

Surgical treatment of pancreatic cystic tumors

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

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ABSTRACT:

The aim of this study was to assess short-term outcomes of surgical treatment of pancreatic cystic tumors (PCTs).

Material and methods: We retrospectively reviewed medical records of 46 patients (31 women and 15 men) who had undergone surgery for pancreatic cystic tumors in our department.

Results: Pancreatic cystic tumors were located within the pancreatic head (21), body (11), tail (13), and whole pancreas (1). The following surgical procedures were performed: pancreatoduodenectomy (20), central pancreatectomy (9), distal pancreatectomy (3), distal pancreatectomy with splenectomy (3), distal extended pancreatectomy with splenectomy (2), total pancreatectomy (1), duodenum preserving pancreatic head resection (1), local tumor resection (4), and other procedures (2). Histopathological tumor types were as follows: serous cystadenoma (14), intraductal papillary mucinous adenoma (5), intraductal papillary mucinous carcinoma (5), solid pseudopapillary tumor (5), mucinous cystadenoma (5), mucinous cystadenoma with border malignancy (1), mucinous cystadenocarcinoma (2), adenocarcinoma (4), and other tumors (5). Early postoperative complications were observed in 14 (30.43%) patients. Reoperations were performed in 9 (19.56%) patients. The perioperative mortality rate was 6.52%.

Conclusions: Serous cystadenoma was the most common pancreatic cystic tumor in the analyzed group. PCTs were most frequently located within the pancreatic head. Pancreatic resection was possible in most patients, and pancreatoduodenectomy was the most common pancreatic resection type.

KEYWORDS:

pancreas; cyst; tumor; surgery.

INTRODUCTION

Pancreatic cystic tumors (PCTs) account for 10–15% of pancreatic cysts and 1% of all pancreatic neoplasms. According to the WHO classification, pancreatic cystic neoplasms involve four main tumor types: serous cyst neoplasms, mucinous cyst neoplasm, intraductal papillary mucinous neoplasms, and solid pseudopapillary neoplasms [1,2]. All these tumors may be benign, of borderline malignancy, or malignant. PCTs require proper differential diagnosis. It is very important to differentiate pancreatic cystic neoplasms from pancreatic pseudocysts that are observed most frequently and do not require surgery. Furthermore, surgical treatment of large, symptomatic, and complicated pancreatic pseudocysts is different from the surgical procedures performed in PCTs.

Just as drainage is the most common treatment for pseudocysts, pancreatic resection is the treatment of choice for PCTs. According to the literature, not all PCTs require surgery, and some of them can be carefully observed. According to the literature, small asymptomatic serous cystadenomas and branch-duct intraductal papillary mucinous neoplasms (IPMNs) should be carefully observed, whereas symptomatic, large, or uncertain serous cystadenomas and cystadenocarcinomas, mucinous cystadenomas and cystadenocarcinomas, main-duct IPMNs, large branch-duct IPMNs with malignant features, and solid pseudopapillary tumors require surgery. This is associated with different malignant potentials of particular PCTs [3,4]. Surgical treatment depends on tumor location and size, and it involves different types of pancreatic resection, such as proximal pancreatectomy (pancreatodu-

denectomy), central pancreatectomy, distal pancreatectomy, total pancreatectomy, and local resection [1,2,5-8].

The aim of this article was to assess short-term outcomes of surgical treatment and to discuss different types of pancreatic resection in patients with PCTs.

MATERIAL AND METHODS

A retrospective analysis of 46 patients operated on for PCTs was performed. There were 31 (67.4%) women and 15 (32.6%) men, with the mean age 59.09 ± 12.43 years (25-79) in the analyzed group. The medical records of these patients were retrospectively reviewed. The following variables were analyzed: demographic characteristics, duration of hospitalization, duration of operation, early postoperative complications, reoperations, and perioperative mortality defined as in-hospital death. Prior to surgery, patients underwent standard laboratory and radiological investigations (ultrasonography, computed tomography, magnetic resonance imaging, and endoscopic retrograde cholangiopancreatography). The analyzed surgical findings involved tumor location, tumor size, and type of pancreatic resection. Specimens obtained during surgery were examined histopathologically. Macroscopic appearance and histopathological findings were obtained from pathological records. Pathological analysis involved tumor type (according to the WHO classification) and tumor size. Also, patient and tumor characteristics (age, gender, location, and size) were analyzed separately for common histopathological types. Results are reported as means \pm standard deviations.

