Modern principles of diagnosis and treatment of post–pancreatic resection bleeding

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Abstract

Objective. To improve the results of treatment of patients with post–pancreatic resection bleeding.

Materials and methods. The results of treatment of 827 patients who underwent radical resection of the pancreas for malignant tumours in the period from 2010 to 2021 were analysed. The patients were divided into two groups: the main group – 449 patients who were treated at the clinic from 2016 to 2021, and the control group – 378 patients who were treated in the clinic from 2010 to 2015. Postpancreatectomy bleeding occurred in 27 (6.0%) patients in the main group who were treated according to the developed diagnostic and therapeutic algorithm with the maximum use of endovascular techniques, and in 20 (5.3%) patients in the control group who received standard treatment.

Results. X–ray endovascular bleeding control was performed in 14 (51.9%) of 27 patients in the main group: X–ray endovascular occlusion – in 9, by means of stent graft placement – in 5. In 3 (11.1%) patients of the main group, the source of bleeding was not detected during angiography, and they underwent laparotomy with subsequent bleeding control. Complications after X–ray endovascular occlusion occurred in 1 (11.1%) patient, and there were no complications after stent graft placement. Open surgical interventions were performed in 13 (48.1%) patients. One (3.7%) patient died after laparotomy with bleeding control due to the development of further purulent–septic complications. In the control group, X–ray endovascular bleeding control was performed in 3 (15%) patients, and relaparotomy with bleeding control in 17 (85%) patients. 6 (30%) patients died after open reoperative interventions.

Conclusions. Endovascular techniques for stopping post–pancreatic transplantation bleeding are highly effective and safe with favourable technical and clinical results. They are advisable as the first step in the treatment of postpancreatic surgery bleeding with stent grafts in case of bleeding from the great vessels.

Keywords: post–pancreatic resection bleeding; endovascular techniques; endovascular embolisation; stent-graft.

Despite the progress in the development of pancreaticobiliary surgery, improvement of surgical techniques, and widespread introduction of new surgical methods, the complication rate after pancreatic resection remains high. Surgical interventions on the pancreas are extremely complex, and although mortality after such interventions has decreased to 5% in highly specialised world centres, the complication rate after them ranges from 30 to 60%, i.e. is one of the highest in abdominal surgery [1–6].

Postpancreatic transplantation bleeding is considered one of the most serious, life–threatening complications, it can occur in approximately 10% of patients [2] and is associated with a mortality rate of 10–38% [2–5, 6].

Since 2007, the International Study Group of Pancreatic Surgery (ISGPS) has developed an objective, generally accepted definition of post–pancreatic surgery bleeding, which has made it possible to compare the results of diagnosis and treatment of this serious complication in different centres.

According to the ISGPS, bleeding after pancreatic resection is determined by three parameters: onset, location, and severity. According to the onset of bleeding, there is early (up to 24 hours after surgery) and late (24 hours or more after surgery) bleeding. According to the location, there are intraluminal and extraluminal bleeding, and according to the severity, there are moderate and severe bleeding.

There are 3 degrees of post–pancreatectomy bleeding, depending on the time of its occurrence and severity.

Grade A (early bleeding of moderate severity) is a minor blood loss, when the patient's clinical condition does not change and there is no need for invasive interventions.

Grade B (early severe bleeding or late moderate bleeding) – rarely threatens the patient's life, requires computed tomography (CT), angiography (AG), esophagofibrogastrroduodenoscopy (EFGDS) with medical interventions (endoscopic bleeding control, vessel embolisation) or relaparotomy (only in case of early severe bleeding).

Grade C (late severe bleeding) is life–threatening and requires CT, AS, EFHDS, and medical interventions (endoscopic, surgical bleeding control) [7].

Early post–pancreatectomy bleeding is associated with technical failures and problems during surgery and requires conservative therapy, and in case of its ineffectiveness, immediate reoperation.

