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# Hemorrhagic Cysts in the Pancreas: Risk Factors, Treatment, and Outcomes – Insights from a Single-Center Study

## Authors' Contribution:

Study Design A  
Data Collection B  
Statistical Analysis C  
Data Interpretation D  
Manuscript Preparation E  
Literature Search F  
Funds Collection G

ABDEF 1 **Michał Serafin**   
ABDEF 1 **Paulina Kluszczuk**  
ABCDE 1 **Sebastian Maślanka**   
ABDEF 1 **Tomasz Kowalczyk**  
ABDEF 2 **Beata Jabłońska**   
AEF 2 **Sławomir Mrowiec** 

1 Students' Scientific Society, Department of Digestive Tract Surgery, Medical University of Silesia, Katowice, Poland  
2 Department of Digestive Tract Surgery, Medical University of Silesia, Katowice, Poland

**Corresponding Author:** Michał Serafin, e-mail: [michal.serafin@interia.com](mailto:michal.serafin@interia.com)  
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**Background:** Hemorrhagic cysts are rarely discussed subtypes of pancreatic pseudocysts that occur in about 10% of these cases. They are caused by erosion of the walls of neighboring vessels by extravasated proteolytic pancreatic enzymes. A retrospective analysis was performed to clinically characterize risk factors, treatment, and outcome in patients with hemorrhagic cysts of the pancreas.





**Material/Methods:** The retrospective study included patients from the Department of Digestive Tract Surgery in Katowice, Poland, who were treated surgically for a pancreatic hemorrhagic cyst from January 2016 to November 2022. We gathered and assessed data on cyst etiology, symptoms, imaging examinations, risk factors, time, type, and complications of surgery.

**Results:** The main symptom was abdominal pain, noted in 5 (62.5%) patients. The most common etiology of cyst was acute pancreatitis, which occurred in 5 patients (62.5%). The most common localization was the tail of pancreas, found in 3 patients (36.5%). The largest dimension of the cyst was  $98 \pm 68$  (30-200) mm. Every patient needed surgical intervention. Patients underwent distal pancreatectomy (n=3) or marsupialization (n=5). One (12.5%) postoperative complication was observed, while mortality was 0%.

**Conclusions:** Hemorrhagic cyst is a life-threatening complication of pancreatitis requiring immediate treatment. In most cases, open surgery is the treatment of choice. Despite the continuous development of minimally invasive techniques, surgical treatment remains the only effective treatment method. Depending on the cyst localization and technical possibilities, pancreatectomy or marsupialization can be applied, and both of them have low complication and mortality rates.

**Keywords:** **Pancreatic Pseudocyst • Pancreatitis • Pancreatitis, Chronic**

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## Introduction

Pancreatic pseudocyst (PPC) is formed on the background of pancreatitis, where the damage of the pancreatic ducts occurs. There is an outflow of the pancreatic juice into the abdomen, and the wall of the cyst is formed by the connective tissue that surrounds the organ. According to the revised Atlanta Classification (2012), the PPC is defined as an encapsulated, well-defined collection of fluid with no or minimal solid components, that occurs >4 weeks after onset of interstitial edematous pancreatitis [1]. Hemorrhagic cyst is defined as PPC, an encapsulated collection of blood. The incidence is estimated to be 1.6-4.5% in the total population and 0.5-1 per 100 000 adults [2]. It is usually a complication of the inflammation of this organ. In acute pancreatitis (AP), the incidence is 6-18.5%, and in chronic pancreatitis (CP) it is 20-40% [3].

Hemorrhagic cysts are a rare subform of pseudocysts, which account for 10% of cases [4] and are caused by the erosion of the walls of neighboring vessels by the extravasated proteolytic pancreatic enzymes. The splenic artery (30-50%), the gastroduodenal artery (17%), and the pancreaticoduodenal arteries (11%) are involved [5]. Less often, the surrounding venous vessels and small vessels associated with pancreatic necrosis are the cause of bleeding [6]. Also, some procedures can be related to the iatrogenic formation of hemorrhagic cysts. One of them is through the needle biopsy of PPC. In 2% of cases, this procedure causes intracystic hemorrhage due to damage to surrounding blood vessels [7].