RESULTS

Surgical procedures

PCTs were located most frequently within the pancreatic head – 21 (45.65%). The location in the pancreatic body and tail was twice less frequent compared to the pancreatic head. Due to such locations of tumors, pancreatoduodenectomy (PD) was the most common pancreatic resection (43.48%) in our patients. Different methods of reconstruction following PD were performed. Most frequently (30.43%), the Traverso reconstruction (pylorus preserving with pancreaticojejunal anastomosis) was performed. The other reconstruction methods were performed less frequently and involved the Whipple, Flautner (pylorus preserving with pancreaticogastric anastomosis) and Clagett (with pancreaticogastric anastomosis) reconstructions. All types of pancreatic resection are presented in Table 1. Local tumor resection (excision or

Tab. I. Clinical characteristics.

PATIENT CHARACTERISTICS	
Age (years)	59.09 \pm 12.43 (25-79)
Female/Male	31(67.4%) / 15 (32.6%)
TUMOR LOCATION	
Head	21 (45.65%)
Body	11 (23.91%)
Tail	13 (28.26%)
Whole pancreas	1 (2.17%)
SURGICAL PROCEDURE	
Pancreatoduodenectomy	20 (43.48%),
Traverso	14 (30.43%)
Whipple	3 (6.52%)
Flautner	2 (4.34%)
Clagett	(2.17%)
Central pancreatectomy	9 (19.56%)
Distal pancreatectomy	3 (6.52%)
Distal pancreatectomy with splenectomy	3 (6.52%)
Extended distal pancreatectomy with splenectomy	2 (4.34%)
Beger pancreatic head resection	1 (2.17%)
Local tumor resection	4 (8.68%),
Pancreatic and hepatic biopsy	1 (2.17%)
Partial gastrectomy BII	1 (2.17%)
Total hospitalization duration (days)	21.83 \pm 17.48 (7-99)
Postoperative hospitalization duration (days)	16.72 \pm 17.13 (1-92)
Surgery duration (hours)	4.61 \pm 1.15 (3-6.25)

enucleation) was possible in 4 (8.68%) patients with serous cystadenomas and solid pseudopapillary tumors. In 1 (2.17%) patient with an unresectable tumor (adenocarcinoma) within the pancreatic body, exploratory laparotomy with celiac plexus neurolysis and pancreatic and hepatic biopsy was performed. In 1 (2.17%) patient with a tumor (adenocarcinoma) located within the pancreatic body that was infiltrating the posterior gastric wall and retroperitoneal space, partial gastrectomy (BII) was performed. The mean duration of surgery was 4.61 ± 1.15 (3-6.25) hours.

Histopathological findings

The most common histopathological types of PCTs were as follows, serous cystadenoma – 14 (30.43%), intraductal papillary mucinous adenoma – 5 (10.87%), intraductal papillary mucinous carcinoma – 5 (10.87%), solid pseudopapillary tumor – 5 (10.87%), mucinous cystadenoma – 5 (10.87%), mucinous cystadenoma with border malignancy – 1 (2.17%), mucinous cystadenocarcinoma – 2 (4.34%), adenocarcinoma – 4 (8.68%). All histopathological types are presented in Table 2. Malignant cystic neoplasms were found in 14 (30.43%) patients. In this group, metastatic lymph nodes were noted in 7 cases (50%). Distant metastases were noted in 3 (21.43%) patients. R0 resections were performed in 5 (35.71%) patients, whereas R1 in 4 (28.57%) and R2 in 3 (21.43%), respectively.

Tumor characteristics according to histopathology

Serous cystadenomas (SCAs)

Serous cystadenomas were noted in patients with the mean age of 63.28 (36-78) years, including 10 (71.43%) women and 4 (28.57%) men. Tumors were located within the pancreatic head – 6/14 (42.86%), body 4/14 (28.57%), and tail 4/14 (28.57%). The mean size of SCAs was 4.64 (2-10) cm.

Mucinous cystadenomas (MCAs)

Mucinous cystadenomas were noted in patients with the mean age of 54.2 (25-69) years, including 4 (80%) women and 1 (20%) man. Tumors were located within the pancreatic head – 2/5 (40%), body 2/5 (40%), and tail 1/5 (20%). The mean size of MCAs was 5.67 (2-12) cm. A mucinous cystadenoma with borderline malignancy was located within the pancreatic body and measured 4.5 cm. Mucinous cystadenocarcinomas were located within the pancreatic head, and their mean size was 1.75 (1-2.5) cm.

