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Standardized Salvage Completion Pancreatectomy for Grade C Postoperative Pancreatic Fistula After Pancreatoduodenectomy (With Video)

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ABSTRACT

Background:

Emergency completion pancreatectomy (CP) after pancreatoduodenectomy (PD) is a technically demanding procedure. We report our experiences with a four-step standardized technique used at our center since 2012.

Methods:

In the first step, the gastrojejunostomy is divided with a stapler to quickly access the pancreatic anastomosis and permit adequate exposure, especially in cases of active bleeding. Second, the bowel loops connected to the pancreatic anastomosis is divided in cases of pancreaticojejunostomy. Third, the pancreatectomy is completed with or without the splenic vessels and spleen conservation according to the local conditions. Finally, the fourth step reconstructs in a Roux-en-Y fashion and ensures drainage.

Results: From January 2012 to December 2019, 450 patients underwent PD at our center. Reintervention for grade C postoperative pancreatic fistula was decided for 30 patients, and CP was performed in 21 patients. The mean intraoperative blood loss and operative duration were relatively low (600 mL and 240 min, respectively). During the perioperative period, three patients died from multiple organ failure, and two patients died intraoperatively from a cataclysmic hemorrhage originating from the superior mesenteric artery.

Discussion:

Our standardized procedure appears to be relatively safe, reproducible, and could be particularly useful for young surgeons.

INTRODUCTION

Mortality after pancreatoduodenectomy (PD), even at very high-volume centers, has been reported to be about 4%^{1,2}. Postoperative pancreatic fistula (POPF) remains a common complication occurring in up to 50% of cases³. POPF can be managed conservatively in some cases but can deteriorate rapidly or result to death. In particular, grade C POPF⁴ is a rare but life-threatening complication associated with severe bleeding,⁵ that may require polytransfusion, transarterial embolization or stenting, catheter drainage^{6,7}, and reintervention, resulting in prolonged hospital stays and increased cost of care^{8,9}. The management of grade C POPF remains a clinical challenge, although the current literature provides several surgical and therapeutic options¹⁰. With or without active hemorrhage, conservative treatment of the remnant pancreatic gland has to be considered but should be counterbalanced with the potential of prolonged intensive care, continuous sepsis, serious iterative bleeding from pseudoaneurysms^{11,12}, and relative immunodepression or delayed chemotherapy. When a reintervention is needed, the surgeon must decide whether to perform a parenchyma-sparing procedure^{10,13}, which involves optimization of the peripancreatic drainage, conversion to an alternative anastomosis¹⁴, and disconnection of the anastomosis with preservation of the pancreatic remnant by wirsungostomy¹⁵, or a completion pancreatectomy (CP) to prevent recurrent bleeding with the hope that the patient recovers quickly¹⁶.

Emergency CP is a technically demanding procedure as the surgeon must simultaneously manage an active hemorrhage, pancreatitis, and the fragility of the inflamed surrounding organs due to a reintervention occurring after a long delay (generally more than a week). This complex surgery, which is sometimes performed in

clinically unstable patients, results in an extraordinary postoperative mortality rate of 30–50%^{17,18}. However, in successful cases, this procedure allows for a rapid and favorable recovery with limited impacts on everyday life, and seems to offer acceptable long-term quality of life^{19,20}. This procedure also raises some technical questions: How does one quickly access the hidden pancreatic anastomosis? How does one deal with the biliary tract? Does the spleen have to be removed or retained? Moreover, CP is performed as an emergency, sometimes at night, in adverse conditions, and not necessarily by the most experienced surgeon. Thus, the development of a fast, relevant, and effective standardized technique is needed. We report our experiences with a four-step standardized technique that has been used in our center since 2012.

MATERIALS AND METHODS

Patient Selection

A total of 450 patients underwent PD between January 2012 and December 2019 at Institut Paoli-Calmettes in Marseille, France. Data were entered prospectively into a clinical database, approved by the Institutional Review Board, and labeled by the National Institute for Data Protection (CNIL no. Sy50955016U). The study participants provided written informed consent as their data are listed in our declared prospective institutional database (NCT02871336). The study protocol adhered to the tenets of the Declaration of Helsinki.