As for late postpancreatectomy bleeding, it has a multifactorial pathophysiological mechanism and is most often associated with the occurrence of other complications after pancreatectomy, such as postoperative pancreatic fistula (POPF). The presence of postoperative amylase–rich fluid...
accumulations in the parapancreatic and subhepatic spaces, around the vessels, can lead to their arosis and haemorrhage, and bleeding can occur in the setting of infectious complications or abdominal abscesses [2, 7–11]. Among all the causes of post-pancreatic transplantation bleeding, PAPB is the most common. Recent studies have confirmed this fact: 80% of patients with postpancreatic surgery bleeding were diagnosed with PAPB [12].

Clinically significant PAP is characterised as an independent risk factor for the development of late post-pancreatic surgery bleeding, with a 17-fold increase in bleeding-related mortality [12].

Post-pancreatectomy bleeding remains a serious complication and requires careful clinical monitoring and urgent treatment with the maximum use of minimally invasive endovascular techniques. Timely diagnosis and proper treatment of this complication can prevent serious consequences and mortality. A multidisciplinary team of experts is essential to ensure the best possible treatment for these patients 24 hours a day.

The aim of the study was to improve the results of treatment of patients with post-pancreatic resection bleeding.

Materials and methods
The results of treatment of 827 patients with malignant tumours of the pancreas and periampullary zone who underwent radical surgery at the Department of Pancreas and Bile Duct Surgery of the National Institute of Surgery and Transplantation named after O. O. Shalimov for the period from 2010 to 2021 were retrospectively analysed. Men predominated among the patients, there were 469 (56.7%), and women – 358 (43.3%), the average age of patients was (55.9 ± 9.4) years (age range ranged from 27 to 82 years).

Post-pancreatectomy bleeding occurred in 47 (5.7%) patients: after pancreas-sparing operation (PSO) – in 38 (4.6%), after distal pancreas resection (DPR) – in 8 (1.0%), including 1 patient after modified Appleby operation, after total pancreas-sparing operation (TPO) – in 1 (0.1%) patient. 7 (14.9%) patients with post-pancreatectomy bleeding died.

Until 2016, we used open surgical interventions more often in the treatment of post-pancreatic transplantation bleeding. Since 2016, the treatment tactics have been changed: we performed AG as the first stage for both diagnosis and endovascular bleeding control. In order to develop an optimal treatment strategy for such a complication as bleeding, we analysed the results of treatment of patients for different periods.

Patients were divided into two groups: the main group – 449 patients who were treated from 2016 to 2021, they were treated according to the diagnostic and treatment algorithm developed by us, and the control group – 378 patients who were treated from 2010 to 2015, they were treated according to standard approaches. The groups were comparable in terms of age, stage of the underlying disease, and comorbidities.

In the main group, as the first stage of treatment, patients with postpancreatic resection bleeding underwent AG for diagnostic and therapeutic purposes. If the general condition of the patient allowed, multidetector CT was performed before the AG to determine the source of bleeding and assess the arterial anatomy.

We believe that CT with intravenous contrast is a necessary component of the diagnostic algorithm in patients with postpancreatic transection bleeding, provided that the haemodynamic condition is stable. CT allows not only to identify the probable source of bleeding, determine the anatomy of blood vessels, but also to diagnose other postoperative complications, such as parapancreatic, retroperitoneal fluid accumulations, which were not previously detected by postoperative ultrasound (PUS). It is not always possible to stop the patient’s bleeding during AG, so if reoperation is possible, which is usually performed immediately, it is extremely important to perform a correct preoperative diagnosis.

An arterial aneurysm (not previously diagnosed by preoperative CT) or active extravasation of contrast medium during CT was considered as a source of bleeding.

In case of diagnosed bleeding during hypertension, endovascular bleeding was stopped: endovascular occlusion of the bleeding vessel or endovascular stenting. In case of bleeding from a major vessel (common, right and left hepatic, superior or mesenteric arteries), endovascular stenting was performed.

If it was technically impossible to perform endovascular bleeding control or the patient's condition was haemodynamically unstable, open surgical interventions were performed.

Results
Postpancreatectomy bleeding occurred in 27 (6.0%) patients of the main group and 20 (5.3%) patients of the control group.

The degrees of post-pancreatic resection bleeding were distinguished according to the ISGPS classification.

In the main group, post-pancreatectomy bleeding grade A occurred in 3 patients, grade B – in 11, grade C – in 13, in the control group – in 2, 3 and 15 patients, respectively.