Intraductal papillary mucinous neoplasms (IPMNs)

Benign IPMNs were noted in patients with the mean age of 60.4 (45-72) years, including 4 (80%) men and 1 (20%) woman. Tumors were located within the pancreatic head – 1/5 (80%), body, and tail 1/5 (20%). The mean size of benign IPMNs was 3.62 (1.5-6.0) cm. Malignant IPMNs were noted in patients with the mean age of 63.8 (50-79) years, including 3 (60%) men and 2 (40%) women. Tumors were located within the pancreatic head – 3/5 (60%), tail 1/5 (20%), and along the whole length of the pancreatic duct within the whole pancreas – 1/5 (20%). The mean size of malignant IPMNs was 3.87 (1-6.5) cm.

Solid pseudopapillary tumors (SPTs)

SPTs were noted in patients with the mean age of 41.4 (33-48) years, including 3 (60%) women and 2 (40%) men. Tu-

Tab II. Histopathology of pancreatic cystic tumors.

Serous cystadenoma	14 (30.43%)
Intraductal papillary mucinous neoplasm	10 (21.17%)
Intraductal papillary mucinous adenoma	5 (10.87%)
Intraductal papillary mucinous carcinoma	5 (10.87%)
Mucinous cystadenoma	5 (10.87%)
Mucinous cystadenoma borderline malignancy	1 (2.17%)
Mucinous cystadenocarcinoma	2 (4.34%)
Solid pseudopapillary tumor	5 (10.87%)
Adenocarcinoma	4 (8.68%)
Adenosquamous carcinoma	1 (2.17%)
Papillary carcinoma	1 (2.17%)
Non differentiated carcinoma	1 (2.17%)
Multilocular simple cyst	1 (2.17%)

Tab III. Early postoperative complications.

Early complications	14 (30.43%)
Intra-abdominal abscess	8 (17.39%)
Wound infection	5 (10.87%)
Acute pancreatitis ³	(6.52%)
Pancreatic fistula	3 (6.52%)
Biliary fistula	2 (4.34%)
Intra-abdominal bleeding	4 (8.68%)
Gastrointestinal bleeding	1 (2.17%)
Delayed gastric emptying	1 (2.17%)
Jejunal perforation	1 (2.17%)
Transverse colon ischemia	1 (2.17%)
Transverse colon necrosis	1 (2.17%)
Pneumonia	1 (2.17%)
Hydrothorax	1 (2.17%)
Acute circulatory and respiratory insufficiency	5 (10.87%)
In-hospital reoperations	9 (19.56%)
In-hospital mortality	3 (6.52%)

mors were located within the pancreatic head – 1/5 (20%), body 2/5 (40%), and tail 2/5 (40%). The mean size of SPTs was 3.25 (2.0-4.5) cm.

Early postoperative outcomes

The mean duration of hospitalization was 21.83±17.48 (7-99) days. The mean duration of postoperative hospitalization was 16.72±17.13 (1-92) days. Early postoperative complications were observed in 14 (30.43%) patients. The most common complications were: intraabdominal collection (abscess) (8), wound suppuration (5), acute pancreatitis (3), pancreatic fistula (3), abdominal bleeding (4), and biliary fistula (2). Acute pancreatitis was noted after the Traverso operation (1), central pancreatectomy (1), and distal pancreatectomy (1). Pancreatic fistula was noted in 1 patient following the Traverso operation and in 2 patients following central pancreatectomy. Biliary fistula appeared in 2 patients following the Traverso and Whipple pancreatoduodenectomy. All early complications are presented in Table 3. Reoperations were performed in 9 (19.56%) patients due to abdominal bleeding (4), jejunal perforation (1), ischemia or necrosis of the transverse colon (2), pancreatic fistula (1), and biliary fistula (1). The perioperative mortality rate was 6.52% due to gastrointestinal bleeding following central pancreatectomy (1), intra-abdominal bleeding following central pancreatectomy (1), ischemia of the transverse colon following local resection, and biliary fistula following the Traverso pancreatoduodenectomy.