PD procedure

A non-pylorus PD was conducted with or without vascular resection²¹ according to tumor etiology and extent of local invasion. Pancreatic reconstruction was performed according to the procedure described by Addeo et al,²² in cases of

pancreaticogastrostomy (PG), and by the duct-to-mucosae technique in cases of pancreaticojejunostomy (PJ). All anastomoses (PG and PJ) were protected by an omental flap²³. In the case of a soft pancreas, we used the recommended optimal mitigation strategy that involves pancreatic duct external stenting³ without administering perioperative octreotide. A large non-aspirated drain was placed around the anastomosis, and the nasogastric tube was removed at the end of the procedure regardless of the technique. A precise technical report was produced immediately after the procedure that included the major relevant details; this report usually help in cases of reintervention by another surgeon, and includes information regarding hepatic artery variations according to the classification by Michels et al²⁴, vascular resection and reconstruction types, pancreatic texture and reconstruction, and antecolic or retrocolic gastro-enteric anastomosis. All patients resumed water intake on postoperative day 1, and a solid diet was resumed gradually from postoperative day 2 or 3.

Four-step salvage CP

The reintervention procedure, in most cases, was decided and subsequently conducted by an experienced pancreatic surgeon. During the procedure, the original bilateral sub-costal transverse incision was completely reopened, and exposure was achieved using a Kent (Takasago Medical Industry Co., Tokyo, Japan) or Ulrich (Falcon Med, Pennsylvania, USA) retractor to produce an optimal view and access to the pancreatic anastomosis. We postulated that hemostasis had to be achieved once the exposure was optimal, except in cases involving massive uncontrolled hemorrhage.

First step: division of the gastrojejunostomy. The gastrojejunal anastomosis has to be sacrificed and divided with a stapler (Proximate[®] Linear Cutter, Johnson & Johnson Health Care Systems, Inc., USA) to quickly access the pancreatic anastomosis

(PJ or PG) and permit adequate exposure in a wide field, especially in cases of active bleeding. We usually choose to dissect from the gastric side as the enteric part will be further removed.

Second step: resection of the bowel loop connected to the pancreatic anastomosis in cases of PJ. The jejunal loop is divided with a stapler (Proximate® Linear Cutter, Johnson & Johnson Health Care Systems, Inc., USA) upstream of the biliary anastomosis. The feeding vessels are divided at the enteric wall from the biliary to the pancreatic side with a reusable bipolar sealing instrument (BiClamp®, Erbé Médical, Limonest, France) and/or ligatures. The mesentery is later used as an epiploplasty for the vessels. Conventional epiploplasty is sacrificed to allow access to the remnant pancreas (Figure 1). During this phase, special attention is paid to several vascular axes that could be damaged: the hepatic artery, portal vein, and the superior mesenteric artery. Thus, the preference is to divide and leave in place the epiploplasty surrounding the portal vein instead of risking a portal vein injury.

The origin of the bleeding is commonly identified during this phase, and hemostasis is ensured cautiously while avoiding ligation/stenosis of the hepatic artery (in cases of bleeding arising from the gastroduodenal artery stump) or the superior mesenteric artery (in cases of bleeding arising from a pancreaticoduodenal artery stump).

Third step: completion of the pancreatectomy. En-bloc pancreatectomy is completed with or without the splenic vessels and splenic conservation according to the local condition. The non-conservative method of the splenic vessels is easier and better adapted for perilous situations as the retrosplenic plane, in most cases, has not been previously dissected (Figure 2).

Fourth step: reconstruction and drainage. Hemostasis is secured, and pancreatectomy is completed. The hepatico-jejunostomy is still intact, and we retrieve the resected area of the gastro-jejunostomy on the same loop. The lower loop is then used for a new gastro-jejunostomy. The two loops (the first, which ensures biliary continuity, and the second, which ensures enteric continuity) are finally connected by side-to-side anastomosis (Figure 3) in a Roux-en-Y fashion.

A complementary antrectomy is preferable in cases of PG to repair the gastric orifice, which is often large. A nasogastric tube is routinely left in place, and a large drainage is placed on both sides of the submesocolic area. At the end of the procedure, control of hemorrhage can be precarious due to a ligature achieved on fragile tissues. In such situations, stenting of the causal artery to prevent early rebleeding could be considered; this option is obviously not based on solid data but on a debatable strategy adopted by our center.

