

CLINICAL STUDY

Distal pancreatectomy

Martin VOJTKO¹, Kristina CMARKOVA¹, Miroslav PINDURA¹, Blazej PALKOCI¹, Roman KYCINA¹, Lenka NOSAKOVA², Marek VOJTKO², Peter BANOVCIN², Juraj MIKLUSICA¹

Clinic of Internal Medicine – Gastroenterology, JFM CU, Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Martin, Slovakia. lenka.bubernakova@gmail.com

ABSTRACT

INTRODUCTION: Distal pancreatectomy is a standard surgical procedure for selected benign, premalignant, and malignant lesions localized in the pancreatic body or tail. Surgical resection remains the only curative option for patients diagnosed with adenocarcinoma of the pancreas.

PATIENTS AND METHODS: Perioperative and postoperative clinical courses were retrospectively assessed in patients, who underwent distal pancreatectomy during the 2011–2021 period.

RESULTS: During the 2011–2021 period, a total of 112 distal pancreatectomies were performed. 67 patients (59.8%) underwent laparoscopic distal pancreatectomy, and 45 patients (40.2%) open laparotomy. The conversion was necessary for 13 patients (11.6%). Distal pancreatectomies performed laparoscopically were associated more often with biochemical leak and the development of grade B fistula, on the other hand grade C fistula developed only in patients operated by open laparotomy (LPT). The mean operating time was slightly longer in the laparoscopic group (227.1 min vs 214.6 min). The mean estimated blood loss was significantly higher in the LPT group (540.4 ml vs 191.9 ml). The mean hospitalization time was slightly longer in the LPT group (11.8 days vs 9.3 days). The rates of early reoperations were comparable between both groups (6 vs 5).

CONCLUSION: Laparoscopic techniques are preferred in centers around the world to bring patients benefits by using a minimally invasive approach. These techniques are also preferred in our center, in nearly 60% of all distal pancreatectomies performed during 10 years, but on the other hand, there is a much more careful approach chosen in cases of malignant disease to achieve adequate radicality (*Tab.4, Ref. 20*). Text in PDF www.elis.sk

KEY WORDS: distal pancreatectomy, laparoscopy, complications, fistula, blood loss.

Introduction

Surgical resection is the only curative option for patients diagnosed with pancreatic cancer (1). Distal pancreatectomy is a standard surgical procedure for selected benign, premalignant, and malignant lesions localized in the pancreatic body or tail. In the case of malignant tumors, a distal pancreatectomy represents pancreatic tissue resection left of the portomesenteric vein, which can be extended with splenectomy and lymphadenectomy. In the case of benign or premalignant lesions they should be done with an effort to preserve the spleen, because splenectomy requires antibiotics administration and vaccination postoperatively to prevent potentially fatal post-splenectomy sepsis prevention (2). The development of minimally invasive techniques led to their application in pancreatic surgery. Laparoscopic distal pancreatectomy is considered a safe procedure with shorter recovery time, less pain and discomfort, low blood loss, and earlier return to diet.

However, the laparoscopic approach is limited by the difficulty of the technique, retroperitoneal localization of the pancreas, proximity to critical structures, and the high rate of postoperative complications (3).

The primary aim of this study is to present results obtained during 10 years of distal pancreatectomy performed in our center and comparison with results documented by other studies.

Patients and methods

Every patient, who underwent distal pancreatectomy at Clinic of General, Visceral and Transplant surgery, Jessenius Faculty of Medicine, University Hospital in Martin, during the 10 years of 2011–2021, was included in the study. All patients were assessed by the hepatopancreatic surgeon to identify the size of the lesion, its localization, distance to important structures, and evaluation of the patient's condition. In the case of malignant tumors, the stage of the disease was determined according to TNM classification. In semi-malignant or premalignant lesions, the risk of malignant behavior was determined. Subsequently, the resectability of the tumor was evaluated, followed by further treatment options and suggestions. We also assessed demographic data, and preoperative clinical status, including performance status according to ECOG classification, comorbidities, nutritional risk, and ASA score established by the anesthesiologist.