Pancreatic pseudocysts may not show any symptoms, but they are often associated with abdominal pain, nausea, vomiting, abdominal bloating, and abdominal mass. Complications related to their presence include compression of the large abdominal vessels, pylorus/duodenum, common bile duct, and, in the worst cases, infections or bleeding into the cyst [4]. To prevent this, it is important to qualify patients for the appropriate treatment method and to adapt the duration of treatment taking into account the size, location, type of cyst, and patient clinical status [8]. Ultrasonography, computed tomography (CT) of the abdomen, endoscopic ultrasonography (EUS), and biopsy are useful for differentiating pseudocysts from cystic tumors [3].

Techniques that can be used to treat pancreatic cysts include internal drainage, external drainage, marsupialization, and pancreatic resection [9,10].

Treatment of hemorrhagic cysts is not standardized. Minimally invasive techniques are contraindicated. Endovascular therapy may be performed on hemodynamically stable patients with pseudoaneurysm visualized on computed tomography angiography (CTA). In the case of hemorrhagic shock or absence of pseudoaneurysms and bleeding vessels in CTA, the classical laparotomy is often used [11].

There is little information regarding pancreatic post-inflammatory hemorrhagic pseudocysts in the worldwide literature. We found only a small series of studies and few case reports. Therefore, the present study performed clinical characterization and analysis of the results of surgical treatment of this rare disease based on retrospective analysis of the data from the Department of Gastrointestinal Surgery of the Medical University of Silesia in Katowice, Poland.

## Material and Methods

### Ethics Statement

This study was conducted based on patient medical records, and all accessed data were fully anonymized by the local medical records archive. Each patient's medical record was given a unique number. All participants sign a written consent to the surgical procedure. All procedures were performed in accordance with the 1964 Declaration of Helsinki on Medical Research Involving Human Subjects. Our retrospective study fell into the category of exempt from Institutional Review Board (IRB) approval because the Polish Act of 5 December 1996 on the Profession of Medical Doctors and Doctors of Dental Medicine (Journal of Laws of 2022, item 1731 as amended) specifies that retrospective data analysis of medical data is not a medical experiment and does not require evaluation by local Bioethics Committee.

### Study Design

The retrospective study included all patients from the Department of Gastrointestinal Surgery in Katowice who were treated surgically for a pancreatic hemorrhagic cyst from January 2016 to November 2022. We individually reviewed the medical records from the electronic system of all surgical treatment of PPCs and analyzed only those with hemorrhagic PPC. Patients who received interventions for non-hemorrhagic PPC were excluded from further analysis.

### Methods

#### Diagnostic Criteria

PPC was diagnosed with a contrast-enhanced CT according to the revised Atlanta Classification from 2012 and was based on 4 criteria: (1) well-circumscribed, homogeneous, round or oval fluid collection; (2) absence of solid component; (3) well-defined wall; and (4) previous AP or exacerbation of CP more than 4 weeks ago [1].

Hemorrhagic PPC was diagnosed with a contrast-enhanced CT/angio-CT based on 3 criteria: (1) contrast outflow to the

cyst lumen in CTA; (2) heterogeneous density, hypo- and hyperdense areas in the lumen of the cyst; (3) low hemoglobin and red blood cells count in blood morphology.

The CTA scans were always evaluated by a surgical and radiological team consisting of several specialists.

### **Methods of Treatment**

All patients were evaluated by surgeons, who decided on qualification for a particular type of surgical procedure during the operation, marsupialization, or distal pancreatectomy.

#### *Inclusion Criteria to Marsupialization/Distal Pancreatectomy*

Marsupialization was performed in case of hemorrhagic PPC, in the absence of previous or active bleeding, or in the case of minor bleeding from small vessels with the successful attempt of local bleeding control.

