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Case Control Study

Dual loop (Roux en Y) reconstruction with isolated gastric limb reduces delayed gastric emptying after pancreatoduodenectomy

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Abstract

BACKGROUND

Single loop reconstruction (SLR) was routine in our institution for patients undergoing pancreatoduodenectomy (PD). Roux-en Y reconstruction with an isolated gastric limb (RIGL) recently became the reconstruction of choice.

AIM

To evaluate the impact of RIGL on incidence and severity of delayed gastric emptying (DGE).

METHODS

This is a single institution, retrospective analysis of patients undergoing PD. All patients undergoing PD from July 2010 through December 2016 were included in the study. Outcome of RIGL were compared to SLR. Primary measure of outcome included incidence and severity of DGE. Secondary measures of outcome were overall complications and postoperative mortality.

RESULTS

One hundred and seventy-nine patients were included in the study. Fifty-two had RIGL, 127 had SLR. Overall complication rate was 40.2%, patients in the RIGL group experienced lower rates of DGE (15.4% vs 59.1%, $P = 0.001$). Other patient related outcomes were also significantly reduced: day of nasogastric tube removal (3 vs 5, $P < 0.001$), regain of normal diet (8 vs 9, $P < 0.001$). On multivariate analysis RIGL was associated independently with reduced rates of DGE ($P < 0.001$, OR 0.14).

CONCLUSION

The current study shows that RIGL reduces the rate of DGE after PD. Further prospective randomized controlled trials are required to affirm the current data.

manuscript

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Core tip: This single institution retrospective analysis showed that patients undergoing pancreatoduodenectomy with reconstruction in a roux en Y with isolated gastric limb fashion have significantly reduced rates of delayed gastric emptying with no change in operative postoperative and oncological outcome. This type of reconstruction may improve patient's quality of life and reduces patient's related costs.

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INTRODUCTION

Pancreatoduodenectomy (PD) is a procedure used for various peri-ampullary pathologies. Although practiced for many years, the procedure is still fraught with significant morbidity and mortality. Mortality was significantly reduced over the years where's morbidity still peaks at 40%-50%^[1-3]. Complications specifically related to the procedure include postoperative pancreatic fistula (POPF), hemorrhage, abscess, biliary and intestinal leaks. Delayed gastric emptying (DGE) is common amongst patients undergoing PD. The presumed etiology for this complication is neurological^[4,5] or hormonal in origin^[6-8]. Definite explanation for the high rates of DGE though in this cohort of patients is still lacking and appears to be multifactorial. DGE prolongs the hospital stay, increases the associated morbidity, compromise patient's quality of life and increase patient's related costs.

The impact of the type of intestinal reconstruction and its association with DGE in PD was previously studied. Studies demonstrated that ante colic reconstruction is preferred over a retro colic in single loop reconstruction (SLR) leading to reduced rates of DGE^[9]. Isolated pancreatic limb was also studied with conflicting results in terms of DGE and POPF.

In the past the Roux en y with isolated gastric limb (RIGL) was used sporadically in our institution especially in young patients with benign or potentially benign disease while in others, reconstruction was fashioned in a classic single loop. We observed that RIGL had a lower incidence of DGE and better overall surgical outcome. Therefore, at the beginning of 2016 we started to reconstruct all our patients who underwent PD with a RIGL technique. The purpose of the current study is to evaluate the effects of the newly used technique on the incidence and severity of DGE in this unique cohort of patients.

MATERIALS AND METHODS

Surgical technique

Following the dissection and resection phases of the procedure a Roux en Y reconstruction with an isolated gastric limb is fashioned. The proximal jejunal loop is brought in a retrocolic (transmesocolic) fashion right to the middle colic vessels. Pancreatoduodenal anastomosis (PJA) is performed followed by end to side hepatico jejunostomy. The bowel is then divided 35-40 cm from the biliary anastomosis by a Gastrointestinal linear cutter.

The distal jejunal end is brought in an antecolic fashion towards the stomach and a gastro-jejunal anastomosis is then performed with either side to side hand sewn anastomosis in a two layers fashion to the anterior wall of the stomach or with a circular stapler (Covidien EEA™, 28-3.5 mm circular stapler with DST series™ technology) to the posterior wall of the stomach. A Jejunio-Jejunal anastomosis is then performed between the biliopancreatic limb and the alimentary limb. **Figure 1** depicts the differences between the traditional SLR (**Figure 1A**) and the RIGL technique

(Figure 1B).

