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Innovative Techniques for the Decrease of the Complications Following the Whipple/Traverso Procedure

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Abstract

Objectives: Pancreaticoduedenectomy (PDE) or Whipple Procedure (WP) or Traverso Procedure (TP) remains the procedure of choice that obtains better survival in pancreatic-head cancer. Many studies have been published describing the complications of these procedures as well as several methods of preventing them. Although very few of them have been proved as highly creditable. Few studies have been published describing the benefits of wrapping the omentum around the anastomosis in order to prevent hemorrhage and/or fistula formation. In our prospective consecutive case series study we compare the frequency of pancreatic fistula formation between patients undergone omental roll-up of the Pancreatojejunostomy (PJ) and Choledochojejunostomy (ChJ) and the ones who have not.

Methods: Thirty (n=30) patients underwent PDE in our department within seven years. The patients were divided into two groups. The first group (n=7) underwent PDE without using the omental flap technique and the second group (n=23), underwent PDE using the omental roll-up technique. The perioperative as well as the postoperative outcome were compared. A prospective consecutive case series was conducted. The pancreatic fistula where detected by measuring the amylase levels from the abdominal drain fluid on the 1st and 3rd postoperative day.

Results: Four patients from Group A developed pancreatic fistula in comparison with three patients from Group B who underwent PDE with the roll up technique. Moreover, one patient from each group appeared with postoperative bleeding and passed away.

Conclusion: Wrapping of the omentum is in favor of benefit the reduction of pancreatic fistula and anastomotic leakage after pancreaticoduodenectomy. Since, more randomized controlled studies shall be published.

Keywords: Omental flap; Roll up; Pancreatic cancer; Fistula; Whipple procedure; Traverso Procedure

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Abbreviations

PDE: Pancreaticoduodenectomy; WP: Whipple Procedure; TP: Traverso Procedure; PF: Pancreatic Fistula; POD: Post Operative Day; PJ: Pancreaticojejunostomy; ChJ: Choledochojejunostomy

Introduction

Pancreaticoduedenectomy (PDE) (Whipple or Traverso Procedure) remains the procedure of choice and the only therapeutic option that obtains long survival in pancreatic-head cancer. It is currently performed at specialized centers and carries a mortality of less than 5%. Despite the evolution in surgery the morbidity rates remain high, ranging from 30% to 65%. Because of improvements in the surgical technique and perioperative care its mortality has fallen dramatically to 5%. The three most common complications following a WP/TP are the formation of pancreatic fistula ranging from 5% to 53%, delayed gastric empting with a 25% rate as well as postoperative bleeding ranging from 1% to 10%. Further complications might be the formation of abscesses as well as anastomotic leakage from the Choledochojejunostomy (ChJ). Few studies have been published describing the benefits of wrapping the omentum around the anastomosis [1]. Quite recently in 2014 a meta-analysis and systematic review of the literature, concluded that there is no clear evidence that omental wrapping can prevent pancreatic fistulas after WP [2].

In our prospective consecutive case series study we compare the frequency of pancreatic fistula formation as well as the leakage of the ChJ between patients undergone omental roll up of the

Pancreatojejunostomy (PJ) and the Choledochojejunostomy (ChJ) with the ones who has not.

Materials and Methods

From January 2010 to January 2021, thirty (n=30) patients underwent PDE in our department. Twenty-five patients underwent surgery due to adenocarcinoma of the pancreas and five patients due to carcinoma of the Vater. The patients were divided into two groups. The first group consisting of seven patients (n=7) underwent PDE without using the omental flap technique, within a period of time from January 2010 till December 2017. The second group consisting of twenty-three patients (n=23), underwent PDE using the omental roll-up technique, within a period of time between January 2012 and January 2021. The perioperative as well as the postoperative outcome of these two groups were compared. A prospective consecutive case series was conducted.

Preoperatively the patients underwent a full check up with lab results as well as ECG (echocardiogram), chest X-ray, spirometry and CT scan of the abdomen. Moreover albumin levels and cancer markers (CEA, Ca 19-9, aFP) where measured in all thirty of the patients. The nutritional status was also evaluated.