¹Clinic of General, Visceral and Transplant Surgery, Jessenius Faculty of Medicine, University Hospital in Martin, Slovakia, and ²Clinic of Internal Medicine – Gastroenterology, Jessenius Faculty of Medicine, Comenius University in Bratislava, University Hospital, Martin, Slovakia

Address for correspondence: Lenka NOSAKOVA, MD, PhD, Clinic of internal medicine – gastroenterology, JFM CU, Jessenius Faculty of Medicine in Martin (JFM CU), Comenius University in Bratislava, Kollarova 2, SK-036 01 Martin, Slovakia.

Intraoperative data included the type of surgical procedure performed, method of pancreatic tissue resection and suture of residual tissue, operative time, blood loss, and possible conversion to open surgery. In the postoperative course, monitoring of vital and laboratory parameters was recorded, along with the need for postoperative blood transfusion and incidence of postoperative complications according to the Clavien-Dindo classification – especially pancreatic fistula. The length of hospital stay, the need for early rehospitalization within the first 30 days after discharge from the hospital, and perioperative mortality were documented. Pathologic protocol was also included in our study – exact type, size, localization, infiltration of surrounding structures and margins of resected tissue, perineural and lymphovascular infiltration, along with the number of removed lymph nodes.

Results

Characteristics of the patients

A total of 112 patients were included in the study, 72 of them (64.3%) were women and 40 of them (35.7%) were men. The mean age was 63 years (the youngest patient was 21 and the oldest was 84 years old). The mean BMI values were similar within both groups.

Although the overall health condition before surgery was defined by worldwide accepted and implemented ASA score, most patients reached ASA 3 score within both groups, we also documented individual comorbidities with potentially negative influence on postoperative recovery. In the pre-disease period, the most frequent comorbidity in both groups was diabetes mellitus. In terms of the occurrence of other comorbidities, there was no significant difference recorded between the groups (Tab. 1).

As for clinical findings, the most common symptoms at the time of the diagnosis were a manifestation of an algic syndrome

Tab. 1. Characteristics of the patients.

	LSK (n=67)	LPT (n=45)
Age (years)	58.5	63.7
Sex n (%):		
Male	15 (22.4)	25 (55.6)
Female	52 (77.6)	20 (44.4)
BMI, mean (kg/m ²)	28.4 (17–59.3)	27.2 (15.1–40.4)
ASA classification n (%):		
I	1 (1.5)	0 (0)
II	27 (40.3)	4 (8.9)
III	34 (50.7)	34 (75.6)
IV	2 (3)	4 (8.9)
Comorbidity n (%):		
Diabetes mellitus 2. type	15 (22.4)	17 (37.8)
Acute pancreatitis	7 (10.4)	4 (8.9)
Chronic pancreatitis	4 (6)	6 (13.3)
Present cholecystolithiasis	6 (9)	5 (11.1)
Removed gallbladder	10 (15)	9 (20)
Previous pancreatic intervention	0 (0)	2 (4.4)
Clinical symptoms n (%):		
Asymptomatic	36 (53.7)	14 (31.1)
Algic syndrome	20 (29.9)	21 (46.7)
Weight loss n (%)	16 (23.9)	21 (46.7)
Weight loss mean (kg/m ²)	7.8 (2–15)	8.9 (2–15)

and weight loss during the last six-month period. The mean weight loss was comparable within both groups (in individual cases up to 15 kg weight loss). A significant portion of assessed patients were entirely asymptomatic in the pre-diagnostic period and the discovery of the lesion was incidental.

Characteristics of the lesions

The most common imaging technique performed to discover pancreatic lesions was within both groups computed tomography, followed by endoscopic ultrasonography and magnetic resonance (Tab. 2). Positron emission tomography was performed to reveal the malignant potential of the pancreatic lesion through excessive accumulation of fluorodeoxyglucose, performed more often before the laparoscopic procedure (13.4%).

From a pathological standpoint, the distribution of individual pathological entities within both groups was comparable, except for the occurrence of pancreatic adenocarcinoma, which was significantly more prevalent in the LPT group.