In the main group, bleeding after DES occurred in 23 (5.1%) patients, after DRPD – in 4 (0.9%). In the control group, bleeding after DRE occurred in 15 (4.0%) patients, after DRPZ – in 4 (1.1%), after TPDE – in 1 (0.3%) patient.

Grade A postpancreatectomy bleeding, which occurred in 3 patients in the main group, was stopped conservatively.

In the main group, AG was performed as the first stage of treatment in 17 (63.0%) of 27 patients, in the control group – in 3 (15%) of 20 patients.

Bleeding was diagnosed in 14 (82.4%) of 17 patients in the main group and they underwent endovascular bleeding control, in 3 (17.6%) patients the source of bleeding was not identified and they underwent laparotomy with subsequent bleeding control.

X-ray endovascular bleeding control was performed in 14 (51.8%) of 27 patients. X-ray endovascular occlusion was performed in 9 patients splenic artery occlusion in 5 patients,
dorsal pancreatic artery in 1 patient, branch of the superior mesenteric artery in 2 patients, and gastroduodenal artery in 1 patient.

In case of bleeding from the main vessels (general, right and left hepatic arteries, superior mesenteric arteries), when X–ray endovascular embolisation was not possible due to severe ischemic complications, X–ray endovascular stenting was performed, which allowed closing the vessel defect without disturbing blood circulation through it. Bleeding control with a stent graft was performed in 5 patients. In 2 patients, after PDE, a stent graft was placed in the common hepatic artery for bleeding from the stump of the gastroduodenal artery. In 1 patient with bleeding from the common hepatic artery, its defect was closed with a stent graft (Figs. 1, 2).

In 2 patients, a stent graft was placed in the right hepatic artery after PDE. In 1 patient who developed bleeding after PDE, an extravasation from the right hepatic artery was diagnosed in hypertension (Figs. 3, 4), which had a separate trunk from the superior mesenteric artery. It was dangerous to perform embolisation of the right hepatic artery due to the high risk of ischaemic complications. The patient with hypertension immediately after diagnosis and detection of extravasation underwent a stent graft in the right hepatic artery (Fig. 5). In control hypertension, bleeding control was confirmed (Fig. 6).

There were no complications after stent graft placement. In all patients, bleeding was stopped without further ischaemic complications.

After X–ray endovascular bleeding control, 1 (7.1%) patient developed a splenic abscess, which was treated with mini–invasive techniques: punctures with abscess debridement under ultrasound control.

In all patients, bleeding was stopped after X–ray endovascular treatment.
Open surgical interventions in the main group were performed in 10 (37%) patients. All patients achieved bleeding control. In 2 (20%) patients, bleeding recurred. In this regard, 1 patient underwent a total pancreatectomy. Bleeding from the pancreatojejunostomy was diagnosed in 1 patient during relaparotomy, and intraoperatively he was stopped from bleeding from the pancreatic parenchyma, but on the 1st day after relaparotomy, bleeding recurred. The patient was urgently taken to the operating room, the pancreaticoduodenal anastomosis was disconnected with the installation of external drainage of the main pancreatic duct.

In the main group, 1 (3.7%) patient died after no-touch PDE. He developed postoperative pancreatitis with infected parapancreatic collections. On the 9th day after surgery, intra-abdominal bleeding occurred. Relaparotomy, bleeding control, completion of total pancreatectomy with splenectomy, auto-arterial prosthesis of the common hepatic artery with a splenic artery stump were performed immediately. On the 1st day after the relaparotomy, thrombosis of the arterial anastomosis occurred, and a repeat surgical intervention with thrombectomy and abdominal cavity rehabilitation was immediately performed. After that, vacuum-assisted dressings were repeatedly installed and replaced, repeated rehabilitation and drainage of the abdominal cavity were performed, but, unfortunately, the patient died.

In the control group, 2 patients developed grade A post-pancreatic resection bleeding, which was stopped conservatively. In 3 patients, postpancreatic resection bleeding of grade B occurred. In 1 patient, it was gastrointestinal bleeding, which was stopped endoscopically. X-ray endovascular occlusion of the splenic artery was performed in 2 (10%) patients.