Studied variables

Morbidities according to the Clavien-Dindo classification ²⁵, including POPF diagnosed and graded according to the 2016 International Study Group of Pancreatic Surgery ⁴ (clinically relevant POPF comprised grade B and C POPF), and postoperative hemorrhage ⁵ (PPH) were studied. The mortality rate (in-hospital or 30-day), perioperative red cell transfusion rate (between surgery and discharge to home), length of hospital stay, and readmission were noted.

RESULTS

Clinically relevant POPF occurred in 77 patients (17%), and hemorrhage occurred in 47 patients (10%); these complications were predominantly treated with successful

endoscopic (n=35) or endovascular therapy (n=23). Finally, reintervention for grade C POPF was decided for 30 patients (6.7%); CP was performed in 21 patients (70%; Table 1), and nine patients (30%) underwent a conservative procedure (optimization of drainage in seven patients and redo anastomosis in two due to intraoperative constraints). During the perioperative period following CP, five deaths occurred (24%): three patients died from multiple organ failure, and two patients died during reintervention from a cataclysmic hemorrhage originating from the superior mesenteric artery. Three patients (14%) had postoperative stenting to prevent early re-bleeding (two stentings of the common hepatic artery and one stenting of the superior mesenteric artery). The mean intraoperative blood loss was 600 ml (100–3000 ml) and the mean operative duration was 240 min (120–300). Our observed mortality rate was 24%.

DISCUSSION

The surgeon's main goal if a grade C POPF after PD requires reintervention is to fix the problem and reduce the risk of supplementary complications. As noticed by Zhou et al¹⁰, simple pancreatic drainage should not be adopted for grade C POPF after PD in hemodynamically unstable or fragile patients because this drainage requires more reoperation (30%) and has a higher perioperative mortality (48%). Pancreas-sparing treatments, such as duct occlusion, external or internal wirsungostomy, and salvage pancreaticogastrostomy have contrasting results. Studies have reported that these treatments, when compared to CP, are associated with significantly higher rates of repeat laparotomy (59% versus 7%, $p=0.003$)²⁶, prolonged hospital stay¹⁵, and encouraging survival rates¹³. However, opting for conservative treatment with a delayed redo pancreatic anastomosis is risky because an interval of several months with

an absence of tumor progression before reintervention is required²⁷. Since our report was not focused on strategy but only on technical aspects, we will not discuss a decision tree to choose between CP and the pancreas-sparing procedure. However, we support the suggestion that conservative procedures have to be reserved for fit patients with benign diseases and appropriate local conditions (i.e., mainly early reintervention), and this option was only adopted in 9 of the 30 patients who required reintervention in our study. We also want to emphasize that CP should not be seen as a failure due to the resulting exocrine and endocrine insufficiency; the patient will be alive and that is the appropriate response to a life-threatening complication.

A total of 450 PDs were performed at our institution over an 8-year period. The more drastic CP was selected as the means of salvage in 21 cases because severe inflammation in the setting of pancreatic anastomotic dehiscence precluded conservative options. However, this option was not so liberal considering that 77 patients experienced clinically relevant POPF. The median hospital stay of the survivors was 39 days, which was shorter than that of patients who had conservative treatment¹⁰. Contrary to common belief, splenic preservation was possible in 43% of the patients. However, considering the perilous context, spleen preservation should not be performed by inexperienced young surgeons facing this situation despite our achievement of acceptable outcomes. Another debate is splenic vein resection in PD, which could lead to sinistral portal hypertension²⁸⁻³⁰. Interestingly, we did not encounter any case of sinistral portal hypertension in our series. One reason is that we preserved the left gastric or marginal colic vein in many cases.²⁹ Our observed mortality rate was 24%, which is acceptable, considering that the usual reported rates are 21–50%³¹. Our observed operative duration was 240 min, which is comparable to those of other reports

which ranges from 144 to 240 min³¹. We also had a relatively lower blood loss (600 mL) compared to other studies³¹ that reported blood losses of 900–2500 ml during such a complex and demanding procedure.