Distal pancreatectomy with splenectomy was performed in case of the hemorrhagic PPC with large active bleeding from the major splenic vessels or their branches when a local bleeding control attempt was not possible, and was accompanied by damage to the pancreatic parenchyma by the primary disease. Due to the cyst and bleeding location, distal pancreatectomy with splenectomy was performed.

#### *Marsupialization*

Laparotomy was performed with a midline incision. Then, the lesser sac was entered by incising the gastrocolic ligament. After dissection of the gastrocolic and splenocolic ligaments, the anterior surface of the pancreas was exposed by dissecting the adhesion between the stomach and pancreas. Through the access between the gastric and the colon, the cyst was opened, and blood-tinged fluid and clots were evacuated from its interior. Access to the interior of the cyst was extended by making a transverse incision in its wall. Subsequently, the cavity was thoroughly irrigated, bleeding vessels ligated (if it was required), and Mikulicz pads were placed. In the central portion of the postoperative wound, fragments of the cyst wall were sutured to the parietal peritoneum, forming a laparostomy. The lower and upper poles of the wound were closed in layers [12].

#### *Distal Pancreatectomy*

Laparotomy was performed with a midline incision. Then, the lesser sac was entered by incising the gastrocolic ligament. After dissection of the gastrocolic and splenocolic ligaments, the anterior surface of the pancreas was exposed by dissecting the adhesion between the stomach and pancreas. Next, the ligaments between spleen and diaphragm, stomach and esophagus were

incised. Then, the space between the retroperitoneum and the pancreas was dissected to mobilize the spleen and the tail of the pancreas sufficiently. In the next step, the splenic vessels were ligated and a splenectomy was performed. The cyst was dissected along with the tail from the retroperitoneal space. Next, the parenchyma was cut proximally to the cyst and the pancreatic tail or the pancreatic tail and distal body with the hemorrhagic cyst were removed. The pancreatic stump was sutured with single stitches. Then, the drains were placed in the left sub-diaphragmatic space and in the area of the closed pancreatic stump, followed by layered closure of the abdominal wall [13].

### **Analyzed Data**

Parameters such as localization, diameter, etiology of the cyst, type of clinical symptoms, duration of surgery, incidence of complications, reoperations, mortality, and duration of hospitalization were selected to be analyzed in the study.

Data on the localization and diameter of the cyst and the duration of surgery were collected from the description of the patient's surgery. The cyst etiology was determined from the patient's medical history (the last type of pancreatitis was considered the etiology). Complications were defined as any adverse event that occurred in the peri- or postoperative period that was related to the surgical procedure. Reoperation was defined as a second surgical intervention related to the primary operation or its complication. Total time of hospitalization was the length of stay from the day of hospital admission to the day of discharge. Time of hospitalization after surgery was the length of stay from the day of surgical approach to discharge.

### **Statistical Analysis**

The Shapiro-Wilk test was used to determine statistical distributions in the analyzed patients. Descriptive statistical analysis and analysis of differences between the marsupialization and distal pancreatectomy surgery groups were performed (*t* test and Mann-Whitney U test). Depending on the distribution type, the continuous variables were presented with values of mean and standard deviation or median and quartile range. Categorical variables were presented as numbers and percentages. A *p*-value <0.05 was considered statistically significant. The statistical analyses were performed using the Statistica® software program, version 13.3 (StatSoft).

## **Results**

### **Characteristic of the Patients**

In the analyzed group, there were 32 patients undergoing surgery for a post-inflammatory pancreatic cyst, of whom 8

(25%) had a hemorrhagic cyst. The mean age of patients with hemorrhagic cyst was  $47 \pm 11$  years (28-61). In 5 (62.5%) patients, it was a complication of AP and in 3 (37.5%) it was a complication of CP.

All the patients in this group were male. Six (75%) of them had normal BMI. The predominant symptom was abdominal pain, which occurred in 5 (62.5%). In 5 patients (62.5%), the cyst originated in the etiology of AP and was mainly located in the tail of pancreas in 3 (37%) cases. All patients underwent surgery. Four (50%) of them had III class on the ASA (American Society of Anesthesiologists) scale. Class II and IV on the ASA scale were reported in 2 (25%) of the patients. Five (62.5%) patients underwent marsupialization, and the remainder underwent distal pancreatectomy (Tables 1, 2).