In 15 patients, repeated surgical interventions were performed to stop the bleeding, and in all patients the bleeding was stopped.

Of the 20 patients in the control group, 6 (30%) died due to the development of further purulent and septic complications. The overall mortality rate for post-pancreatectomy bleeding was 14.9% (7 out of 47 patients died).

After laparotomy with bleeding control, 7 (25%) of 28 patients died due to further septic complications: 1 patient in the main group and 6 patients in the control group.

No patient died after endovascular bleeding control techniques were applied. Thanks to the diagnostic and treatment tactics developed by us with the extensive use of endovascular methods of diagnosis and bleeding control, we managed to reduce the mortality rate of post-pancreatic surgery bleeding in the main group to 3.7%, while in the control group this figure was 30% ($\chi^2 = 6.3, p = 0.01$).

Discussion

Postoperative complications are one of the most discussed and relevant topics in pancreatic surgery.

According to world data, the only effective measure to treat postoperative bleeding and reduce mortality in this severe category of patients is the use of minimally invasive endovascular techniques, which are available in the clinic of interventional radiology with hypertension around the clock 7 days a week [6–13].

According to the literature, endovascular bleeding control is effective in 80 – 100% of patients with mortality significantly lower than the corresponding figure after surgery. D. Roulin and co-authors [13] published data showing a significant increase in mortality after laparotomy (47%) compared with the corresponding figure for endovascular haemostasis (22%), and thus supported endovascular interventions. According to our data, the efficacy of endovascular hemostasis was 85%, i.e., effective endovascular hemostasis was noted in 17 of 20 patients who underwent AG as the first stage.
Open surgery is considered an alternative approach to the treatment of post-pancreatectomy bleeding, but relaparotomy should be performed as an urgent first step only in patients with massive bleeding, unstable hemodynamics, as well as in pancreatic fistulas requiring total pancreatectomy, or if AG is not available for any reason [5–7].

Despite advances in the surgical technique of pancreatic surgery and the development of new modern equipment, the incidence of postoperative complications remains high even in the world's highly specialised centres. A systematic review of bleeding outcomes after pancreatectomy, stratified according to the ISGPS score and published by T. A. Maccabe and colleagues [8], included 62 studies from 2008 to 2020. The results of pancreatic resection in 10,775 patients were presented, of which 608 patients had bleeding, which was 5.6%.

The review published by A. Floortje van Oosten and colleagues [2], contains data from 14 studies involving 467 patients who underwent pancreatic resection. Postoperative bleeding occurred in 3–16% of patients. The mortality rate for bleeding after pancreatic resection ranged from 30 to 50% [11].

According to our data, post–pancreatectomy bleeding occurred in 5.7% of patients. Seven patients with bleeding died. The overall mortality rate was 14.9%, and in the main group – 3.7%.

According to world studies, early bleeding from the surface of the pancreas (41.2%) and from anastomoses (23.6%) was most often detected. Late bleeding from the gastroduodenal (27.4%) and common hepatic (21.4%) arteries occurred more often than late bleeding from the pancreaticoduodenal anastomosis [9, 11]. Late arterial bleeding is the most common. According to P. Biondetti and colleagues [10], one third of patients with post–pancreatectomy bleeding have aneurysms.

In our study, no early post–pancreatectomy bleeding was diagnosed. In all patients, bleeding was late, occurring on days 2 to 38.

As for the location, according to our data, bleeding from the pancreatic anastomosis, common or right hepatic artery was the most common, and this indicator correlated with the incidence of postoperative pancreatogenic complications, in particular, PAH.

According to the literature, 30 – 66% of patients develop ischaemic complications after embolisation of the common hepatic artery. Occlusion of the common hepatic artery can lead to cholangitis, hepatic abscesses, and fatal liver failure [11]. Embolisation of a single stump of the gastroduodenal artery is very difficult and usually impossible due to its short length. In 100% of patients, bleeding recurs and can occur from another segment of the common hepatic artery. Many authors consider AG to be a first–line procedure for bleeding from the gastroduodenal or common hepatic artery, followed by stent grafts. The literature describes complications after stent graft placement, such as thrombosis, stent dislocation, and recurrent bleeding. Infectious complications associated with para-pancreatic infectious accumulations around the stent are also possible [12–15]. We did not observe any complications associated with stent placement, nor did we observe any subsequent recurrence of bleeding.