Our standardized approach in cases where salvage CP is the appropriate solution, provides younger surgeons with some landmarks in this very hostile field. Furthermore, sacrificing the gastrojejunostomy first, is a surgical “gateway” to quickly obtain a good comprehension of the field and to assess whether reconstruction surgery will be required at the end of the surgery, if damage control surgery is required in very unstable patient. In elective surgery, CP should be done without dividing the gastrojejunostomy, by combination of taping and hanging. Even in the context of emergencies, for grade C POPF with even active hemorrhage, not dividing the gastrojejunostomy could be an alternative choice. However, surgeon have to deal with severe pancreatitis associated and inflamed surrounding organs, as the median delay for reoperation is 12 days. Furthermore, the pancreatic area is sometimes fully obscured by the previous omental positioning as pancreatic anastomoses are usually protected by an omental flap modified technique whenever possible, as we have previously described.²³ Moreover, this choice is also greatly dependent on the position of the gastrojejunostomy (antecolic versus retrocolic positions). In our experience, the antecolic position provides a longer jejunal loop for the biliary tract in cases of CP as described, but it often preclude a adequate exposure of the field without sacrificing the gastrojejunostomy. Retrocolic anastomosis is easier to deal with without sacrificing the gastrojejunostomy (if you can dissect it away from the pancreatic anastomosis without injury), but the jejunal loop for biliary tract is always shorter and sometimes difficult to manage if the gastrojejunostomy is finally sacrificed. Finally, we believe that in this context, the time spared from avoiding

redo-anastomosis is completely lost in dealing with difficult field exposure and comprehension, especially for young surgeons or in adverse condition.

Regarding the treatment strategy, we hope to highlight three main points. First, we are convinced that the timing of performing CP can influence outcomes. Independent predictive factors of mortality after reintervention for POPF include organ failure on the day of the operation and the need for further surgical reintervention¹⁸; thus, advocating for an early strategy to definitively resolve the problem of pancreatic leakage is required. Furthermore, we believe that close monitoring is required for high-risk patients with a fistula; a low threshold for re-exploration is preferable in high-risk patients^{32,33} with progressive organ deterioration. The intraoperative death of two patients was most likely due to excessively delayed reintervention resulting from a desire to manage them conservatively. Importantly, endovascular treatment first is the key to successful management. In our study, 15 patients (71%) had significant hemorrhage. Of these, 6 had angiographic interventions before reoperation, with successful embolization in 5 patients (5/6; 83%). In cases of successful management, any patient with POPF that is not optimally drained must undergo reintervention to solve the POPF. In such situations, it is permitted to proceed with CP without active bleeding. In case of failure, it confirmed the need for reoperation and hemostasis intervention (n=1). Angiographic intervention was not considered in 9 cases, due to risky hemodynamic conditions that lead directly to the operating room (including two cardiac arrest). We want to emphasize that the indication for CP was not dictated by isolated hemorrhage alone but was multifactorial. Second, the risk for remnant anastomosis (i.e., biliary and gastric) leakage remains. Obviously, removal of the pancreatic anastomosis does not prevent other leakages that can also occur due to

vascular erosion and bleeding. When considering post-CP gastric leakage, all gastric fistulas occurred in patients who underwent PG with primary closure of the gaping hole; we support the suggestion that antrectomy is preferable to orifice closure in such patients. Conversely, we did not experience any case of gastrojejunostomy leakage, and we believe that sacrificing the gastrojejunostomy at the first step is safe and offers a wide surgical field in stressful situations. When considering hepatico-jejunostomy, the exposure and manipulation of the loop can result in increased fragility and unrecognized injury that could lead to hazardous outcomes. In cases of hepatico-jejunostomy, repair of damages identified during CP with interrupted, closely spaced, synthetic absorbable sutures could be insufficient. An externalized transanastomotic T-tube drainage or a redo anastomosis can be discussed to avoid recurrent biliary fistula and permit healing. In all cases, a large drainage of the submesocolic area is strongly recommended. Third, dealing with the main arteries or venous axis have to be done with caution. The epiploplasty surrounding the portal vein is usually divided instead of removed and the management of the tempting clot has to be reserved at the end of CP as any removal could lead to major injury in already fragile patients (Figure 4). Thus, the operative field and the surgeon have to be ready for vascular exclusion.

