Impact of COVID-19 on pancreatic cancer surgery: A high-volume Polish center experience

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Abstract

Background. A total of 148 surgeries were performed in our center on patients with pancreatic cancer in 2020. In 2019, 263 such procedures were performed (77.7% more) in this facility.

Objectives. To analyze the impact of coronavirus disease 2019 (COVID-19) on pancreatic cancer surgery type, number and outcome in our center.

Materials and methods. Retrospective data analysis of medical documentation in a hospital database from January 2019 till December 2020.

Results. In 2020, we observed an increase of tumors localized in the tail of the pancreas (P) – 29 cases (19.9%) in 2020 compared to 26 cases (9.9%) in 2019 ($p = 0.005$). In 2020, our patients presented with much greater advancement of the disease illustrated by the increased tumor size (median 3.5 cm in 2020 compared to 3.0 cm in 2019), although it did not reach statistical significance ($p = 0.073$). In 2020, we performed more palliative procedures, e.g., bypassing anastomoses (17 (11.6%) in 2020 compared to 8 (3%) in 2019 ($p < 0.001$)), more open biopsies of P (21 (14.4%) in 2020 compared to 21 (7.9%) in 2019 ($p = 0.041$)), and more percutaneous biopsies of P (7 (4.8%) in 2020 and 0 in 2019 ($p = 0.001$)). We observed a significant decrease in the number of Whipple procedures (53 (36.3%) in 2020 and 125 (47.5%) in 2019 ($p = 0.037$)). The most common histopathological finding was adenocarcinoma of the P, accounting for 50% in 2020 and almost 52% of all tumor cases in 2019. In a group of 148 patients operated on due to a P tumor during the COVID-19 pandemic, only 6 patients died, which resulted in a mortality rate of 4.1% compared to 13.4% mortality rate in 2019 (34 deaths/263 patients; $p = 0.005$). We observed less leakage of gastrointestinal anastomosis (0/148 in 2020 and 10/263 in 2019 ($p = 0.038$)).

Conclusions. Particular attention should be paid to patients with an aggressive type of cancer who have completed neoadjuvant therapy, as they are unable to undergo other therapeutic options. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)-positive cancer patients should be postponed until recovery. Relatively few postoperative complications and low all-cause mortality are the result of a more careful selection of oncological patients before the admission to the surgical ward, as well as a ompliance with the principles of planning the procedure and organization of the operating theater during the COVID-19 pandemic.

Key words: adenocarcinoma, pancreatic cancer, COVID-19, adjuvant therapy, neoadjuvant therapy

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Background

From March 4, 2020 until November 9, 2021, the total number of coronavirus disease 2019 (COVID-19) cases in Poland reached 3,111,534. According to the Polish Ministry of Health, 77,760 infected patients died and most of them had been suffering from comorbidities.[1] Mortality rate from COVID-19 in Polish population is ~2.5%.

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic has caused a huge overload of the healthcare system worldwide.[2] From March 13, 2020, many hospitals in Poland were converted into infectious diseases hospitals, which resulted in unavailability of treatment for non-COVID-19 patients. In numerous hospitals, the scheduled operations were cancelled and the ambulatory care was suspended due to the medical staff shortages. In some cases, the delay of diagnosis or treatment might not significantly impact the prognosis; however, in oncological patients, timing is crucial. The decision on whether to postpone the operations of oncological patients should be carefully considered, especially for those who have completed neoadjuvant therapy and patients with biologically aggressive tumors, such as pancreatic cancer, or patients without therapeutic alternatives. Delaying the operation should not worsen the oncological prognosis. However, patients with pancreatic cancer should not undergo the surgery at the time of the COVID-19 infection and the operation should be postponed. The meetings of the oncological team play a significant role in the shared clinical decision-making process and in planning the best treatment available. Videoconferences are a preferred option for such meetings and telemedicine should be used for the time being, although this is not always possible due to technical and organizational reasons.