Postoperative management

Postoperatively, patients are admitted to a step-down unit or to an ICU, based on their medical comorbidities and clinical condition. Post operative NG tube policy was changed over time and now is typically removed on postoperative day 1 or 2 unless the output is more than 500 mL/d, diet than is slowly advanced. All patients have a drain placed intraoperatively; it is removed when the patient is tolerating a full diet and drain volume is less than 100 mL/d. The decision to start supplemental nutrition is made case per case, depending on patients' underlying nutritional status and severity of DGE. A CT scan of the abdomen and pelvis is obtained for patients with DGE who demonstrate clinical evidence of Grade B or C POPF or infection, in order to rule out abdominal fluid collections that might be responsible for DGE. Patients are discharged home when tolerating full diet, and are in no need for advanced analgesia.

Patient population and data collection

We retrospectively reviewed the electronic charts of all patients undergoing PD for any pathology in the division of general surgery at the RHCC, Haifa, Israel. All patients undergoing PD from July 2010 through December 2016 were included in the study. Data collected included demographic, clinical, operative and postoperative data. Patients undergoing RIGL reconstruction were compared with those reconstructed in an SLR technique. We have postulated that RIGL reduces the incidence and severity of DGE, and although has one more jejunal anastomosis it is feasible, safe and does not increase the rate of overall complications. Therefore the Primary measure of outcome was incidence and severity of DGE. Secondary measures of outcome included overall complication rate and postoperative mortality. We defined DGE according to the international study group of pancreatic surgery (ISGPS)^[10].

Statistical analysis

Continuous parametric variables were analyzed using the Student's *t*-test. The Mann-Whitney *U* test was used to analyze non-parametric variables. Chi-square test was applied to analyze the association between frequencies in a Univariate fashion. Multivariate analysis was performed using a stepwise logistic regression model and a likelihood ratio test was applied to identify positive associations with the primary and secondary measure of outcome. JMP Pro for Mac (Version 13.0.0) was used to analyze the data. $P < 0.05$ (2-sided) was considered to indicate statistical significance.

RESULTS

During the time frame of the study 52 patients underwent PD with RIGL reconstruction and 127 patients underwent PD with a SLR. The most common indication for PD was ductal adenocarcinoma (63.7%) followed by intraductal papillary mucinous neoplasms (19.5%), other pancreatic cystic lesions (8.9%) and Neuroendocrine tumors in 4.4%. Both study and control groups were homogeneous in terms of demographic variables and clinical presentation (Table 1). Of the 114 patients with ductal adenocarcinoma, 5.3% ($n = 6$) were operated following neoadjuvant chemotherapy. There was no significant difference in operative time between the study and the control group respectively (221.3 ± 39.7 min *vs* 221.3 ± 40.1 min, $P = 0.99$) and the need for intraoperative blood transfusion (5.8% *vs* 10.3%, $P = 0.3$). In patients undergoing PD for malignancy, RIGL did not cause any oncological compromise with the same rate of positive distal or radial margins (5.7% *vs* 2.4%, $P = 0.58$), and no change in average number of lymph nodes procured between the two groups respectively (16.5 ± 6.1 *vs* 16.1 ± 6.2 , $P = 0.76$). Overall complication rate in the study group was 36.5% *vs* 41.7% in the control group ($P = 0.52$) (Table 2). The rate of DGE was significantly lower in the study group (15.4% *vs* 59.1%, $P < 0.001$), with no change in rates of POPF formation, intra-abdominal abscesses, and postoperative mortality. These differences remained significant also in subgroup analysis of the different grades of DGE (A-C) (Table 2). Furthermore, patients in the study group had significant improvement in all patients related outcome such as earlier extraction of the nasogastric tube, emesis following its extraction, therefore they returned earlier to normal diet and had a shorter stay in the hospital (Table 3). Univariate analysis was used to identify factors associated with development of DGE. SLR, female gender, and postoperative complications were significantly associated with DGE (Table 4). Known factors such as gender, malignancy, POPF, Bilirubin levels, and the Roux en Y reconstruction were inserted into a logistic regression model for multivariate analysis using a likelihood ratio test. SLR and postoperative complications were the only