Finally, concerning the high rate of grade C POPF (6.7%) in western studies compared to the most recent large-scale prospective Eastern study³⁴, higher BMI in Western countries, retrospectively biases the classification of POPF according to different postoperative management strategies and the lower postoperative mortality in our study preclude any conclusion. Further studies are needed to determine the optimal strategy and timing for such a radical and morbid surgery.

CONCLUSION

Our standardized procedure appears to be relatively safe and reproducible, offers some landmarks in this very demanding field, and is particularly useful for young surgeons.

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Study conception: Garnier, Turrini

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Figure 1: Steps #1 and #2

Suppression of the pancreaticojejunostomy and resection of the loop connected to the pancreatic anastomosis. The yellow arrow indicates the fistulized pancreatic anastomosis

Figure 2: Step #3

(A, B) Operative field after completion of salvage pancreatectomy with spleen and vessel preservation. Note that a clot located on the superior mesenteric artery was removed after optimal exposure provided by the completion pancreatectomy to ensure hemostasis of a stump of the pancreatic-duodenal artery from which the hemorrhage originated

SA, splenic artery; SV, splenic vein; PV, portal vein.

Figure 3: Step #4

Enteric reconstruction with Roux-en-Y gastrojejunostomy

Highlighted parts indicate the sources of postoperative complications

Figure 4: Perilous situation

Dissecting a hematoma in the Portal vein/Superior Mesenteric Vein axis with loss of venous wall. The attempted reparation led to massive injury, requiring vascular exclusion with SMV clamping and Pringle maneuver. The final reparation consisted of lateral venorrhaphy with uninterrupted suture using Prolene 7/0.

GDA: Gastroduodenal artery

PV: Portal vein

SMV: Superior mesenteric vein

SV: Splenic vein

H: Hematoma

*: Hepatico-jejunostomy loop

**Table 1: Our recent experience with salvage completion pancreatectomy
(2012–2019)**

n (total PD, %)	21 (450, 4.7)
Median age*	68 (45–85)
Sex ratio (M/F)	16/5=3.2
Mean BMI* (kg/m ²)	25 (20–37)
Type of pancreatic anastomosis (%)	
Pancreaticogastrostomy	5 (24)
Pancreaticojejunostomy	16 (76)
Soft pancreatic texture (%)	18 (86)
Wirsung stenting (%)	18 (86)
Indication for reintervention	
<i>Bleeding/Hemodynamic instability (%)</i>	5 (24%)
<i>Unsolved septic shock (%)</i>	16 (76%)
Median delay for completion pancreatectomy (days)*	12 (7–42)
Median operative time (min)*	240 (120–300)
Median blood loss (mL)*	600 (100–3000)
Patients requiring blood transfusion (%)	16 (76)
Median number of blood pack*	5 (10–16)
Splenectomy (%)	12 (57)
Iterative laparotomy (%)	5 (24%)
Biliary fistula	3 (14%)
Gastric fistula	3 (14%)
In-hospital mortality (%)	5 (24)

Median length of hospital stay (days) [*] for survivors	39 (26–131)
Administration of adjuvant chemotherapy (%) [†]	1 (7%)

CP, completion pancreatectomy; ^{*} range, BMI, Body Mass Index, kg/m²; [†] concerning 14 patients (67%) for whom adjuvant chemotherapy was indicated.