As for late bleeding, it is most often associated with vascular arosis associated with pancreatic fistula, parapancreatic fluid accumulation, infectious complications, or intra-abdominal abscess [11, 16]. Pancreatic fistula is the main cause of late post–pancreatectomy bleeding. According to recent studies, in 80% of patients, bleeding occurred in the setting of a PFOA, which is not only a reliable risk factor for postoperative bleeding but also increases bleeding–related mortality by 17 times [12].

In our study, out of 47 patients with postpancreatic resection bleeding, 29 (61.7%) had it in the setting of PAP and related infectious complications.

It is worth remembering that in the event of postoperative bleeding, you should think not only about ulcers in the digestive tract, but also about problems with the pancreatic anastomosis. Often, if it fails, bleeding is possible both through the drains and into the digestive tract. Hemobilia can occur when a false aneurysm with a breakthrough into the biliary system is formed after the common hepatic artery is aroused. Mortality in this complication can range from 35 to 50% [12].

Among other causes of intra-abdominal bleeding, venous bleeding is also possible. Portal thrombosis is associated with the development of multiple portal collaterals and bleeding from varicose veins. The main method of treatment of such bleeding is laparotomy with bleeding control.

The choice of treatment for late post–pancreatic transplant bleeding depends on the clinical picture. The first stage of treatment is to assess whether the patient is haemodynamically stable. If the patient is haemodynamically unstable, it is recommended to perform a second operation immediately. Hemodynamically unstable patients are usually prone to intense bleeding, such as active arterial and pancreaticojejunal anastomosis bleeding. Emergency laparotomy is considered the only way to save the lives of these patients [12–16].

The choice of surgical intervention is important for emergency surgery, it is best to choose operations that are accompanied by little surgical trauma. Completion of the operation with a total pancreatectomy is often technically very difficult due to the modified anatomy, postoperative adhesions and inflammatory postoperative changes, especially when bleeding occurs in the setting of PAP with the development of septic complications. Some authors recommend the use of special pancreatic drainage instead of performing a complete total pancreatectomy.

Due to the significant surgical trauma associated with laparotomy, surgery is not considered the first choice in haemodynamically stable patients.
Some authors suggest performing AG in the event of signal bleeding, but the source of such bleeding cannot be found in many patients, probably due to its intermittent nature. In case of signal bleeding, AG is the most sensitive. Multidetector CT – AG can detect the cause, nature and location of bleeding, which allows to determine further treatment [12].

When the source of bleeding is not identified after the initial diagnosis, it is recommended to perform diagnostic angiography of the abdominal trunk and superior mesenteric artery. This study can demonstrate both direct (extravasation of active contrast) and indirect (spasm or disturbance of the vessel contour) signs of bleeding. The diagnostic value of AH is limited in the case of diffuse, venous, or intermittent bleeding [12–16].

Thus, late post–pancreatic surgery bleeding is a serious complication of pancreatic surgery, and pancreatic anastomosis is the most common site. The mortality rate for such bleeding is high due to diagnostic difficulties and its sudden onset. This rate can be reduced only if pancreatic resection is performed in highly specialised medical institutions that can recognise this complication in a timely manner and perform appropriate intervention with round–the–clock access to endovascular techniques and subsequent bleeding control [6].

Conclusions

1. Endovascular techniques for stopping post–pancreatic transplantation bleeding are highly effective and safe with favourable technical and clinical results. They should be the first step in the treatment of such patients with stent grafts in case of bleeding from the great vessels.

2. Thanks to the developed treatment tactics with the maximum use of minimally invasive endovascular techniques, it was possible to significantly reduce the mortality rate of post–pancreatic surgery bleeding from 30 to 3.7% (χ² = 6.3, p = 0.01).

3. To improve the treatment of this severe complication, endovascular interventions should be available around the clock at any time of the day.

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References


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