### Cyst Characteristics

In all the cases of a cyst that occurred after AP, a marsupialization was performed, and when the etiology was CP, distal pancreatectomy was performed (Table 3).

The localization of the cysts treated by marsupialization was head ( $n=1$ , 12.5%), body ( $n=1$ , 12.5%), tail ( $n=1$ , 12.5%), body and tail ( $n=1$ , 12.5%), and whole pancreas ( $n=1$ , 12.5%). The only localization of the cyst treated by distal pancreatectomy was tail of the pancreas ( $n=3$ , 37.5%) (Table 4).

The largest dimension of cyst in CTA was  $98 \pm 68$  (30-200) mm. There were no significant differences between the type of intervention and the size of the cyst (238 vs 84,  $t$  test  $P=0.072$ ) (Table 5). PPC size was not a variable taken into account in surgical decision-making about the type of surgery. Two examples of hemorrhagic PPCs are presented Figures 1 and 2. A comparison between the hemorrhagic and non-hemorrhagic PPC is presented in Figure 3.

### Surgery Characteristics

No significant differences were observed between the time of marsupialization and distal pancreatectomy (95 vs 270 min, U-Mann  $P=0.073$ ), the time of hospitalization (23 vs 13 days, U-Mann  $P=0.233$ ). The lack of statistically significant difference in the duration of marsupialization and distal pancreatectomy might be related to the long duration of marsupialization in 1 patient (265 min) due to difficult conditions during the procedure (many postoperative adhesions). Two patients required a transfusion of red blood cell concentrate (RBC); in each case, 2 units were needed. There was a higher perioperative risk on the ASA scale in patients with CP compared to AP ( $P=0.047$   $t$  test). This finding may be related to a chronic debilitating disease such as CP, which could have caused an increased perioperative risk. Only 1 patient (12.5%) had a complication of

acute cardiopulmonary failure due to general anesthesia, and the mortality rate was 0% (Table 6).

### Follow-Up

Follow-up was defined as the patient's last registered visit to the ward or clinic. The average time of patients appearing at the clinic for follow-up appointments was 20.3 (1.5-82.3 IQR 41.5) months. During the follow-up period, there were no reported adverse events or recurrence of cysts. However, considering the wide range of follow-up times, adverse events and cyst recurrence might have been underreported.

## Discussion

Hemorrhagic cysts are a rare and rarely discussed subform of pancreatic pseudocysts. In the present study, we found a large difference in the treatment of different types of cysts.

The main symptoms at admission were abdominal pain in 5 patients (62.5%) followed by nausea, vomiting, and melaena in 2 (25%) patients. In addition, fainting and loss of appetite were also reported in 1 (12.5%) patient. One patient (12.5%) was asymptomatic. In the literature on PPCs, the incidence of abdominal pain is 88-94%, nausea and vomiting 5-62%, melaena 8%, and mechanical jaundice 2-15% of cases. The difference in occurrence of symptoms between the present study and the literature might be caused by our small study group size. Nonetheless, the symptoms of hemorrhagic PPC are similar to those of non-hemorrhagic PPC. As shown above, both non-hemorrhagic and hemorrhagic PPC have a variety of uncharacteristic symptoms ranging from asymptomatic to upper gastrointestinal bleeding and cholestasis [6,9].

EUS with thin-needle aspiration has become the preferred examination to differentiate pseudocysts from other cystic lesions of the pancreas [2]. In our patients, EUS was not performed due to a clear diagnosis of the pancreatic hemorrhagic PPC based on CECT, as well as previous or active bleeding to the cyst lumen, which is a contraindication for EUS with thin-needle aspiration. The diagnostic methods used in the diagnosis of hemorrhagic PPCs are Doppler ultrasound, CECT, CTA, digital subtraction angiography, and angiography, and invasive methods such as through-needle biopsy are contraindicated [3]. Balthazar et al found that CTA can detect hemorrhagic complications of PPC in 46% of patients who present with nonspecific abdominal concerns in whom this disease was not suspected. CTA also can suggest the likely etiology of hemorrhagic complications and can precisely indicate the site of bleeding. Therefore, CTA can directly influence management and decrease the mortality rate in patients with hemorrhagic PPC [1]. Visceral selective angiography can detect the exact