Pancreatic tumors are a heterogeneous group of rare neoplasms. However, epidemiological studies show a significant increase in the incidence of pancreatic cancer in Poland, as well as worldwide. It is foreseen that pancreatic cancer will be among the top 5 cancers with the highest mortality rates in 2030.[3,4]

According to the Polish National Cancer Registry, a total of 164,875 new cancer cases and 99,644 cancer-related deaths were recorded in 2017. The number of new cases of malignant pancreatic neoplasms in 2017 was 3508 (2.1% of all new cancer cases (n = 1738) in men and 2.18% (n = 1770) in women). In 2017, a total of 99,644 people died of cancer in Poland, out of which 4864 people died of pancreatic cancer (4.4% (n = 2409) men (6th place among all types of cancer in Poland) and 5.4% (n = 2455) women (5th place)).[3]

In Poland, in 2010, mortality due to pancreatic cancer was comparable to the average mortality level for EU countries (data from 2009) in both sexes: male around 8/105 and female around 5/105. [3]

Pancreatic cancer, among all cancers, is the 7th leading cause of cancer-related deaths worldwide.[4] The course of the disease is very rapid and the average survival time starting from the diagnosis is approx. 6 months. From the time of the pancreatic cancer diagnosis, the 5-year survival rate is <9%, and less than 50% of patients live 3 months or more.[4,5] In case of resectable lesions, the 5-year survival rate is approx. 20%, but only 10–20% of patients are primarily diagnosed at such stage.[5]

Most cases of malignant pancreatic neoplasms occur after the age of 50 (92% cases in men and 95% cases in women). It is more common in men (5.5 per 100,000) than in women (4.0 per 100,000).[4] Nearly 80% of pancreatic cancer patients are diagnosed between the age of 60 and 80.[4–6] Cases under the age of 40 are extremely rare.[1]

About 85–90% of malignant pancreatic neoplasms are cancers of the exocrine portion of the pancreas of the glandular type, i.e., adenocarcinomas.[4] Other, less common types of pancreatic cancer include follicular cell carcinoma, pancreatoblastoma (the cancer of embryonic origin found in children), solid pseudopapillary carcinoma, and anaplastic (undifferentiated) cancer. These tumors differ slightly in biology, prognosis and treatment management from the most common pancreatic adenocarcinoma.[7]

The diagnosis of pancreatic cancer, despite the recent progress in diagnostic methods, is still challenging and causes a delay of the final diagnosis by about 4–9 months, which has probably increased during the COVID-19 pandemic, yet it is difficult to make an exact estimation.

The surgical treatment of pancreatic cancer should be performed in high-volume centers with extensive experience in pancreatic surgery, that conduct clinical trials.[8] In Poland, in 2011, the Polish Pancreatic Club and the Working Group of the Polish National Consultant in Gastroenterology published recommendations of oncological surveillance and diagnostics as well as therapeutic recommendations regarding patients with chronic pancreatitis.[9] The Department of Gastroenterological Surgery and Transplantology of the Central Clinical Hospital of the Ministry of the Interior and Administration in Warsaw, Poland is a leading center in pancreatic oncology in Poland, where the largest number of pancreatic cancer surgeries are performed every year in our country. In 2019, a total of 251 surgeries were performed in our clinic due to pancreatic cancer, while the 2 leading centers in the Lower Silesia Province performed overall only 22 such procedures and the next 2 largest centers in the Lesser Poland Province performed 60 such procedures.[10]

Unfortunately, in Poland as well as worldwide, the COVID-19 pandemic impeded the access to the oncological treatment and in the worst period of the pandemic, the number of surgeries dropped by up to 40%.[11]

Based on the meta-analysis of 34 publications which included almost 1.2 million oncological patients, scientists from the UK and the USA found that every 3-month diagnosis and treatment delay worsens the 5-year survival by about 10%, and a 6-month delay worsens these results by up to 30%.[12] Hanna et al. calculated that in the case

of surgical treatment, the risk of death increased by 6–8% with every 4-week period of delay. This turned out to be even worse in case of chemotherapy and radiotherapy (the risk of death increased by 9–13% (for radiotherapy for head and neck cancer and chemotherapy for colorectal cancer)). In addition, the researchers calculated that the 8-week and 12-week delay increased the risk of death, i.e., an 8-week delay in cancer surgery increased the risk of death by 17%, and a 12-week delay by up to 26%.[12]

The authors calculated that delaying the surgery by 12 weeks per year for all breast cancer patients (for example during the COVID-19 pandemic) would lead to 1400 additional deaths in the UK, 6100 in the USA, 700 in Canada, and 500 in Australia.