The most frequent indication for distal pancreatectomy within the laparoscopic group was a cystic lesion of the pancreas documented in 23 patients (34.3%), followed by neuroendocrine pancreatic tumor diagnosed in 19 cases (28.4%) and ductal pancreatic adenocarcinoma presented in 13 patients (19.4%). Nevertheless, in the assessed group of patients, several variable forms of cystic neoplasm occurred – mostly represented by mucinous cystic neoplasm present in 10 patients (14.9%), serous cystic neoplasm in 7 patients (10.4%) and intraductal pancreatic mucinous neoplasm in 6 patients (9%).

On the other hand, the most common pancreatic lesion documented within the LPT group was ductal adenocarcinoma, found in 22 patients (48.9%), followed by neuroendocrine pancreatic tumor in 10 cases (22.2%) and cystic lesion in 7 patients (15.5%). Out of all the cystic lesions that occurred, most of them were evaluated as IPMN (n = 4; 8.9%). Serous and mucinous cystic neoplasms were represented less often in comparison to the LSK group.

Within the laparoscopic group, the most frequent placement of the tumor was within the tail of the pancreas, present in 38

Tab. 2. Characteristics of the lesions.

	LSK (n=67)	LPT (n=45)
Imaging modality n (%):		
CT	52 (77.6)	40 (88.9)
MR	36 (53.7)	18 (40)
PET/CT	9 (13.4)	3 (6.7)
Pathological finding n (%):		
Adenocarcinoma	13 (19.4)	22 (48.9)
NET	19 (28.4)	10 (22.2)
MCN	10 (14.9)	1 (2.2)
SCN	7 (10.4)	2 (4.4)
IPMN	6 (9)	4 (8.9)
Pseudopapillary neoplasm	4 (6)	1 (2.2)
Others	8 (11.9)	5 (11.1)
Localization of the lesion n (%):		
Pancreatic body	17 (25.4)	18 (40)
Pancreatic tail	38 (56.7)	17 (37.8)
Multiple areas of the pancreas	9 (13.4)	9 (20)

cases (56.7%), the second most common area of the pancreas affected by tumor was the body – in 17 patients (25.4%) and 9 cases (13.4%), multiple areas at the same time were affected. On the other hand, the affection of the body and the tail of the pancreas were almost similar within the LPT group.

Characteristics of surgery

Out of the spectrum of operative techniques, there were 67 cases (59.8%) realized through the laparoscopic approach, and in 45 cases (40.2%) open approach was chosen. The conversion was necessary in 13 patients (11.6%) (Tab. 3).

During the 2011 to 2021 period, 67 patients underwent laparoscopic distal pancreatectomy. In most cases, the classic distal pancreatectomy was performed (n = 33 patients; 49.3%), spleen-preserving distal pancreatectomy was possible to be performed in 20 patients (29.9%), and radical antegrade modular pancreatectomy (RAMPS) in 6 cases (9%). Selective resection of the pancreatic tail was performed in 5 patients (7.5%). In cases of favorably situated neuroendocrine tumors, extirpation or enucleation was successfully performed.

Out of all the patients in the open laparotomy group, the most common surgical procedure was distal pancreatectomy performed in 22 patients (48.9%), followed by RAMPS (n = 16; 35.6%) and spleen-preserving distal pancreatectomy (n = 5; 11.1%). Both – the selective resection of the pancreatic tail and the extirpation of the pancreatic lesion in situ, were sufficient only for 1 patient (2.2%).

Perioperative complications occurred in 6 patients (9%) within the LSK group, whereas the most frequent was iatrogenic vascular injury (n = 3; 4.5%), followed by the forced splenectomy (n = 2; 3%) and the injury of surrounding anatomical structures (n = 1; 1.5%). On the other hand, there were no perioperative complications recorded within the LPT group.

The mean operating time reached 227.1 minutes within the laparoscopic group and 214.6 minutes in pancreatectomies performed through an open approach.

The mean perioperative bleeding reached 191.9 ml (20–1800 ml) within the LSK group, however, there was no mention of exact perioperative blood loss in the protocol in 19 cases (28.4%). The mean estimated blood loss within the LPT group reached 540.4 ml (50–2500 ml).