Perioperatively blood tests where measured to evaluate the need for blood transfusion as well as to check the levels of the electrolytes and the renal/liver function. Furthermore, the pancreatic tissue was evaluated as hard or soft by the surgeon during palpation. The pancreatic duct was also measured and evaluated as dilated (diameter >3 mm) or not dilated (diameter <3 mm). Moreover, the bile duct was measured and evaluated as dilated or not. The infusion of somatuline analogue was also evaluated and was injected to the patients, perioperatively immediately after the extraction of the tumor.

Postoperatively blood tests were counted daily as well as the amylase levels of the fluid coming out of the drainage on the 1st and 3rd postoperative day. The wound was evaluated as well as the nutritional status. Postoperatively all the patients remained in the (Intensive Care Unit) ICU for monitoring for about 24 h.

According to our protocol, amylase levels from the abdominal drain fluid where measured on the 1st and 3rd postoperative day. The drain was removed on the 5th to 7th postoperative day when no fistula was detected. Otherwise the drainage was maintained intact. On the 5th to 7th postoperative day the patients underwent an upper gastrointestinal tract opacification with water-soluble contrast to visualize a potential anastomotic leak.

Preoperatively all the patients received prophylactic antibiotic therapy (Ertapenem) as well as bowel preparation, intravenous hydration and respiratory physiotherapy. Right before the surgery, epidural analgesia was conducted, a urine catheter and a nasogastric tube were placed as well as a central venous catheter and an arterial catheter. Intraoperatively the patients underwent Traverso-Longmire procedure as described in the literature. A Kocher-Chevron incision was conducted 2 cm below the costal margin. Cholecystectomy was performed as well as excision of the head and neck of the pancreas and duodenectomy removing the 2nd, 3rd and 4th part of the duodenum. The hepatic artery, the portal vein, the celiac trunk and the superior mesenteric artery where routinely skeletonized. The pylorus was preserved as well as the 1st part of the duodenum. Later on, the jejunum helix was mobilized and 3 anastomosis where conducted: An end sided PJ, an end sided ChJ as well as an end sided duodenojejunostomy. The nasogastric tube was inspected within the stomach and was set with a stitch on patients' nose. A feeding jejunostomy was performed using either a Foley catheter or a jejunostomy - set when available. Before closing, an abdominal drain was placed through the hiatus of Winslow near the right side of the PJ and ChJ.

Figure 1: Omental Flaps [1].

Figure 2: Roll up in pancreaticojejunostomy [1].

Figure 3: Roll up in choledochojejunostomy [1].

The wrapping technique

After performing all three of the anastomosis and the peritoneal cavity was washed up with warm water for injection, the greater omentum, which was detached from the colon to reveal the minor intraomental space, was divided using a Ligasure Precise, longitudinally up to the left gastroepiploic vessels which were systematically preserved (Figure 1). The flap which was evaluated viable was then mobilized and placed circumferentially anteriorly on the PJ (Figure 2) and ChJ (Figure 3) and fixed by three non-absorbable sutures.

Results

Preoperative status

The 1st group (Group A) consisted of seven patients, five of which

Table 1: Patients' characteristics.

	GROUP A (n=7)	GROUP B (n=23)
Age: >45, <60	6	15
>60	1	8
Gender: Male	5	14
Female	2	9
ASA score: 1	4	20
2	2	1
3	1	2
Albumin:		
>3.5 g/dl	1	8
<3.5 g/dl	6	15
BMI: >25	4	15
<30	3	8
Wirsung duct diameter:		
>3 mm	2	12
<3 mm	5	11
Pancreatic tissue:		
Hard	6	14
Soft	1	9
Fatty	2	5
Non fatty	5	18
Prophylactic Antibiotics:		
Yes (Ertapenem 2 gr)	7	23
No	0	0
Preoperative Hydration:		
Yes	7	23
No	0	0
Bowel cathartics:		
Yes	7	23
No	0	0
Preoperative Biliary Drainage:		
Yes	5	18
No	2	5
Somatulin Analogue:		
Yes	7	22
No	0	1
Postoperative feeding jejunostomy:		
Yes		
No	7	23
	0	0
Preoperative Neoadjuvant Chemotherapy:		
Yes		
No	0	1
	7	22
Vessels resection:		
Yes	0	0
No	7	23
Perioperative Transfusion:		
Yes	5	18
No	2	5
Diagnosis:		
Pancreatic Adenocarcinoma	5	20
Carcinoma of the Vater	2	3

Table 2: Postoperative results.

