinal bleeding. Death in a patient of the RL group (mortality; 2.17%) resulted after the patient who had pancreaticojejunal anastomotic failure also developed postoperative intrabdominal bleeding accompanied by profound hypoglycemia. Although the patient was reoperated and hemostasis was achieved, he died a few days later as he developed sepsis and multiple organ failure.

Leak from the pancreaticojejunal anastomosis, as defined above, occurred in 3 patients of the SL group (7.1%) and in 2 patients of the RL group (4.3%). The overall leak rate was 5.7%. Comparison of the leak rate between the two groups showed no significant difference ($P = 0.66$). The incidence of the other grave complication of the procedure, hemorrhage, was not found significantly different between the two groups ($P = 1.0$) as it occurred in one patient each. Minor complications reported in both groups were wound infection, pulmonary infection and delayed gastric emptying, contributing to morbidity rates of 30.9% for the SL group and 39.1% for the RL group, without significant difference between the two groups ($P = 0.422$). One patient of the SL group developed cardiac failure, and in one patient of the RL group a subhepatic biloma was detected which was treated nonoperatively with CT-guided drainage.

Patients of the SL group remained in hospital postoperatively for a mean of 19.5 ± 10.1 d (range 9–49). The mean hospital stay of the patients of the RL group was shorter (14.6 ± 5.5 d, range 9–31), but without statistically significant difference between the two groups.

DISCUSSION

The present study failed to demonstrate any significant reduction of pancreatic anastomosis failure when the

isolated Roux loop technique was performed for the construction of pancreaticojejunal anastomosis instead of the single loop technique.

The operative mortality rate of pancreaticoduodenectomy, which had remained at unacceptably high levels since the 1970s^[6,10,11], dropped dramatically in the last two decades to less than 5% in many reports^[3,12,13]. The improved mortality rates can be attributed to a variety of reasons including better perioperative care, accumulated experience on the part of the pancreatic surgeons, refinement of surgical instruments and materials and better anesthesiologic management^[14].

Despite reductions in mortality after pancreaticoduodenectomy, the incidence of postoperative morbidity remains high, ranging between 30%–50%^[12,13,15,16]. Common postoperative complications include pancreatic fistula, delayed gastric emptying and wound infection. Pancreatic anastomosis failure, which is a major source of morbidity, is considered as the “Achilles’ heel” of the procedure. Pancreatic fistula rate can reach 20% even in specialized centers and does not seem to have declined in the same way as mortality rate has done over the last few decades^[13,14,17]. Hemorrhage and sepsis are the most frequent sequels of pancreatic fistula, both of which contribute largely to the mortality (20%–40%) as well as to prolonged hospitalization and increased hospital cost^[15,18,19].

We analyzed a series of 88 consecutive patients who underwent PD in our department. During the first period (1994–1999), the pancreatic stump was anastomosed sequentially to the single jejunal loop used for the reconstruction of all anastomoses. Mortality (2.3%), morbidity (30.9%) and failure rate of the pancreaticojejunal anastomosis (7.1%) did not differ significantly from those reported in the literature. Although initial reports concerning the use of an isolated jejunal loop for the construction of the pancreaticojejunal anastomosis were far from encouraging with high fistula rates^[5,20], various studies published during this first period supported this alternative technique, presenting considerably improved results^[21–24]. These studies demonstrated extremely low anastomotic leak rates ranging from 0% to 5.7% and zero fistula-related mortality. Table 3 demonstrates results of the isolated Roux loop technique from various studies^[20–28].

The concept of isolation of the pancreatic anastomosis was based mainly on the rationale of diverting biliary from pancreatic secretions. On one hand, this results in avoidance of activation of pancreatic enzymes which could, in theory, erode the anastomotic line and weaken the anastomosis. On the other hand, the jejuno-jejunal anastomosis carries the risk of occlusion due to edema which could increase intraluminal pressure with probably detrimental consequences for the pancreatic anastomosis.