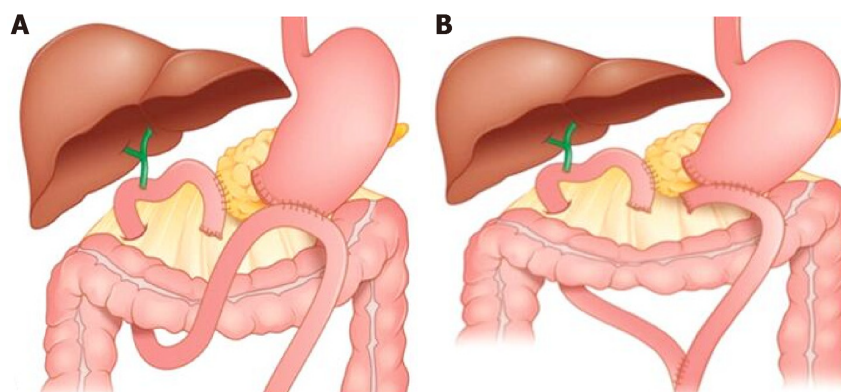


Figure 1 Traditional single loop reconstruction (A), and the Roux en Y with an isolated gastric limb reconstruction (B).

factors independently associated with the development DGE (Table 4).

DISCUSSION

DGE is a common hurdle after PD. Its incidence range between 19%-57%^[9]. DGE is defined as the intolerance of standard diet on the 8th post-operative day. Three different grades (A-C) are defined based on the impact on the clinical course and the post-operative management^[10].

The type of intestinal reconstruction and its effect on rates of DGE was previously evaluated. Several studies showed that in SLR antecolic reconstruction is preferred over a retrocolic in reducing the rates of DGE^[9]. Klaiber *et al*^[11] in a recent meta-analysis compared the classic SLR with a Roux en Y reconstruction using an isolated pancreatic limb. The authors concluded that this reconstruction did not reduce the rates of DGE or the rates of POPF. Deng *et al*^[12] further evaluated these results, in a second meta-analysis replicating the results of their peers.

In our study the overall incidence of DGE was 46.4% ($n = 83$). The study group showed lower rates of DGE in all the subgroups (A-C) (Table 3) with an overall rate of 15.4% ($P < 0.001$). The relatively high incidence of DGE in the control group (59.1%) is attributed in our opinion to the strict adherence to the ISGPS definitions and the time frame of study. Patients in the control group were operated in times were the NG tube was left in place for 3-4 d routinely. Subgroup analysis though, shows that the vast majority of these patients presented with grade A DGE, with minimal to no effect on the clinical outcome. The relatively short hospital length of stay of the control group (12 d) further reiterates this assumption. The study group on the other hand shows very low rates of grade B and C DGE (1.9% and 0% *vs* 11.8% and 2.4% $P < 0.001$ respectively). We believe that this type of reconstruction reduces the high grade DGE with its associated morbidity.

The type of reconstruction continues to be of great interest to surgeons around the world, Barakat *et al*^[13] described in 2016 an isolated proximal gastro-jejunal anastomosis with pyloric ring resection compared with a traditional SLR. Overall rates of DGE were 10.2% and 57% in the study and the control group respectively, with a significant reduction in the clinically relevant (grade B and C) DGE. These results are similar to the results of our study, with a technique that is quite demanding relatively to the one described in our cohort of patients.

Khan *et al*^[14] described a modification to the traditional SLR technique using a flange gastro-enterostomy. In this technique the gastro-enterostomy is performed in an infra-mesocolic fashion through a hole in the mesocolon left to the middle colic vessels. The authors described an overall DGE incidence of 9% and 23% in the flange and non-flange technique respectively with a prominent reduction in the clinically relevant DGE.

Numerous studies evaluated the risk factors for the development of DGE. Qu *et al*^[9] in a meta-analysis studied factors associated with increased risk for DGE. Gender, malignancy, pre-existent diabetes mellitus, preoperative biliary drainage, pre-operative jaundice, antecolic *vs* reterocolic reconstruction, pylorus preserving procedure, POPF, postoperative complications and early enteral feeding were studied. The authors concluded that postoperative complications, pre-existent diabetes mellitus and POPF are the only factors significantly and independently associated with DGE.