	GROUP A (n=7)	GROUP B (n=23)
ICU stay:		
Yes	7	23
No	0	0
Overall Morbidity:	5 pts	4 pts
	71.40%	17.40%
Pancreatic Fistula:		
Yes	4	3
No	3	20
ChJ Leakage:		
Yes	1	2
No	6	21
Postoperative Bleeding:		
Yes	1	1
No	6	22
Delayed Gastric Empting:		
Yes		
No	0	3
	7	20
Perianastomotic collection:		
Yes		
No	4	8
	3	15
Intra abdominal Collection:		
Yes		
No	1	1
	6	22
Relaparotomy:		
Yes	1	1
No	6	22
Jejunostomy dysfunction:		
Yes.		
No	3	8
	4	15
Hospital stay:		
< 12 days	4	16
> 12 days	3	7
Deaths:		
Yes	1	1
No	6	22

were males and two of which were females. The 2nd group (Group B) consisted of twenty-three patients - fourteen of which were males and nine were females. All patients aged >45 years old. ASA score was 1 in twenty-four patients (four from Group A and twenty from Group B), 2 in three patients (two from Group A and one from Group B) and 3 in three patients (one from Group A and two from Group B). Nine patients where malnourished (Albumin level was counted preoperatively as well as BMI) (four from Group A and fifteen from Group B) while four patients were overweight (30>BMI>25) (three from Group A and one from Group B). The diameter of Wirsung duct was dilated >3 mm in fourteen patients (two from Group A and twelve from Group B) while normal in the rest sixteen study patients. Two patients from Group A and five patients from Group B had a fatty pancreas. All of the thirty patients preoperatively where infused with prophylactic antibiotic Ertapenem 2 g and received intravenous hydration and bowel preparation with cathartics. Furthermore preoperative biliary drainage was performed in twenty-three patients in total (five from Group A and eighteen from Group B). Twenty patients had a hard pancreatic tissue (six from Group A and fourteen from Group B) while ten patients has a soft pancreas (one from Group A and nine from Group B). Somatulin analogue was infused perioperatively in twenty nine of the patients while one patient from study Group B received no analogue. All of the thirty patients postoperatively carried a feeding jejunostomy. None of the patients required portal vein or arterial resection. Only one patient from Group B received preoperative chemotherapy (Table 1).

Postoperative status

All of the thirty patients remained postoperatively routinely in the Intensive Care Unit (ICU) for 24 hour-monitoring. Overall morbidity in the Group A was measured 71.4% and in the Group B it was counted 17.4%. In details, four patients from Group A developed pancreatic fistula *vs.* three patients from Group B. The pancreatic fistula where detected by measuring the amylase levels from the abdominal drain fluid on the 1st and 3rd POD. The amylase levels (u/L) are presented in Table 3. Four patients from Group A developed pancreatic fistula in comparison with three patients from Group B who underwent PDE with the roll up technique. Moreover, one patient from each group appeared with postoperative bleeding due to splenic vessels and passed away. One patient from Group A and 2 patients from Group B developed ChJ leakage. None of the patients from Group A and three of the patients from Group B presented with delayed gastric empting. Such results where proved with undergoing upper gastrointestinal tract opacification by using a water-soluble contrast to visualize a potential anastomotic leak. One patient from each group developed intra abdominal collection as appeared in the abdominal ultrasound and was absorbed on the 6th POD on both cases. Perianastomotic collection was observed on the 4th POD in two patients of Group B *vs.* eight patients from Group A. These patients where the ones who developed pancreatic fistula. Dysfunction of the feeding jejunostomy was observed. The jejunostomy was either removed or kept closed. Most patients were discharged within 12 days postoperatively (Table 2, 3).

The univariate analysis revealed that patients who underwent PDE using the omental flap technique appeared to develop less postoperative complications specifically lower percentage of pancreatic fistula or anastomotic leaks and less days of hospitalization.