DISCUSSION

Serous cystadenoma was the most frequent PCT type in our patients. It was reported commonly in women, whereas IPMN was the most frequently recorded tumor in men. Patients with malignant IPMNs were older compared to patients with benign IPMNs. Patients with SPTs were predominantly young women. It should be emphasized that there were 2 (40%) men with SPTs, although solid pseudopapillary tumors are found typically in young women. According to the literature, more than 90% of SPTs are found in women. In the analyzed group, this figure was only 60%, which is different from the available data.

Our reports regarding demographic characteristics of patients with other PCTs correlated with the available data [1,2,9-12].

Different types of pancreatic resection can be used for surgical treatment of PCTs. The choice of surgical procedure depends on tumor location and size regardless of the histopathological type. Depending on tumor location, different pancreatic

resection types are performed: pancreatoduodenectomy (for PCTs located within the pancreatic head), central pancreatectomy (for PCTs located within the pancreatic isthmus or body), distal pancreatectomy (for PCTs located within the pancreatic body or tail), and total pancreatectomy (for PCTs located within whole pancreas) [2,4,8,11,13]. Simple cystic enucleation (for small peripherally located PCTs), as a less invasive surgical procedure, in order to preserve pancreatic parenchyma, has been described earlier [11,14]. Talamini et al. [14] compared enucleation and pancreatoduodenectomy for the surgical treatment of mucinous cystadenomas. The authors reported that enucleation had taken less time and had been associated with lower blood loss than pancreatic resection, but pancreatic fistulas had occurred more frequently after enucleation than resection. The rate of major complications was comparable between both groups. The authors recommended this conservative treatment for benign PCTs. Kiely et al. [7] also compared enucleation and resection (proximal and distal pancreatectomy) results in 30 patients with mucinous cystic neoplasms (n=16), serous cystadenomas (n=10), and cystic islet cell tumors (n=4). The authors reported significantly shorter operative time in the enucleation group and significantly reduced blood loss in the enucleation group compared to the resection group. Pancreatic fistula rates (27% vs. 26%) and duration of hospitalization were comparable between both groups. A high rate of pancreatic fistulas following enucleation is associated with leakage of pancreatic juice from the pancreatic parenchyma in the enucleation site. According to the literature, enucleation is suitable for the treatment of benign, small, and peripheral PCTs [11]. In our patients, typical tumor enucleation was performed in patients with serous cystadenomas and solid pseudopapillary tumors located with the pancreatic body and tail. In one patient, Roux-Y pancreaticojejunostomy was performed in order to decrease the risk of pancreatic fistula. Pancreatic fistulas following enucleation did not occur in our patients. Central pancreatectomy (CP) is also a less invasive surgical procedure compared to standard pancreatic resections. It is recommended for benign and borderline tumors located within the pancreatic body or isthmus, because it is associated with a lower risk of complications such as endocrine and exocrine pancreatic insufficiency. It is associated with conservation of the normal pancreatic parenchyma, similarly to enucleation. However, a higher rate of postoperative complications, and primarily of pancreatic fistula (PF), is a disadvantage of this procedure. CP is associated with presence of the so-called “soft pancreas”, narrow pancreatic duct, and two pancreatic stumps that require supplying (15-21). Crippa et al. [16] compared CP and extended distal pancreatectomy (EDP) for the treatment of pancreatic tumors, including serous cystadenomas, branch-types IPMNs, and neuroendocrine tumors.

The morbidity rates, including pancreatic fistulas and blood loss, were comparable between both groups. The mean duration of hospitalization was longer in the CP group. The authors noted a lower rate of endocrine and exocrine insufficiency in the CP group compared to the DP group. Muller et al. [17] compared CP with standard pancreatic resections (pancreatoduodenectomy and distal pancreatectomy) in patients with pancreatic tumors, including 9 cystic neoplasms. The authors noted comparable morbidity and mortality rates in both groups, whereas pancreatic insufficiency was significantly lower in the CP group. We performed CP in 9 patients with PCTs located within the pancreatic body. Pancreatic fistulas were observed in 2/9 (22%) patients following CP, which is in line with earlier studies reporting a rate of around 25%.