Objectives

This study had 4 objectives: 1) to assess the advancement and localization of the pancreatic cancer in our study group; 2) to establish how COVID-19 pandemic impacted the types of surgical procedures performed; 3) to find if there was any change in histopathological findings in our study group; 4) to assess mortality and number of complications in a group of patients operated on for a pancreatic tumor during the COVID-19 pandemic.

Materials and methods

The retrospective data analysis of medical documentation in a hospital database was performed. The research covered a period from January 2019 until December 2020. This study was performed in compliance with the Declaration of Helsinki. Informed consent was not obtained since we have only analyzed retrospective data from hospital database and personal information was anonymized.

Study setting

In Poland, in accordance with the Law of March 2, 2020 on special solutions related to the prevention, counteraction and combating COVID-19, other infectious diseases and the emergencies caused by them, the model of infectious diseases hospitals was implemented.[13] Based on this Law, the selected multidisciplinary units have been completely transformed into infectious disease hospitals dedicated to the fight against COVID-19. It is a model unparalleled in other countries.

By the decision of the authorities of Masovian Voivodeship, on March 13, 2020, the Central Clinical Hospital of the Ministry of Interior and Administration was transformed into an infectious diseases hospital with the highest level of reference for patients with COVID-19. This caused a significant reduction in the number of beds in the Surgery Clinic (55 beds before the pandemic) – 15 beds were designated for surgical COVID-19 patients and 9 beds for patients without COVID-19, dedicated to oncological patients.

On May 9, 2020, the regulations on infectious diseases hospitals ceased to apply, but on November 9, 2020, due to the 2nd wave of COVID-19 pandemic, a decision to convert the Central Clinical Hospital of the Ministry of the Interior and Administration into a hospital of the highest level of reference for patients with COVID-19 was made again.

Preoperative management of oncological patients

The preparation of the patient and the operating room was based on the guidelines of the Polish Surgical Society and the guidelines of the European Society of Surgeons.[14,15]

All of the patients need to be consulted during multidisciplinary consultation meetings once a week. If the patient is qualified for the surgery, he or she is informed about the procedures before the hospital admission, including: home observation towards COVID-19 symptoms (fever, cough, shortness of breath, sore throat, but also myalgia, diarrhea, fatigue, runny nose or congestion, loss of smell, altered sense of taste); the reverse transcription polymerase chain reaction (RT-PCR) negative test (valid 72 h) and the blood donation made by family members (the lack of blood during the pandemic has been the rising problem because of the decreased number of the donors). If a test yielded a positive result for a given patient, the procedure would be postponed depending on symptoms and illness severity. On the admission day, after checking the RT-PCR test results, the patient is screened for their body temperature and COVID-19-related symptoms. If the screening result is negative, an antigen test is conducted and the patient is not transferred to the clean area until the negative result is obtained. In the clinic, there is no isolation ward; therefore, the observation of the patients qualified for surgery for 3–7 days, as has been suggested in some publications, could not be taken into consideration.[16] Despite this, none of the oncological patients developed SARS-CoV-2 symptoms or has been tested positive after the surgery.

Statistical analyses

The statistical analyses were performed with the use of the licensed program STATISTICA v. 13 (StatSoft Inc., Tulsa, USA). The data were presented with the use of descriptive statistics, mainly mean, standard deviation (SD) and medians, as well as numbers and percentages. The Shapiro–Wilk test was used to check the normality of the distribution of the examined variables (Table 1). Continuous variables divided into groups were analyzed using the t-test with Welch's correction. The χ^2 test was used to evaluate the qualitative data in the individual groups and if the subgroup was small, the Yates's correction was used. The correlation analysis was performed using the Spearman's rank correlation coefficient. The level of significance was set at $p \leq 0.05$.