**Table 1.** Descriptive and demographic characteristics of patients.

Patient no.	1	2	3	4
Patient age (y)	35	47	56	41
Body mass index	26.47	24.39	17.72	19.41
Symptoms	Abdominal pain	Abdominal pain, syncope	Abdominal pain	Melaena
Comorbidities	No	Portal hypertension	Diabetes	Portal hypertension
Drugs	Cigaretts, Alcohol	No	No	No
Cyst etiology	AP	CP	CP	CP
Cyst localization	Head	Tail	Tail	Tail
Pseudocyst size (mm)	200	100	32	120
ASA scale	2	3	4	4
Procedure	Marsupialization	Distal pancreatectomy	Distal pancreatectomy	Distal pancreatectomy
Procedure time (min)	55	270	200	425
Complications	No	No	No	No
Hospitalization time after procedure (days)	10	7	10	14
Patient no.	5	6	7	8
Patient age (y)	27	59	44	54
Body mass index	18,72	25,31	22,64	24,15
Symptoms	Abdominal pain, nausea, vomiting	Loss of appetite, melaena	No	Abdominal pain, nausea, vomiting
Comorbidities	Portal hypertension	Hypertension, Diabetes,	Hypertension	No
Drugs	No	No	No	Cigarettes
Cyst etiology	AP	AP	AP	AP
Cyst localization	Body and Tail	Tail	Whole pancreas*	Body
Pseudocyst size (mm)	300	100	400	193
ASA scale	3	3	3	2
Procedure	Marsupialization	Marsupialization	Marsupialization	Marsupialization
Procedure time (min)	100	265	90	95
Complications	No	Acute cardiopulmonary failure	No	No
Hospitalization time after procedure (days)	21	24	22	15

\* Due to the large size of the cyst, it was not possible to determine its exact location. All patients were male.



Table 2. Study group characteristics.

Age (years)	47±11 (28-61)	Drugs	
Female/Male	0 (0%)/8 (100%)	Alcohol	1 (12.5%)
Body mass index (BMI)	22.35±3.31 (17.71-26.47)	Cigarettes	1 (12.5%)
17.00-18.49	1 (12.5%)	Localisation of the cyst	
18.5-24.99	5 (62.5%)	Head of pancreas	1 (12.5%)
25-29.99	2 (12.5%)	Body of pancreas	1 (12.5%)
Symptoms		Tail of pancreas	4 (50%)
Abdominal pain	5 (62.5%)	Whole pancreas*	1 (12.5%)
Nausea and vomiting	2 (25%)	Body and tail of pancreas	1 (12.5%)
Melaena	2 (25%)	Cyst etiology	
Loss of appetite	1 (12.5%)	Acute pancreatitis	5 (62.5%)
Syncope	1 (12.5%)	Chronic pancreatitis	3 (37.5%)
None	1 (12.5%)	American Society of Anesthesiologists (ASA) scale	
Comorbidities		I	0 (0%)
Portal hypertension	3 (37.5%)	II	2 (25%)
Hypertension	2 (25%)	III	4 (50%)
Diabetes	2 (25%)	IV	2 (25%)
None	2 (25%)	Type of operation	
		Marsupialization	5 (62.5%)
		Distal pancreatectomy	3 (37.5%)

\* Due to the large size of the cyst, it was not possible to determine its exact location.

Table 3. Type of operation depending on the PPC etiology.