Table 1 Comparison of demographic and clinical data between the study and the control group

	RIGL, <i>n</i> = 52	SLR, <i>n</i> = 127	<i>P</i> value
Age	68.2 ± 9.6	68 ± 13.7	0.93
Gender (male)	50 (<i>n</i> = 26)	48.8 (<i>n</i> = 62)	0.89
Risk factors			
Smoking	48.7 (<i>n</i> = 19)	35.8 (<i>n</i> = 44)	0.15
Diabetes	32.6 (<i>n</i> = 17)	39.4 (<i>n</i> = 50)	0.4
Chronic pancreatitis	9.6 (<i>n</i> = 5)	9.5 (<i>n</i> = 12)	0.3
Alcohol abuse	8.8 (<i>n</i> = 3)	5.8 (<i>n</i> = 7)	0.5
Clinical presentation			
Weight loss	40.4 (<i>n</i> = 21)	55.6 (<i>n</i> = 70)	0.06
Abdominal pain	61.5 (<i>n</i> = 32)	66.7 (<i>n</i> = 84)	0.51
Nausea	23.1 (<i>n</i> = 12)	23 (<i>n</i> = 29)	0.99
Emesis	15.4 (<i>n</i> = 8)	13.5 (<i>n</i> = 17)	0.74
Jaundice	42.3 (<i>n</i> = 22)	51.6 (<i>n</i> = 65)	0.26

RIGL: Roux en y with isolated gastric limb; SLR: Single loop reconstruction.

In our cohort of patients univariate analysis identified female gender, SLR, overall complications and post-operative pneumonia to be associated with DGE. On multivariate analysis the RIGL was independently associated with low rates of DGE, while female gender and overall complications were independently associated with high rates of DGE.

Whereas primary DGE is presumably caused by disruption of the neuro-hormonal pathway, several studies have shown that intra-abdominal complications may cause angulation of the gastrojejunostomy and this is a possible cause of secondary DGE. A lower incidence of DGE was also observed in procedures that allowed for the straight passage of the gastric content under gravity into the jejunum. We believe that RIGL technique may bring both advantages, reduce the chances for torsion or angulation cancelling the omega produced by the SLR on one hand, and allow straight passage of the gastric content due to the antecolic fashion of the anastomosis. Furthermore, in RIGL the stomach is not exposed to the pancreatic-biliary secretions and this may also cause reduction in rates of DGE, but currently there is no evidence to support this assessment. The results of Barakat *et al*^[13] who performed a proximal isolated gastric limb might support this assumption. Apparently the use of proximal or distal loop of jejunum has the same results, although we believe that the RIGL is less demanding technically. In addition the isolated gastric limb permits patients who experience pancreatic or biliary leak to resume normal diet earlier with good results.

The limitation of the current study is its retrospective nature. Some of the patients of the control group were operated at times when NG tube was removed routinely in day 3-4 after surgery. This might compromise our results in part, but the significant differences in high grade DGE (B-C) suggest that the results are valid. There is no doubt that only a prospective randomized control trial is of benefit at this point.

In conclusion, the current study show that dual loop reconstruction with isolate gastric limb cause significant decrease in rates of DGE, particularly in the rates of severe DGE (grade B and C) and other patient's related outcome. Furthermore, we demonstrated that this type of reconstruction does not increase the overall complications rate and has no negative impact on the oncological outcome of this unique cohort of patients.

Table 2 Rate and type of complications within the study and the control group

	RIGL, <i>n</i> = 52	SLR, <i>n</i> = 127	<i>P</i> value
Overall complications	36.5 (<i>n</i> = 19)	41.7 (<i>n</i> = 53)	0.52
Superficial SSI	23.1 (<i>n</i> = 12)	21.3 (<i>n</i> = 27)	0.8
Deep SSI	3.2 (<i>n</i> = 4)	1.9 (<i>n</i> = 1)	0.65
Abscess	15.4 (<i>n</i> = 8)	11 (<i>n</i> = 14)	0.42
POPF	28.9 (<i>n</i> = 15)	29.1 (<i>n</i> = 37)	0.96
Intestinal leak	3.9 (<i>n</i> = 2)	0 (<i>n</i> = 0)	0.03
Bile leak	17.3 (<i>n</i> = 9)	20.5 (<i>n</i> = 26)	0.62
Phlebitis	5.8 (<i>n</i> = 3)	17.3 (<i>n</i> = 22)	0.04
Pneumonia	7.7 (<i>n</i> = 4)	17.3 (<i>n</i> = 22)	0.09
Pulmonary embolism	0 (<i>n</i> = 0)	1.6 (<i>n</i> = 2)	0.53
DVT	0 (<i>n</i> = 0)	0.8 (<i>n</i> = 1)	0.52
PVT	5.8 (<i>n</i> = 3)	3.2 (<i>n</i> = 4)	0.41
CV	9.6 (<i>n</i> = 5)	12.6 (<i>n</i> = 16)	0.57
UTI	7.7 (<i>n</i> = 4)	15 (<i>n</i> = 19)	0.18
Delayed gastric emptying	15.4 (<i>n</i> = 8)	59.1 (<i>n</i> = 75)	< 0.001
Grade A	13.5 (<i>n</i> = 7)	44.9 (<i>n</i> = 57)	< 0.001
Grade B	1.9 (<i>n</i> = 1)	11.8 (<i>n</i> = 15)	< 0.001
Grade C	0	2.4 (<i>n</i> = 3)	NR
Postoperative Mortality	3.9 (<i>n</i> = 2)	5.5 (<i>n</i> = 7)	0.64