Table 1. The distribution of normality of patients groups (2019 compared to 2020)

Variable	Total (n = 411)	2019 (n = 263)	2020 (n = 148)
	normality	normality	normality
Age	p < 0.001	p < 0.001	p < 0.001
Tumor size [cm]	p < 0.001	p < 0.001	p < 0.001
Surgery time [min]	p < 0.001	p < 0.001	p < 0.001
ICU hospitalization [days]	p < 0.001	p < 0.001	p < 0.001
Hospitalization from surgery [days]	p < 0.001	p < 0.001	p < 0.001

ICU – intensive care unit.

Results

Despite a significant reduction in the number of oncological beds in the 2020, a total of 148 surgeries were performed in the clinic in patients with pancreatic cancer. In 2019, 263 such procedures were performed (77.7% more). The characteristics of the 2019 group compared to the 2020 group are presented in Table 2.

The operated group in 2019 included 108 (41.22%) male (M) and 154 (58.78%) female (F), compared to 60 (40.82%) M and 87 (59.18%) F in 2020 (the correlation was not significant).

In 2020, when compared to 2019, our patients had much greater advancement of the disease defined by the increased tumor size (median 3.0 cm in 2019 and 3.5 cm in 2020), although this correlation did not reach statistical significance (p = 0.073). The duration of the intensive care unit (ICU) stay was longer in 2019 compared to 2020 (p < 0.001). Gender of patients, time of operation and hospitalization time after the surgery did not differ significantly between 2019 and 2020 (Table 2,3). The relatively short time of hospitalization in 2020 was caused by the limited number of beds in the clinic for COVID-19-negative patients and the necessity to quickly transfer patients in good condition to other hospitals in the area.

The most common location of the pancreatic tumor was the head of the pancreas – 97 cases (66.4%) in 2020 compared to 173 cases (66.3%) in 2019. In 2020, we observed an increase of tumors localized in the tail of the pancreas

Table 2. Characteristics of patient groups (2019 compared to 2020)

Variable	2019 (n = 263)					2020 (n = 148)					p-value
	mean	SD	Me	Q1	Q3	mean	SD	Me	Q1	Q3	
Age	62.49	11.46	64.0	57.0	70.0	61.15	11.29	63.0	55.0	69.0	0.259
Tumor size [cm]	3.41	1.86	3.0	2.0	4.2	3.81	2	3.5	2.5	5.0	0.073
Surgery time [min]	102.42	40.53	110.0	70.0	120.0	95.4	39.06	90.0	65.0	120.0	0.093
ICU hospitalization [days]	1.66	5.98	0.0	0.0	0.0	0.31	1.5	0.0	0.0	0.0	<0.001
Hospitalization from surgery [days]	12.74	11.92	9.0	7.0	13.0	12.42	15.79	9.0	7.0	13.0	0.835

ICU – intensive care unit; SD – standard deviation; Me – median; Q1– lower quartile; Q3 – upper quartile; t-test with Welch's correction was used.

Table 3. Gender of patients and localization of tumor of pancreas

Variable		2019 (n = 263)		2020 (n = 148)		p-value
		n	%	n	%	
Gender	male	108	41.22	60	40.82	0.936
	female	154	58.78	87	59.18	
Head of the pancreas	no	88	33.72	49	33.56	0.974
	yes	173	66.28	97	66.44	
Body of the pancreas	no	182	69.73	108	73.97	0.365
	yes	79	30.27	38	26.03	
Tail of the pancreas	no	235	90.04	117	80.14	0.005
	yes	26	9.96	29	19.86	
>1	no	243	93.10	137	93.84	0.939*
	yes	18	6.90	9	6.16	

The χ^2 test was used; * the Yates's correction was used.