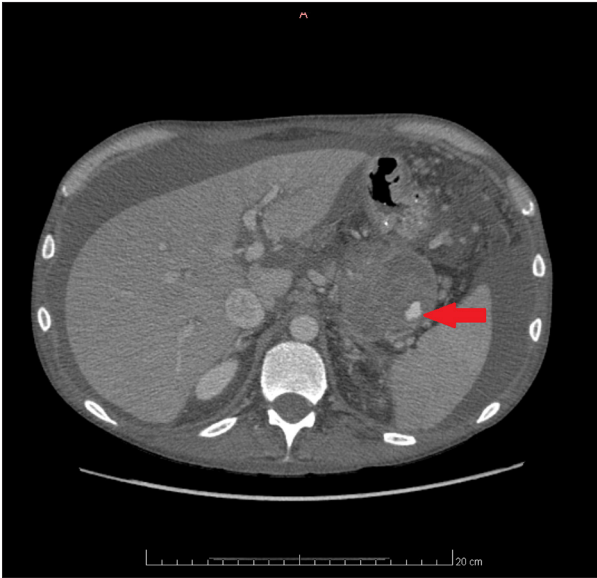
	Marsupialization	Pancreatectomy	Total
Acute pancreatitis	5	0	5
Chronic pancreatitis	0	3	3
Total	5	3	8

Table 4. The type of operation depending on the localization of the PPC.

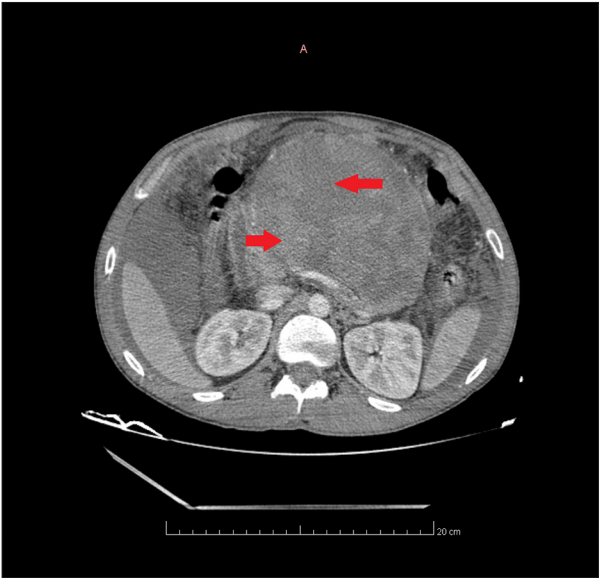
	Marsupialization	Distal pancreatectomy	Total
Head	1	0	1
Body	1	0	1
Tail	1	3	4
Body and tail	1	0	1
Whole pancreas	1	0	1
Total	5	3	8

**Table 5.** Type of the operation depending on the size of the PPC.

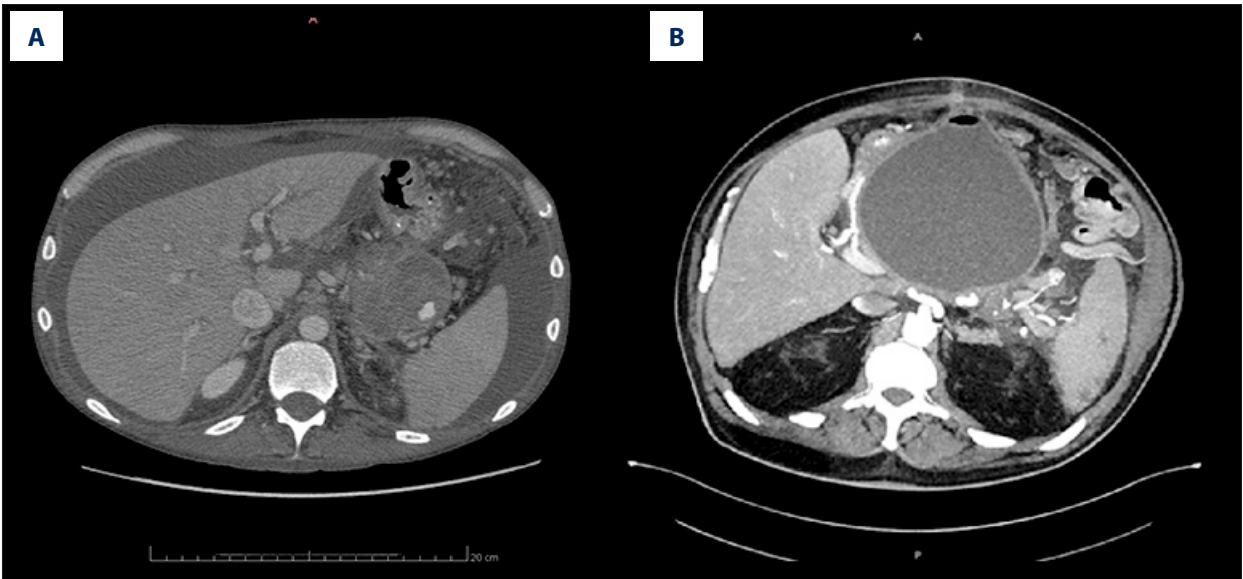
The greatest size of the cyst	Marsupialization	Distal pancreatectomy	Total
<5 cm	0	1	1
5-10 cm	1	1	2
10-15 cm	0	1	1
>15 cm	4	0	4