RIGL: Roux en y with isolated gastric limb; SLR: Single loop reconstruction; SSI: Surgical site infection; DVT: Deep vein thrombosis, PVT: Portal vein thrombosis; CV: Cardiovascular; UTI: Urinary tract infection; POPF: Postoperative pancreatic fistula; NR: Not report.

Table 3 The study group showed better outcome in terms of all variable related to delayed gastric emptying

	RIGL, <i>n</i> = 52	SLR, <i>n</i> = 127	<i>P</i> value
Day of NG tube extraction (d) (median)	3 (3-4)	5 (4-6)	< 0.001
Length of hospital stay (d) (median)	10 (8-14)	12 (10-18)	0.005
Emesis After feeding tube extraction	0 (<i>n</i> = 0)	19.7 (<i>n</i> = 25)	< 0.001
Need for returning of NG tube	1.9 (<i>n</i> = 1)	24.4 (<i>n</i> = 31)	< 0.001
Day of return to normal diet (d) (median)	8 (6-9)	9 (8-15)	< 0.001

RIGL: Roux en y with isolated gastric limb; SLR: Single loop reconstruction; NG: Naso-gastric tube.

Table 4 Univariate and multivariate analysis of factors associated with delayed gastric emptying

	DGE, <i>n</i> = 83	No DGE, <i>n</i> = 96	Univariate <i>P</i> value	Multivariate <i>P</i> value
Age	67.3 ± 14.5	68.8 ± 10.8	0.4	
Gender (female)	59 (<i>n</i> = 49)	43.8 (<i>n</i> = 42)	0.04	0.03
BMI	26.8 ± 4.8	26.1 ± 5	0.39	
RIGL (yes)	9.6 (<i>n</i> = 8)	45.8 (<i>n</i> = 44)	0.001	< 0.001
Chronic pancreatitis	8.4 (<i>n</i> = 7)	10.4 (<i>n</i> = 10)	0.58	
Alcohol abuse	3.9 (<i>n</i> = 3)	9 (<i>n</i> = 7)	0.19	
Pre-existent DM	38.5 (<i>n</i> = 32)	36.5 (<i>n</i> = 35)	0.77	
Jaundice	53.7 (<i>n</i> = 44)	44.8 (<i>n</i> = 43)	0.24	
Bilirubin total (mg/dL) (median)	1.1 (0.4-4.5)	0.8 (0.4-5.5)	0.84	
Malignancy	78.3 (<i>n</i> = 65)	74 (<i>n</i> = 71)	0.5	0.88
Overall complications	49.4 (<i>n</i> = 41)	32.3 (<i>n</i> = 31)	0.019	0.04
Pancreatic leak	26.5 (<i>n</i> = 22)	31.3 (<i>n</i> = 30)	0.48	0.5
Bile leak	22.9 (<i>n</i> = 19)	16.7 (<i>n</i> = 16)	0.29	
Pneumonia	20.5 (<i>n</i> = 17)	9.4 (<i>n</i> = 9)	0.03	0.18
Length of hospital stay (d) (median)	14 (11-22)	10 (8-14)	< 0.001	
Postoperative mortality	4.8 (<i>n</i> = 4)	5.2 (<i>n</i> = 5)	0.9	

BMI: Body Mass index; DM: Diabetes mellitus; DGE: Delayed gastric emptying; RIGL: Roux en y with isolated gastric limb.

ARTICLE HIGHLIGHTS

Research background

Single loop reconstruction was routine in our institution for patients undergoing pancreatoduodenectomy (PD).

Research motivation

Roux-en Y reconstruction with an isolated gastric limb (RIGL) recently became the reconstruction of choice.

Research objectives

The current study evaluates the impact of RIGL on incidence and severity of delayed gastric emptying (DGE).

Research methods

Retrospective analysis of patients undergoing PD.

Research results

On multivariate analysis RIGL was associated independently with reduced rates of DGE.

Research conclusions

The current study shows that RIGL reduces the rate of DGE after PD.

Research perspectives

Further prospective randomized controlled trials are required to affirm the current data.

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