– 29 cases (19.9%) in 2020 compared to 26 cases (9.9%) in 2019 (p = 0.005). The localization in body and multiple localization in pancreas did not differ significantly when compared with 2019 (Table 3). In 2020, patients with pancreatic cancer tended to be referred to our center with more advanced stage of the disease than in 2019. Due to that, in 2020 we performed more palliative procedures, e.g., bypassing anastomoses – 17 (11.6%) in 2020 compared to 8 (3%) in 2019 (p < 0.001); open biopsies of the pancreas – 21 (14.4%) in 2020 compared to 21 (7.9%) in 2019 (p = 0.041); and percutaneous biopsies of the pancreas – 7 (4.8%) in 2020 compared to 0 in 2019 (p = 0.001). Moreover, the number of Whipple procedures significantly dropped in 2020 to 53 (36.3%), compared to 125 (47.5%) in 2019 (p = 0.037). Statistical significance was also observed regarding the numer of operations titled as "other", performed in 2019 and 2020, which include operations such as central pancreatectomy, Frey's procedure, thoracoscopic transection of the visceral nerve, cholecystectomy, drainage of the peripancreatic abscess, and enucleation of a pancreatic tumor (Fig. 1).

The most common histopathological finding was adenocarcinoma of the pancreas, accounting for 50% of cases in 2020 and almost 52% of all tumor types in 2019. More pancreatic intraepithelial neoplasia cases were found in 2019 (51/263) than in 2020 (6/148) (p < 0.001), but in 2020, more chronic pancreatitis cases were diagnosed (p = 0.004, Fig. 2). In 2019, more "other" types of neoplasms were found, e.g., mixed types of tumor like adenocarcinoma/squamous cell carcinoma or anaplastic carcinoma (p = 0.016, Fig. 2).

In a group of 148 patients operated on for a pancreatic tumor during the COVID-19 pandemic, only 6 people died, which resulted in all-cause 30-day mortality rate of 4.1%, compared to 34 deaths/263 patients and all-cause mortality rate of 13.4% in 2019 (p = 0.005). We have observed less leakage of gastrointestinal anastomosis (0/148) in 2020 than in 2019 (10/263) (p = 0.038). Apart from that, we noted no difference in surgical and nonsurgical complications (Fig. 3).

In patients with advanced inoperable tumor who underwent percutaneous biopsies, open biopsies and/or bypass anastomoses, full staging according to TNM classification was impossible; therefore, the data presented in Table 4 concern only those patients who underwent a tumor resection and have a complete histopathological examination of the tumor (TNM). There were no differences between 2019 and 2020 in terms of TNM features or tumor resectability; however, much more frequent diagnoses of low-differentiated G3 and G4 anaplastic tumors were stated in 2020, and these tumors are characterized by a rapid growth (p = 0.037). A diagnosis of more advanced tumor influenced the decision to administer adjuvant chemotherapy. In 2020, the rate of qualification for adjuvant treatment significantly decreased – 51% of patients in 2020 received such treatment compared to 68% in 2019 (p < 0.001, Table 4). In our study, we have also