For prevention of postoperative pancreatic fistula development, octreotide was administered perioperatively and in the early postoperative period in a comparable number of patients within both groups.

The need for postoperative transfusion was recorded in 6 patients within the laparoscopic group (9%) in comparison to 9 patients (20%) operated through an open approach.

The mean hospitalization time was documented to be slightly longer in the patients operated on through laparotomy and reached 11.8 days. The mean hospitalization time within the LSK group reached 9.3 days.

Tab. 3. Surgical characteristics.

	LSK (n=67)	LPT (n=45)
Approach n (%)	67 (59.8)	45 (40.2)
Surgical procedure n (%):		
Distal pancreatectomy	33 (49.3)	22 (48.9)
Spleen-preserving distal pancreatectomy	20 (29.9)	5 (11.1)
RAMPS	6 (9)	16 (35.6)
Selective resection of the pancreatic tail	5 (7.5)	1 (2.2)
Enucleation	2 (3)	0 (0)
Extirpation	1 (1.5)	1 (2.2)
Perioperative complications n (%):		
Iatrogenic vascular injury	3 (4.5)	0 (0)
Iatrogenic injury of surrounding organ	1 (1.5)	0 (0)
Forced splenectomy	2 (3)	0 (0)
Operating time mean (minutes)	227.1 (57–384)	214.6 (106–410)
Estimated blood loss mean (ml)	191.9 (20–1800)	540.4 (50–2500)
Postoperative blood transfusion n (%)	6 (9)	9 (20)
Octreotide administration n (%)	59 (88.1)	41 (91.1)

Hospital stay, complications, and reoperations

From the postoperative complications standpoint, all the patients were divided into groups according to the Clavien-Dindo classification (I-V) (Tab. 4). Postoperative complications classified as significant (Clavien-Dindo IIIa-V) were documented in 9 patients within both groups.

Development of pancreatic fistula was slightly more prevalent in distal pancreatectomies performed laparoscopically in comparison to the open approach. The biochemical leak was present in 32 patients (47.8%), and grade B fistula requiring antibiotics administration or drainage developed in 14 patients (20.9%). Nevertheless, the occurrence of grade C fistula was documented only within the LPT group – it developed in 3 cases (6.7%), 2 of them required early reoperation in the first 30 days.

Tab. 4. Postoperative complications.

	LSK (n=67)	LPT (n=45)
Early mortality n (%)	1 (1.5)	0 (0)
Clavien-Dindo classification n (%):		
0	18 (26.9)	15 (33.3)
I	11 (16.4)	6 (13.3)
II	28 (41.8)	15 (33.3)
IIIa	4 (6)	2 (4.4)
IIIb	4 (6)	6 (13.3)
IV	1 (1.5)	1 (2.2)
V	0 (0)	0 (0)
Development of pancreatic fistula n (%):		
Biochemic leak	32 (47.8)	13 (28.9)
Fistula grade B	14 (20.9)	4 (8.9)
Fistula grade C	0 (0)	3 (6.7)
Postpancreatectomy hemorrhage n (%)	5 (7.5)	2 (4.4)
Development of abscess n (%)	4 (6)	3 (6.7)
Development of pseudocyst n (%)	3 (4.5)	2 (4.4)
Postoperative pancreatitis n (%)	1 (1.5)	0 (0)
Wound complications n (%)	0 (0)	2 (4.4)
Hospital stay mean (days)	9.3 (3–22)	11.8 (6–34)
Early rehospitalization n (%)	8 (11.9)	5 (11.1)
Early rehospitalization n (%)	6 (9)	5 (11.1)

In terms of the occurrence of other postoperative complications, the number of abscesses, pseudocysts, or postoperative pancreatitis developed was comparable within both groups, as shown in Table 4.

Early reoperation in the first 30 days after operation was necessary for 6 patients (9%) within the LSK group, comparable with the number of patients, who required reoperation within the LPT group. The most common reason for reoperation within both groups was postoperative bleeding, followed by the development of an abscess.