Discussion

The great omentum has several advantages and offers plenty of benefits. It contributes in vascularization, neovascularization, prothromvin activation, fluid absorbance, formation of adhesions around the anastomosis offering protection as well as protection against infections and acceleration of the healing process [1,2,3]. As mentioned in a previous study of ours in 2017, it could be easily characterized as the "Knight" of the Abdominal Cavity [1]. First described by Moriura et al. [3] in 1994, wrapping in pancreatic surgery involves the use of the omentum or the falciform ligament to wrap the pancreaticojejunostomy as well as local retroperitoneal vessels [4,5,3]. Such a technique reduces the rate of postoperative hemorrhage avoiding the slipping of vascular ligatures due to the action of pancreatic juices and decreases the formation of pancreatic fistula around the pancreaticojejunostomy preventing serious complications [2,6-8,9,4,10-13]. Of course, many studies are in progress since no clear evidence exists at present, proving the benefits of this technique.

Table 3: Amylase levels from the abdominal drain fluid as counted on the 1st and 3rd postoperative day (POD).

Group A (n=7)	1st POD	3rd POD
Patient 1	85 u/L	**440 u/L**
Patient 2	12 u/L	50 u/L
Patient 3	**2814 u/L**	**14058 u/L**
Patient 4	80 u/L	5 u/L
Patient 5	**3025 u/L**	18 u/L
Patient 6	**5690 u/L**	**1800 u/L**
Patient 7	4 u/L	2 u/L
Group B (n=23)	**1st POD**	**3rd POD**
Patient 1	**20023 u/L**	**14058 u/L**
Patient 2	203 u/L	60 u/L
Patient 3	247 u/L	10 u/L
Patient 4	165 u/L	15 u/L
Patient 5	80 u/L	2 u/L
Patient 6	8 u/L	7 u/L
Patient 7	45 u/L	4 u/L
Patient 8	7 u/L	6 u/L
Patient 9	10 u/L	6 u/L
Patient 10	10 u/L	7 u/L
Patient 11	**1400 u/L**	60 u/L
Patient 12	**36000 u/L**	**20300 u/L**
Patient 13	54 u/L	0 u/L
Patient 14	0 u/L	0 u/L
Patient 15	12 u/L	5 u/L
Patient 16	0 u/L	17 u/L
Patient 17	**2100 u/L**	**18190 u/L**
Patient 18	17 u/L	4 u/L
Patient 19	**300 u/L**	25 u/L
Patient 20	96 u/L	64 u/L
Patient 21	89 u/L	32 u/L
Patient 22	56 u/L	20 u/L
Patient 23	28 u/L	5 u/L

The most serious complication following PDE is undoubtedly the formation of pancreatic fistula. It is accompanied by a high rate of mortality that ranges from 8% to 28%. Its direct and indirect morbidity rates are also high as it causes intra-abdominal infection often accompanied by bleeding of the great abdominal vessels in 16% to 40% of the patients [2,5-7,10,14]. Factors that may lead to formation of pancreatic fistula are small pancreatic duct (diameter <3 mm), soft pancreatic parenchyma, postoperative bleeding, heart disease, advanced age and the need for transfusion perioperatively [1,2,6,10,13].

Technical variations have been tested in order to create a safe anastomosis between the pancreas just to avoid the formation of pancreatic fistula; various types of pancreaticojejunostomy like end-to-end/end-sided/nucleation of the pancreas or duct to mucosa anastomosis or even the use tutors/biological adhesives, duct occlusion, external drainage and many more [1,2,7,10,12,13,14]. One of the above techniques which is quite promising, is the wrapping of the omentum as described in pour previous study in 2017 [1]. Such a technique involves the use of the omentum surrounding the pancreaticojejunostomy offering two main benefits: 1) placing the omentum around the pancreaticojejunostomy may form a barrier to avoid the formation of pancreatic fistula and 2) the omentum may protect the surrounding organs against the autolytic effect and proteolytic activity of the pancreatic fluids (which are rich in trypsin and elastate), especially the local vessels like gastroduodenal artery, portal vein, hepatic artery and celiac truck [2,3,6,8,9,11-14]. Many studies have been also published describing the way of performing the choledochojejunostomy [15,16].

In colorectal surgery, the use of the omentum has been previously described [3]. However, the omental wrapping in pancreaticojejunostomy has been described in few studies. In 2017 we conducted a consecutive series study showing that wrapping may benefit the PDE while it may benefit the minimization of fistula formation [1].