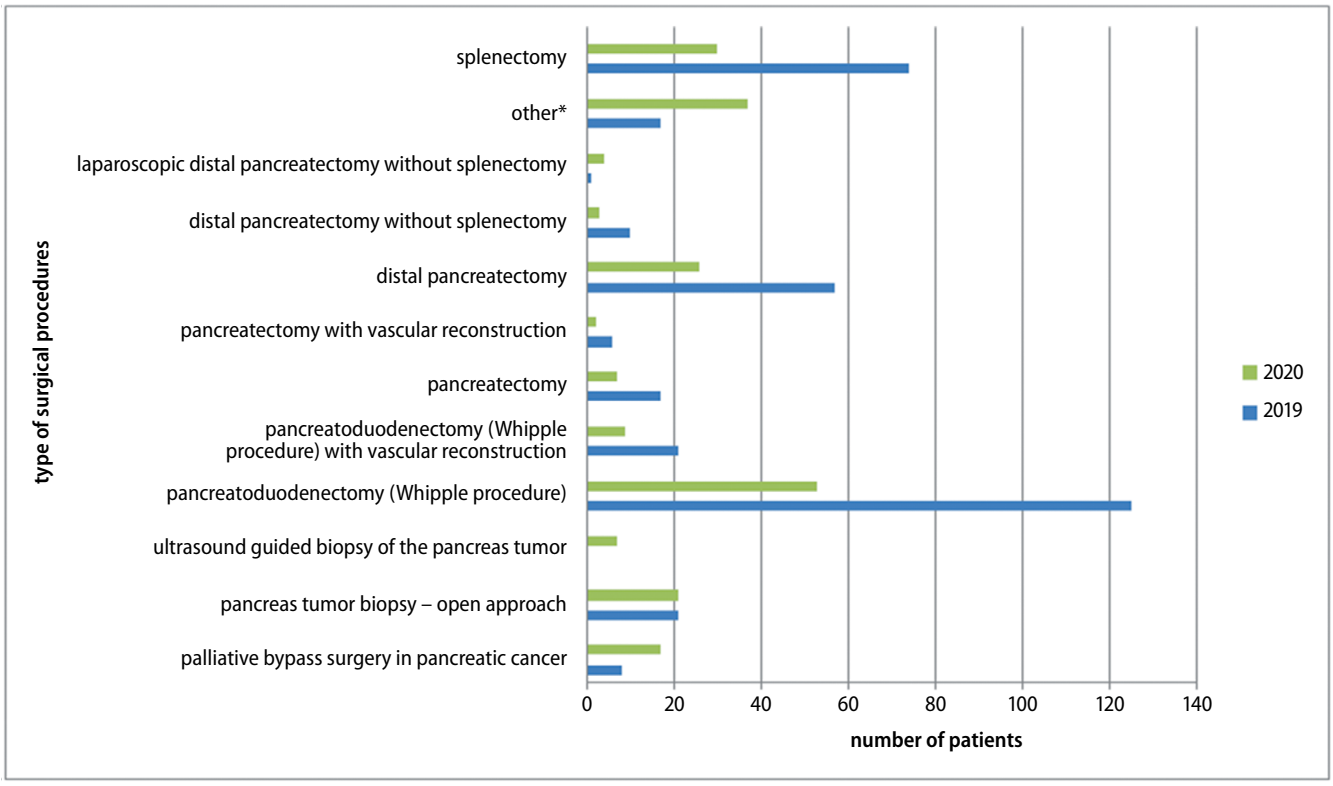

Fig. 1. Types of surgical procedures in 2019 compared to 2020

* other, e.g., central pancreatectomy, Frey's procedure, thoracoscopic transection of the visceral nerve, cholecystectomy, drainage of the peripancreatic abscess, enucleation of a pancreatic tumor.