Performance of radiointerventional method was required only within the LSK group – 1 patient (1.5%) underwent percutaneous puncture of intraabdominal collection, 1 patient (1.5%) required an endosonographic navigated drainage of pancreatic pseudocyst and in 1 case (1.5%) an embolization of a vessel had to be performed.

Overall hospital stay was documented to be slightly longer in patients operated through laparotomy – the meantime reached 11.2 days, than in the laparoscopic group (the meantime reached 9.7 days).

Early rehospitalization within 30 days after surgery required 8 patients operated laparoscopically (11.9%), whereas in patients operated through laparotomy it was necessary for 5 patients (11.1%). Early mortality within 30 days after surgery was documented only in 1 patient (1.5%), within the laparoscopic group.

Discussion

Distal pancreatectomy was considered a standard procedure to remove lesions inside the pancreatic body or tail since the first resection of the pancreatic body and tail was performed in 1884 (4). The first laparoscopic distal pancreatectomy was performed by Cushieri in 1996 to treat chronic pancreatitis with a successful result at the end (5). During the following period, there has been a massive development of minimally invasive surgical techniques, which have been implemented as a standard and an alternative to surgery performed through laparotomy (6). Extensive periods and experience have shown, that mini-invasive surgical methods can easily compete with an open approach, according to multiple studies realized throughout the years, there were documented better perioperative outcomes, less blood loss, and less need for blood transfusion in patients operated on through a laparoscopic approach. Besides that, hospital stay was also shorter in comparison to open surgery. Nevertheless, there was no significant difference in postoperative morbidity, including pancreatic fistula development, documented (7). However, the most important question remained the preservation of radicality in the case of the minimally invasive option used. Postlewit and Cooby affirmed that distal pancreatectomy performed using minimally invasive techniques for ductal adenocarcinoma in appropriately selected patients is fully effective and safe. These findings were further validated within the LEOPARD study in prospective randomized settings, but these data were limited because only high-volume centers were included, despite a quite high number of pancreatectomies performed within community centers (8). Besides that, a large pan-European study published in 2017 comparing the oncological

safety of open and minimally invasive distal pancreatectomy for ductal adenocarcinoma showed, that despite higher R0 resection rates, Gerota's fascia was resected less often and number of lymph nodes removed was lower using minimally invasive approach (9).

In terms of the need for conversion of laparoscopic to open approach, there were quite comparable results in our study with results achieved by De Rooij and a collective of authors in 2018 documented (11.6% in our study compared to De Rooij's study, which reached 8%) (10). A large-volume study published by Nassour in 2017 recorded a conversion rate of over 17% in the laparoscopic group and suggested higher body mass index, current smoking habit, poor nutritional status objectified by low preoperative albumin levels, chronic pancreatitis, and T3/T4 staged malignant disease as a risk factor for conversion (11).

Perioperative blood loss was significantly higher in patients operated through laparotomy, these findings were documented also in other studies (8, 12, 13). There was no significant difference between both groups in terms of operating time document, confirmed by multiple studies (14, 15, 16). However, some studies showed that the overall blood loss was lower during a minimally invasive approach, but the operating time was usually longer (17, 18). The transfusion rate was documented to be significantly higher during open distal pancreatectomy (20% vs 9%), but Song's study in 2020 reached comparable numbers within both groups (18).

According to Partelli, postoperative complications occurred less frequently in the laparoscopic group, which was proven also by our study, on the other hand, the development of postoperative pancreatic fistula was not significantly different between both groups according to Partelli's study, but grade B pancreatic fistula occurred more often in the laparoscopic group (16.4%) and grade C pancreatic fistula was present only after distal pancreatectomy performed through laparotomy in our study (19). A higher rate of grade B pancreatic fistula after laparoscopic distal pancreatectomy was confirmed also by Song's study in 2020, but there was no difference between the distribution of grade C pancreatic fistula within both groups (18). On the other hand, in 2021 there was a meta-analysis of 2 randomized controlled trials published, describing an increasing trend towards grade B/C postoperative pancreatic fistula development after minimally invasive distal pancreatectomy, but comparable drainage rates between both groups. According to the authors, the difference could be associated with differences in methods of transection of the pancreatic tissue or amylase levels in drain fluid on the third day after surgery (13). Another study published in 2018 documented a higher rate of grade III–IV Clavien-Dindo complications in patients operated on through laparotomy, which was confirmed also by our study (10).