In 2012, Tani et al. [11] conducted a multi-centre retrospective study of 2,597 patients who underwent pancreatic surgery. Wrapping with omentum and/or Falciform Ligament, was performed in 918 patients. Wrapping patients had a longer operative time, a higher PF rate, more severe fistulas and more wound infection. Interestingly, the amylase level in the drainage was lower in the group with wrapping. The location of the wrapping (vessel protection or peri-anastomotic) did not change the complication rate, which was higher in the group with wrapping in all cases. Wrapping did not decrease the post-operative bleeding rate.

Within the same year, three more studies were conducted. Choi et al. [10] presented a retrospective series of 68 pancreaticoduodenectomis, dividing the patients into two non-randomized but comparable groups. In the first group, an omental flap was wrapped around the pancreaticojejunostomy to protect the anastomosis and to decrease the rate of pancreatic fistula, and also to protect retroperitoneal vessels. In the second group, the omental roll was not used. The overall pancreatic fistula rate for the series was high (42.3%). The group of patients who underwent omental wrapping of the pancreaticojejunostomy showed a significantly lower rate of fistulas (20.7% *vs.* 59%), less severe fistulas (grade A) and shorter hospital stay. There was no difference in post-operative bleeding rate. Also Rosso et al. presented a prospective series of 61 PDE in which there were compared 33 patients with a double omental flap *vs.* 28 patients without wrapping. The double flap protected regional vessels and pancreaticojejunostomy anastomosis. Morbidity rate was 27.8% and the pancreatic fistula rate was 13.1%. The omental flap group presented a reduced rate of relaparotomy (10.7% *vs.* 0%) and perianastomotic collections, but more pleural effusions. Matsuda et al. [17] published a retrospective series of 229 patients, in 157 of which an omental flap was performed to protect regional vessels. The overall pancreatic fistula rate was 35.4% and the post-operative bleeding rate was 3.9%. The rate of bleeding in the group without the flap was 8.3%, compared with 1.9% in the group with the flap.

In 2011 Mimatsu et al. [18] performed a prospective study (20 PDEs) in which the omentum and FL were used together to protect vessels and the pancreatogastrostomy. They obtained a pancreatic fistula rate of 10% and no post-operative bleeding was recorded. Nor were there any complications associated with the double wrapping.

In 2005, Maeda et al. [6] conducted a prospective series of 100 pancreaticoduodenectomies reporting a technique, dividing the greater omentum in order to create a flap that is positioned in front of the vessels (portal vein and hepatic artery) and behind the anastomosis in contact with the posterior face of the pancreaticojejunostomy and the hepaticojejunostomy without covering the front face of the pancreaticojejunostomy, covering and protecting arterial stumps such as the gastroduodenal artery stump. In the article, the authors stress the need to ensure that the stomach is not torsioned. They fix the flap only if it is deemed necessary and perform Doppler ultrasound during and after surgery to ensure proper portal flow. In this study, the pancreatic fistula rate was 15% and the post-operative bleeding rate was 1%. The only patient who presented bleeding had a body mass index of 15, and the omentum was extremely thin. The authors concluded that wrapping is effective for preventing bleeding but not for diminishing pancreatic fistula. One year later, in 2006, Kapoor et al. [7] presented a prospective series of 77 pancreaticoduodenectomies, in 25 of which a double omental flap was used: One wrap to cover pancreaticojejunostomy, and the other covering the duodenojejunostomy. No complications were reported. The pancreatic fistula rate was similar in the wrapping and non-wrapping groups, but the fistulas were less severe in patients with wrapping. The rates of bleeding and mortality were similar in the two groups, but there was no mortality related to post-operative bleeding in the wrapping group.

In their retrospective series of 54 pancreaticoduodenectomies, Kurosaki et al. [14] in 2004 used the omentum to protect vessels, placing it in the retroperitoneum and behind the pancreaticojejunostomy. The pancreatic fistula rate was 9.3% and there was no bleeding [1].

Conclusion

To summarize, the great omentum represents the "Knight" of the abdominal cavity and is characterized by many advantages. Its use in visceral and colorectal surgery is undoubtedly, beneficial. The wrapping of the omentum, however, in oncologic pancreatic surgery is scarce. In bibliography, few studies have been reported. These studies are retrospective and prospective and not randomized. Thus there are no control groups, so their level of evidence is low. Different types of pancreatic surgery are also mixed up as well as various wrapping techniques, making it difficult to compare the results.

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