**Figure 1.** Computed tomography angiography – visible contrast outflow into the lumen of hemorrhagic cyst.



**Figure 2.** Computed tomography angiography – heterogeneous density, hypo- and hypertensive areas that indicate the past bleeding to the lumen of the cyst.



**Figure 3.** Computed tomography angiography. Heterogeneous content density with visible contrast outflow to cyst lumen that indicate the past and active bleeding to the lumen of the hemorrhagic cyst (A). Homogeneous content density that indicates the fluid collection in the non-hemorrhagic cyst (B).

Table 6. Intraoperative properties and complications.

	Marsupialization	Distal pancreatectomy	P (U-Mann/Chi-square)
Time of operation (minutes)	95 IQR 10 (55-265)	270 IQR 225 (200-425)	0.07
Time of hospitalization (days)	23 IQR 6.29 (11-29)	13 IQR 4 (13-17)	0.23
Transfusion of RBC (%)	2 (40%)	0	0.36
Complications			
Acute cardiopulmonary failure	1 (20%)	0	0.78
Death	0	0	

localization of bleeding false aneurysms and it is ideally suited as a therapeutic method to embolize the bleeding artery. Nonetheless, it is an invasive procedure, with higher complications risks than CTA [1]. Therefore, the method of choice for hemorrhagic complications of pancreatitis should be CTA, as a non-invasive investigation is a safer but no less accurate diagnostic method than angiography [1,14].

In our study, the main imaging methods used to diagnose hemorrhagic cysts were abdominal CECT and CTA, which showed the pancreatic parenchyma and cyst location, as well as the bleeding source, in all patients. In addition, CECT showed other non-arterial (venous and capillary) bleeding origins that could be not visualized in arteriography. In arteriography, only the bleeding source, but not the morphology of the pancreatic cysts and pancreatic parenchyma, is visible.

The diameter of the cyst is one of the main factors influencing the choice of treatment. In the study by Yeo et al, 67% of cysts with a diameter of more than 6 cm required surgical procedures, whereas only 40% of cases with a cyst diameter of less than 6 cm were treated with surgery [15]. In our material, the median diameter of the cyst was 18.1 cm and varied between 3.2 and 40 cm.

For pseudocysts, surgical treatment should be considered if the cyst diameter is >6 cm and/or complications (bleeding, infection) occurred [3]. The aim is to empty and/or remove the cyst. The methods used in PPCs are: internal drainage (cystogastrostomy – Jurasz’s surgery/cystojejunostomy – Roux-Y method), percutaneous catheter drainage (transperitoneal), endoscopic method (transpapillary drainage, non-EUS-guided/EUS-guided transmural drainage), resection (removal of the cyst with tail/head/body of the pancreas), and marsupialization [8,10,16-19].