Figure 1

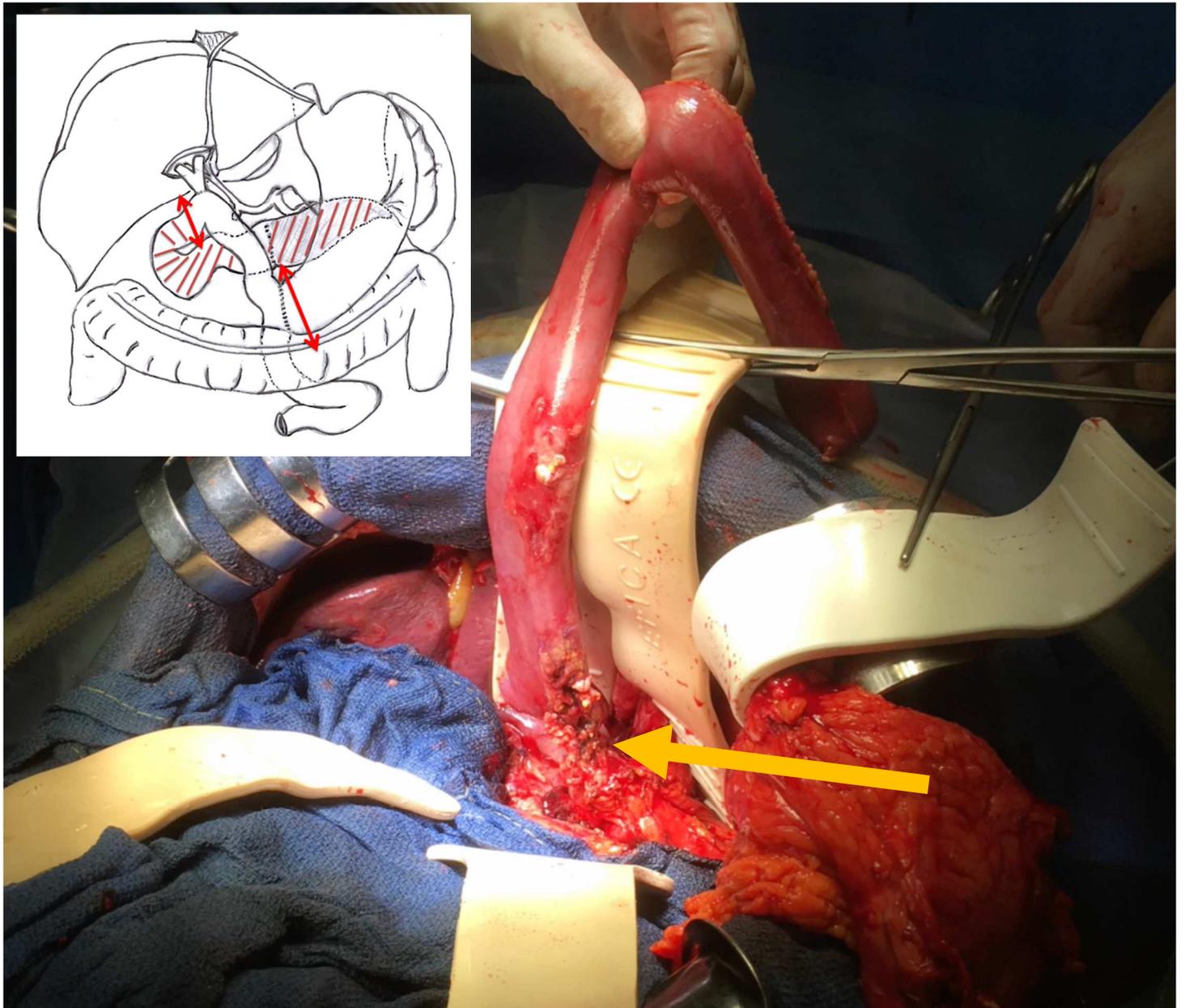