In terms of total hospital stay, there was a significantly shorter hospital stay documented by different studies within the laparoscopic group, which was not found in our study – nevertheless, shorter hospital stay was present within the laparoscopic group too, but the difference was not that significant (8, 13, 14).

Readmission and reoperation rates were higher within the laparoscopic group (11.9% vs 8.9% and 1.5% vs 0%), but did not differ between both groups according to Soreide's study published in 2018 (20).

Major limitations

Results obtained from our study were compared with available world literature, including meta-analyses and other single-center experiences. As a main limitation, we consider it to be the inability to follow up on some parameters, overall survival above all. The non-existent central register of patients caused the inability to capture all the complications, especially after discharge from the hospital.

Conclusion

There is an increasing trend in the incidence of pancreatic tumors around the world. Pancreatic adenocarcinoma reaches leading positions from mortality caused by malignant disease standpoint. That's one of the many reasons for a rising demand for new pathophysiological, diagnostic, and therapeutic findings. Despite advanced multimodal therapy implementation, incidence and mortality remain practically the same. Surgical treatment further remains the only potentially curative option, but results are nowhere near optimistic. Early discovery of premalignant and malignant disease in early stages is crucial as well as stratification of malignant behavior of premalignant or border-line lesions to perform surgical treatment before the transition to advanced stage.

Laparoscopic techniques are preferred in centers around the world to bring patients benefits by using a minimally invasive approach. These techniques are also preferred in our center, in nearly 60% of all distal pancreatectomies performed during 10 years, but on the other hand, there is a much more careful approach chosen in cases of malignant disease to achieve adequate radicality. In case of any doubts in the context of oncological safety during laparoscopic operation, immediate conversion to an open approach is necessary.