Treatment of hemorrhagic cysts is often a subject of disputes. Intravascular therapy including arterial embolization may be performed in hemodynamically stable patients diagnosed with pseudoaneurysm [11]. Stabile et al showed that this method reduces patient mortality by 12.5% [20]. However, if patients

show hemodynamic instability or no active arterial bleeding vessels or pseudoaneurysms are visible in the CTA, a conventional laparotomy is used. During the open surgery, it is possible to ligate the bleeding vessels and thereby to stop the bleeding. In most cases, the bleeding vessels are the splenic artery, gastroduodenal artery, or pancreaticoduodenal arteries. Also, during the procedure, resection of the pancreas or marsupialization can be performed. The factor that was considered primarily when choosing the method of surgery in our cohort was the presence of active bleeding. In the case of minor bleeding, particularly from small blood vessels, with the possibility of local bleeding control (eg, by ligation of bleeding vessels), the method of choice was marsupialization, which is associated with minor damage to the pancreas parenchyma and can preserve most of the endocrine and exocrine function of the pancreas. However, in the presence of major bleeding from the main splenic vessels or their branches, local bleeding control was not possible. The distal cyst location and damage to splenic vessels determined the type of pancreatic resections (distal pancreatectomy) as well as splenectomy. In all patients, the cyst was located distally. Therefore, only the pancreatic tail or pancreatic tail and distal body had to be removed, which is associated with a lower risk of postoperative pancreatic endocrine and exocrine insufficiency. A resection of the pancreas along with splenectomy was performed.

Endovascular treatment is a method in which few complications are observed, including acute post-embolization pain, post-embolization syndrome, infection, and rebleeding; mortality rates are as high as 19% [20]. After the surgical treatment, other complications may occur: pancreatic fistulas, intra-abdominal abscesses, gastric emptying disorders, wound infection, acute cardiopulmonary failure, abdominal hemorrhage, AP-related renal failure, pneumonia, pulmonary embolism, pleural effusion, and postoperative diabetes [21,22].

In our group, postoperative complications were observed in 1 (12.5%) patient, while mortality was 0%. According to the literature, complications of surgery for pancreatic pseudocysts occur in 9-36% of cases and mortality is 0-8% [16]. In our study group, all patients were hemodynamically stable, had no



pseudoaneurysms, and were undergoing no emergency surgeries. In contrast, the cohorts from the cited literature included patients undergoing emergency surgery due to hemodynamic instability, and in these cohorts pseudoaneurysms requiring endovascular treatment were present. In addition, in our group, all patients were treated with open surgery, in contrast to the groups from the cited literature, where the endovascular procedure of pseudoaneurysm embolization was present. Hemodynamic instability, emergency surgery, and endovascular pseudoaneurysm embolization are related to a higher risk of postoperative mortality [23,24]. All of the above could have contributed to the fact that the mortality rate in our group of patients was lower than in the literature.

### Limitations of the Study

There are important limitations to this study. First of all, we enrolled a very small and limited group of patients in which only men were present, which may have affected the power of statistical analysis. Therefore, the results of this study may not be reflected in the general population, especially in females. Second, as a retrospective study, there are many patient details such as predominant symptoms or comorbidities that were unreliably documented throughout the study period. Third, the follow-up period varied widely (1.5-82.3 months); therefore, the data on long-term outcomes may not be consistent. This fact may affect the number of adverse events and cyst recurrences, which could translate into misinterpretation of the long-term

outcomes of the study. The limitations mentioned above theoretically limit the conclusions that can be drawn. Nonetheless, this study has one of the largest groups of patients analyzed for treatment of hemorrhagic PPCs, as there are few case reports and case series on the treatment of hemorrhagic PPCs in the literature. Future research in this topic should include a more diverse group of patients who underwent not only elective but also urgent intervention due to hemodynamic instability. Future research should compare endovascular surgery with classic surgery in the treatment of hemorrhagic PPCs.

### Conclusions

Pancreatic hemorrhagic cysts are a rare complication of both CP and AP, and if left untreated, there is a significant risk of death. Despite the continuous development of minimally invasive techniques and the availability of endovascular therapy, surgical treatment remains the only effective treatment for some patients. Depending on the cyst localization and technical possibilities, pancreatectomy or marsupialization can be applied. Both methods have low complication and mortality rates.

### Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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