Influenced by these data and aiming to reduce the anastomotic leak rate, in the second period of the study (2000–2006) we adopted the isolated Roux loop technique. However, in our study no significant advantage of this method was found. Although many previous studies utilizing an isolated Roux loop reported zero anastomotic leaks^[21–23,25,26], in our study the leak rate was higher (4.3%).

Table 3 Roux-en-Y pancreaticojejunostomy results from various studies

Series	Study type	Patients (total)	Fistulae (%)	Mortality related to fistula (%)	Overall mortality (%)	Hospital stay (d)
Machado <i>et al</i> ^[5]	CS	15	2 (13.3)	0	0	20.0
Funovics <i>et al</i> ^[20]	CS	48	9 (18.7)	0	3 (6.2)	NA
Kingsnorth <i>et al</i> ^[22]	CS	52	0	0	3 (5.8)	18.4
Albertson <i>et al</i> ^[23]	CS	25	0	0	0	12.2
Meyer <i>et al</i> ^[24]	CS	35	2 (5.7)	0	4 (11.4)	NA
Papadimitriou <i>et al</i> ^[21]	CS	109	0	0	1 (0.9)	7.6
Khan <i>et al</i> ^[24]	CS	41	0	0	1 (2.4)	19.6
Sutton <i>et al</i> ^[25]	CS	61	0	0	3 (5)	16.0
Jover <i>et al</i> ^[27]	CS	80	16 (20)	3 (60)	5 (6.6)	20.6
Kaman <i>et al</i> ^[28]	RC	60 (111)	6 (10)	2 (33.3)	5 (8.3)	17.75

NA: Not available; CS: Case series; RC: Retrospective comparative.

This rate was lower than the leak rate of the group in which a single loop of jejunum was used, but without statistical significance. In contrast to previous series of isolated Roux-en-Y pancreaticojejunal anastomosis, which presented no pancreatic fistula-associated mortality^[5,20-26], both our fatalities (one from each group) died due to sequelae of pancreatic anastomosis failure.

Overall postoperative morbidity in our study is in accordance with major series^[29,30]. The lower anastomotic failure rate reported in the RL group possibly contributes to the shorter hospital stay, but also increases the duration of the operation (adding 30 min) and subsequently exposes patients with concomitant diseases to increased risk of complications not related to the operation. Delayed gastric emptying occurred at an increased frequency in patients of the isolated Roux loop group due to the small percentage of pylorus-preserving procedures taken place in this group.

Our study does not confirm that construction of the pancreaticojejunal anastomosis with an isolated Roux loop proves beneficial. Success may well depend on already known parameters, such as consistency of the pancreatic parenchyma and diameter of the pancreatic duct. Hard pancreatic tissue accompanied by wide, dilated duct, as seen in chronic pancreatitis, can result in a safer anastomosis than one constructed over soft tissue and thin duct^[31,32].

In conclusion, creation of an isolated Roux-en-Y loop in 46 out of 88 patients in our study did not provide sufficient evidence of superiority over the single loop technique regarding the leak rate, morbidity, mortality and hospital stay.

COMMENTS

Background

Pancreaticojejunal anastomosis failure remains the leading cause of postoperative morbidity and mortality after pancreaticoduodenectomy. Various methods of surgical management of the pancreatic remnant have been proposed, addressing this serious problem. One of these methods utilizes an isolated Roux loop for the construction of the pancreaticojejunal anastomosis.

Research frontiers

This study investigated the outcome of the isolated Roux loop pancreaticojejunal anastomosis and compared it to the single loop technique.

Innovations and breakthroughs

Although the isolated Roux loop technique has been previously described and evaluated, its comparison with the standard single loop technique was not fully studied.

Applications

The isolated Roux loop technique has not been proven to reduce the incidence of pancreatic fistula formation and additionally prolonged the operation time. Single loop technique with sequentially constructed anastomoses remains the operation of choice for reconstruction after pancreaticoduodenectomy. Further randomized controlled studies could strengthen this conclusion.

Peer review

This is a nice series of pancreaticoduodenectomies. The mortality is acceptable and the authors note the limitations of their study.

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