References

- Zhang AB, Wang Y, Hu C, Shen Y, Zheng SS. Laparoscopic versus open distal pancreatectomy for pancreatic ductal adenocarcinoma: a single-center experience. *J Zhejiang Univ Sci B* 2017; 18 (6): 532–538. DOI: 10.1631/jzus.B1600541.
- Coco D, Leanza S, Schillaci R, Reina GA. Laparoscopic distal pancreatectomy for benign and malignant disease: a review of techniques and results. *Prz Gastroenterol* 2022; 17 (2): 103–109. DOI: 10.5114/pg.2021.109625.
- Bauman MD, Becerra DG, Kilbane EM, Zyromski NJ, Schmidt CM, Pitt HA et al. Laparoscopic distal pancreatectomy for pancreatic cancer is safe and effective. *Surg Endoscopy* 2017; 32 (1): 53–61. DOI:10.1007/s00464-017-5633-7
- Finney JM. VII. Resection of the Pancreas: Report of a Case. *Ann Surg* 1910; 51 (6): 818–829. DOI: 10.1097/0000658-191006000-00007.
- Cuschieri A. Laparoscopic Pancreatic Resections. *Semin Laparosc Surg* 1996; 3 (1): 15–20. DOI: 10.1053/SLAS00300015.
- Lof S, Moekotte AL, Al-Sarireh B, Ammori B, Aroori S, Durkin D, Fusai GK, French JJ, Gomez D, Marangoni G, Marudanayagam R, Soonawalla Z, Sutcliffe R, White SA, Abu HM. Multicentre observational cohort study of implementation and outcomes of laparoscopic distal pancreatectomy. *Br J Surg* 2019; 106: 1657–1665. DOI: 10.1002/bjs.11292.
- Jiang L, Ning D, Chen XP. Improvement in distal pancreatectomy for tumors in the body and tail of the pancreas. *World J Surg Oncol* 2021; 19 (1): 49. DOI:10.1186/s12957-021-02159-9.
- Bashir MU, Kandilis A, Jackson NM, Parikh JA, Jacobs MJ. Distal pancreatectomy outcomes: Perspectives from a community-based teaching institution. *Ann Hepatobiliary Pancreat Surg* 2020; 24 (2): 156–161. DOI: 10.14701/ahbps.2020.24.2.156.
- Van Hilst J, de Rooij T, Klompmaker S, Rawashdeh M, Aleotti F, Al-Sarireh B et al. Minimally Invasive versus Open Distal Pancreatectomy for Ductal Adenocarcinoma (DIPLOMA). *Ann Surg* 2019; 269 (1): 10–17.1. DOI:10.1097/sla.0000000000002561.
- De Rooij T, van Hilst J, van Santvoort H, Boerma D, van den Boezem P, Daams F et al. Minimally Invasive Versus Open Distal Pancreatectomy (LEOPARD). *Ann Surg* 2019; 269 (1): 2–9. DOI: 10.1097/SLA.0000000000002979.
- Nassour I, Wang SC, Porembka MR, Augustine MM, Yopp AC, Mansour JC et al. Conversion of Minimally Invasive Distal Pancreatectomy: Predictors and Outcomes. *Ann Surg Oncol* 2017; 24 (12): 3725–3731. DOI:10.1245/s10434-017-6062-5.
- Stauffer JA, Coppola A, Mody K, Asbun HJ. Laparoscopic Versus Open Distal Pancreatectomy for Pancreatic Adenocarcinoma. *World J Surg* 2016; 40 (6): 1477–1484. DOI:10.1007/s00268-016-3412-6.
- Korrel M, Vissers FL, van Hilst J, de Rooij T, Dijkgraaf MG, Festen S et al. Minimally invasive versus open distal pancreatectomy: an individual patient data meta-analysis of two randomized controlled trials. *HPB* 2021; 23 (3): 323–330. DOI:10.1016/j.hpb.2020.10.022.
- Lyu Y, Cheng Y, Wang B, Zhao S, Chen L. Assessment of laparoscopic versus open distal pancreatectomy: a systematic review and meta-analysis. *Minim Invasiv Ther Allied Technologies* 2022; 31 (3): 350–358. DOI: 10.1080/13645706.2020.1812664.
- Bauman MD, Becerra DG, Kilbane EM, Zyromski NJ, Schmidt CM, Pitt HA, Nakeeb A, House MG, Ceppa EP. Laparoscopic distal pancreatectomy for pancreatic cancer is safe and effective. *Surg Endosc* 2018; 32 (1): 53–61. DOI: 10.1007/s00464-017-5633-7.
- Zhang AB, Wang Y, Hu C, Shen Y, Zheng SS. Laparoscopic versus open distal pancreatectomy for pancreatic ductal adenocarcinoma: a single-center experience. *J Zhejiang Univ Sci B* 2017; 18 (6): 532–538. DOI: 10.1631/jzus.B1600541.
- Matsumoto I, Kamei K, Satoi S, Murase T, Matsumoto M, Kawaguchi K et al. Laparoscopic versus open distal pancreatectomy for benign and low-grade malignant lesions of the pancreas: a single-center comparative study. *Surg Today* 2019; 49 (5): 394–400. DOI: 10.1007/s00595-018-1743-7.
- Song SH, Kim HJ, Park EK, Hur YH, Koh YS, Cho CK. Comparison of laparoscopic versus open distal pancreatectomy for benign, pre-malignant, and low grade malignant pancreatic tumors. *Ann Hepatobiliary Pancreat Surg* 2020; 24 (1): 57–62. DOI: 10.14701/ahbps.2020.24.1.57.
- Partelli S, Andreas V, Rancoita PMV, Perez-Sanchez E, Muffatti F, Balzano G et al. Outcomes after distal pancreatectomy for neuroendocrine neoplasms: a retrospective comparison between minimally invasive and open approach using propensity score weighting. *Surg Endoscopy* 2021; 35 (1): 165–173. DOI: 10.1007/s00464-020-07375-0.
- Søreide K, Olsen F, Nymo LS, Kleive D, Lassen K. A nationwide cohort study of resection rates and short-term outcomes in open and laparoscopic distal pancreatectomy. *HPB* 2019; 21 (6): 669–678. DOI: 10.1016/j.hpb.2018.10.006.

Received October 14, 2023.
Accepted November 4, 2023.