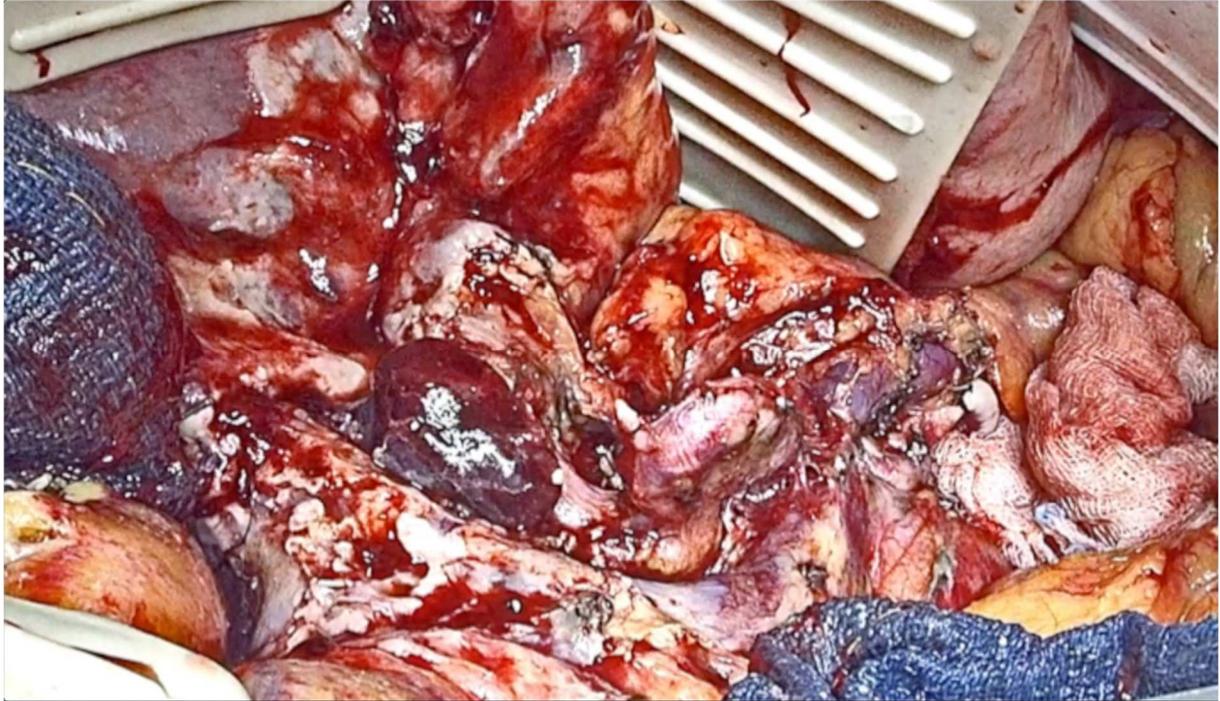