The pancreatic head was the most frequent location of PCTs in the presented group (45.65%). Therefore, pancreatoduodenectomy was performed most frequently in our patients (43.48%). Proximal and distal pancreatectomies are standard pancreatic resections associated with a higher morbidity (30-60%) and mortality rates (1-5%) compared to the conservative surgical procedures mentioned above [13]. Pancreatic fistula is the common complication (2-20%) both after proximal and distal pancreatectomy. Biliary fistulas and delayed gastric emptying (DGE) are other important complications following PD. Infectious complications associated with splenectomy are reported in patients following DP. Complications such as wound infection, intra-abdominal abscess, intra-abdominal bleeding, sepsis, and other conditions are reported in patients following all types of pancreatectomy [21-28]. Intra-abdominal abscesses and wound infections were the most common postoperative complications in our patients. PD is the most complex pancreatic resection that involves three anastomoses (pancreaticojejunostomy (PJ) or pancreaticogastrostomy (PG), hepaticojejunostomy and gastro- or duodenojejunostomy). Currently, less invasive, pylorus preserving (Traverso and Flautner) procedures are recommended, if possible, due to a lower morbidity. Different reconstructions of digestive tract continuity are performed following PD. Different improvements regarding the technique of pancreatic anastomoses are used in order to decrease the risk of postoperative pancreatic fistulas. According to most authors, pancreaticogastrostomy (Flautner and Clagett reconstructions) is associated with a lower morbidity, including PF, compared to pancreaticojejunostomy. Moreover, PG allows direct access to the pancreatic stump by endoscopy during follow-up. Some authors recommend stenting of the main pancreatic duct in order to decrease the PF rate [28-31]. To date, no prospective, randomized, controlled trials have proven the benefits of these techniques. Prospective, randomized, controlled trials are needed in order to com-

pare pancreaticojejunostomy and pancreaticogastrostomy. The Traverso reconstruction was most commonly performed in our patients (30.43%). In 3 patients following PD, we performed reconstruction with pancreaticogastrostomy. We noted PF only in one patient (5%) following PD (after the Traverso procedure).

Currently, spleen preserving distal pancreatectomy, as a more conservative procedure, is recommended due to a lower rate of postoperative infectious complications [32,33]. It was possible in 3 patients with serous cystadenomas, IPMN, and SPT located within the pancreatic tail in the analyzed group. Total pancreatectomy (TP) is the most extensive pancreatic resection leading to endocrine and exocrine pancreatic insufficiency. Therefore, it is recommended for a limited group of patients with IPMNs arising along the main pancreatic duct and its side branches [29]. We performed TP only in one patient with IPMN – invasive carcinoma involving whole pancreas.

Serous cystadenomas were predominant in our patients. This observation is in line with previous reports. They are the most common type of pancreatic cystic neoplasms. Therefore, we would like to separately discuss surgical treatment of these tumors. Serous cystadenomas were indicated for surgery, when they were symptomatic or had uncertain histopathology (malignancy was suspected). According to the literature, symptomatic or uncertain tumors should be treated surgically. The following surgical procedures were performed in our patients with serous cystadenomas: pancreatoduodenectomy – 5 (35.17%), central pancreatectomy – 6 (42.86%), distal pancreatectomy – 1 (7.14%), local excision/enucleation – 2 (14.28%). Pancreatoduodenectomy was performed, when local tumor resection (excision or enucleation) was not possible technically (for example in tumors located within the pancreatic uncinate process). This management is also comparable with the available data. The overall perioperative mortality rate in all patients with all tumor types was 6.5%. In patients operated on for serous cystadenomas, the mortality rate was 0%.

Laparoscopic approach for the surgical treatment of PCTs has also been described in the literature. Laparoscopic procedures including pancreatic resections and tumor enucleation are safe, and they are recommended especially for young patients [34].

CONCLUSIONS

Serous cystadenoma was the most common pancreatic cystic tumor in the analyzed group. PCTs were most frequently

located within the pancreatic head. Pancreatic resection was possible in most patients operated on for PCTs, and pancreatoduodenectomy was the most common pancreatic resection type in the analyzed patients.

Different types of pancreatic resection are the treatment of choice for patients with PCTs qualified for surgery. Conservative sur-

gical treatment, including local tumor enucleation (excision) and central pancreatectomy, can be performed in patients with benign, small, and peripheral tumors. Standard pancreatic resections (proximal and distal pancreatectomy) are recommended for patients with large and malignant tumors. Total pancreatectomy is performed in a limited group of patients with the main-duct IPMNs involving the whole pancreatic ductal system.

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