Figure 2

A)



B)

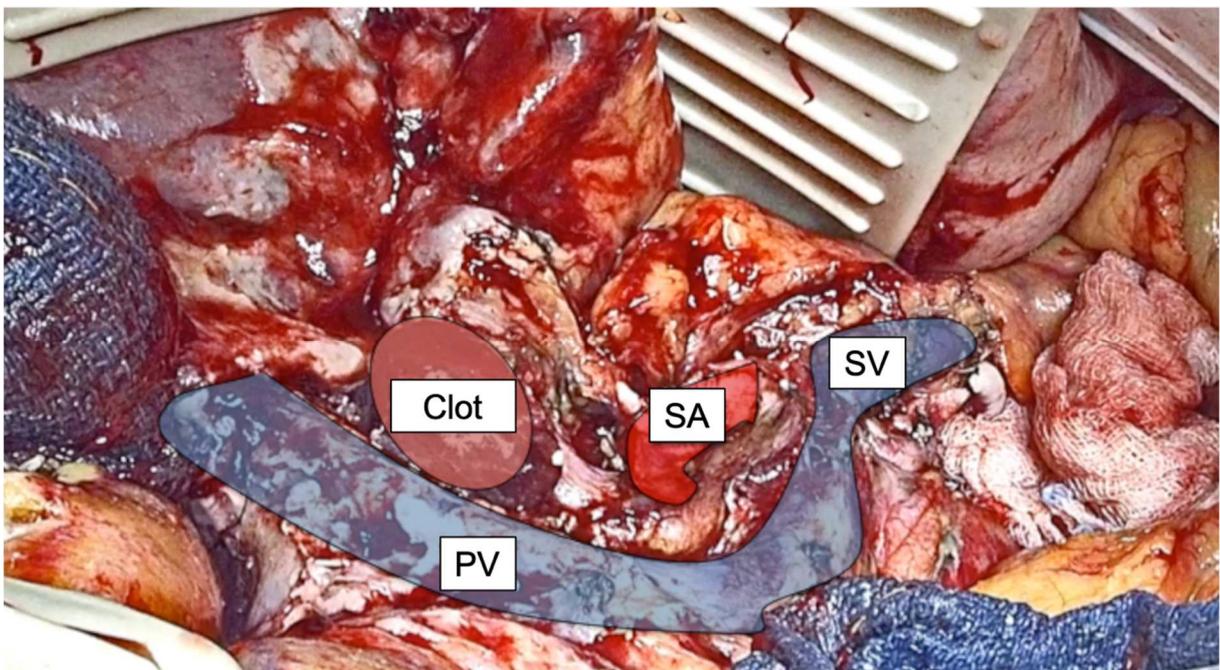


Figure 3

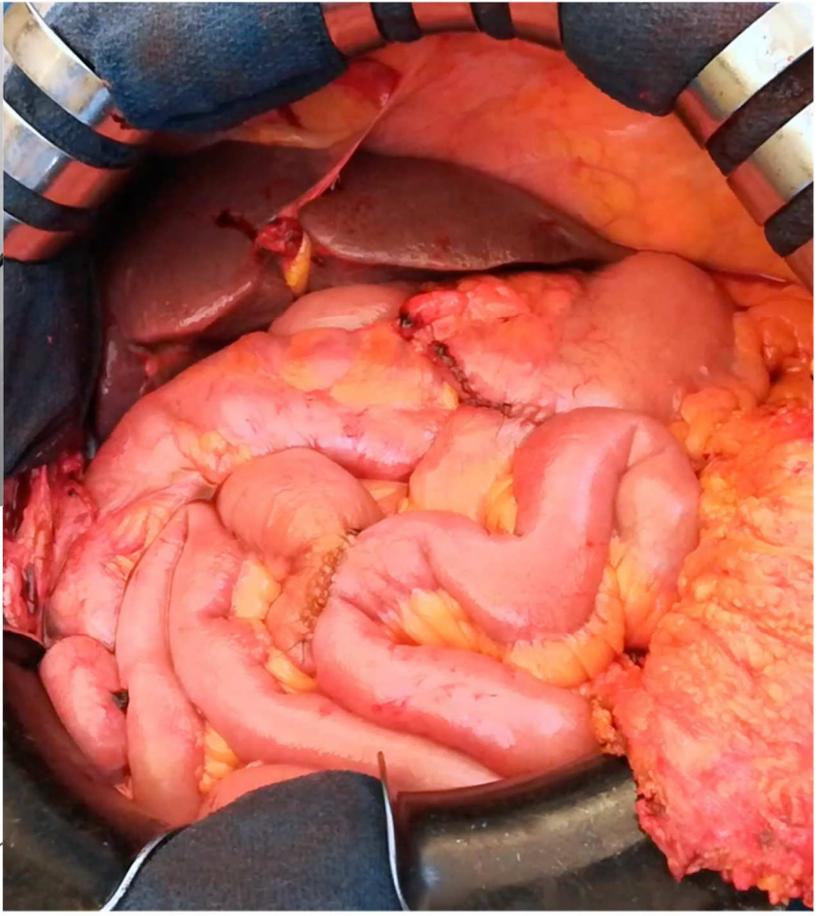
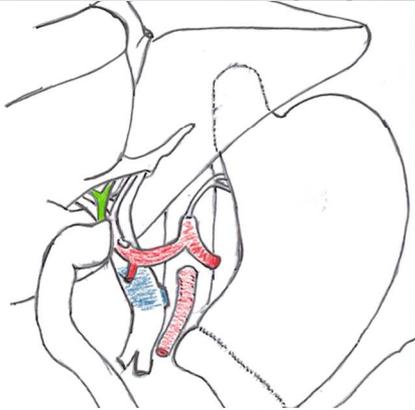
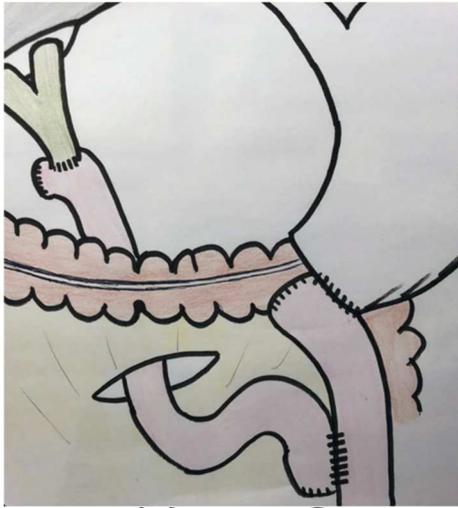


Figure 4

A/



B/