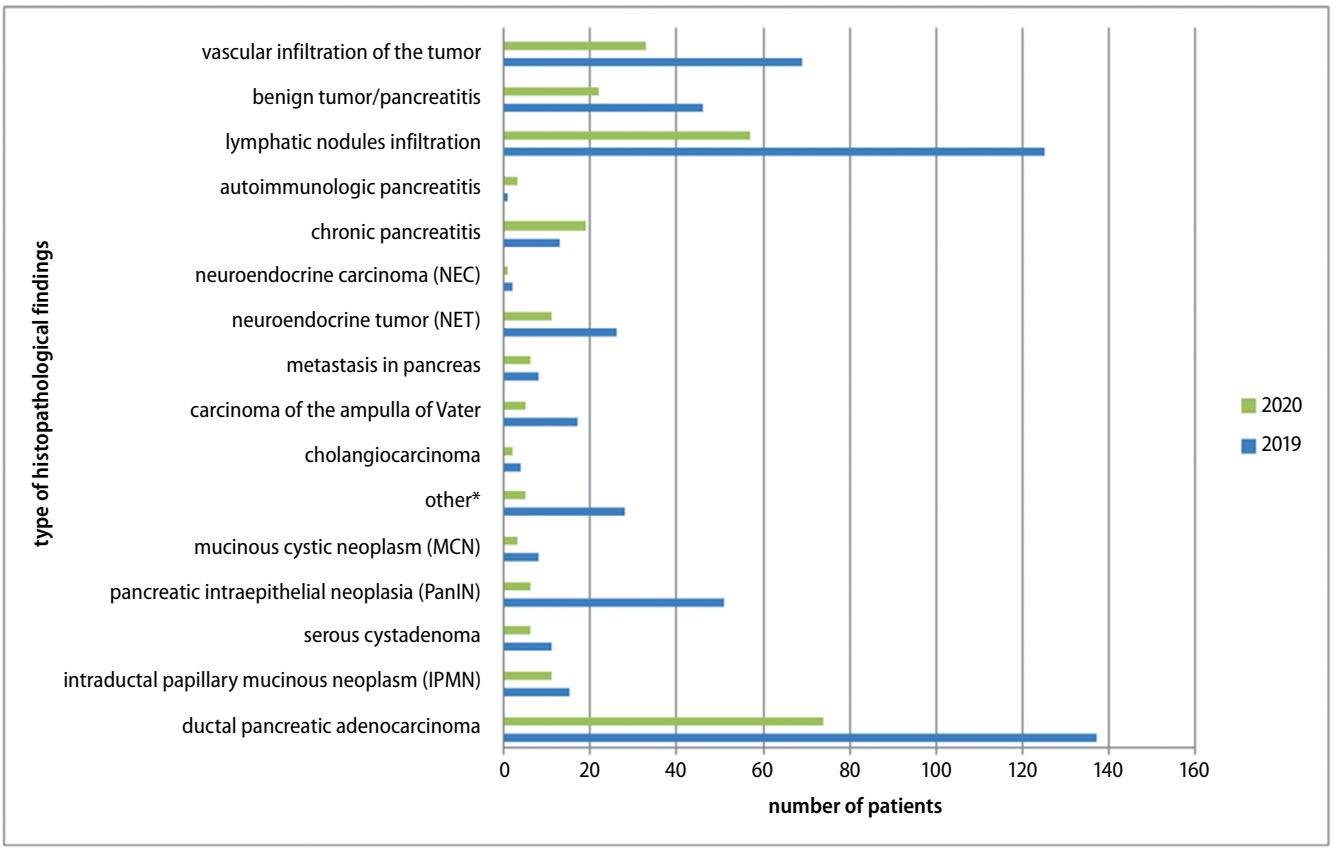

Fig. 2. Histopathological findings in 2019 and 2020

* other: mixed types of tumor like adenocarcinoma/squamous cell carcinoma, anaplastic carcinoma, lipomatous atrophy, serous cystadenoma, necrotic tissue, malignant neoplasm of epithelioid cells, sarcoma, additional spleen, mixed adenocarcinoma/sarcoma, yellow tufts, or B-cell lymphoma.

Table 4. Analysis of TNM tumor staging, tumor resection type and grading (patients after biopsies and palliative procedures were excluded) in 2019 compared to 2020

Variable		2019 (n = 263)		2020 (n = 148)		p-value
		n	%	n	%	
T1/T2/T3/T4	T1 T2 T3 T4	15 76 74 2	8.98 45.51 44.31 1.20	2 9 15 0	7.69 34.62 57.69 0.00	0.608
N0/N1/N2/N>3	N0 N1 N2 Nx	48 64 56 4	27.91 37.21 32.56 2.33	24 24 23 2	32.88 32.88 31.51 2.74	0.861
M/Mx	M1 Mx	17 6	73.91 26.09	18 4	81.82 18.18	0.780*
R0/R1/R2	R0 R1 R2	87 79 6	50.58 45.93 3.49	49 26 1	64.47 34.21 1.32	0.108
G1/G2/G3/G4	G1 G2 G3 G4	32 105 35 1	18.50 60.69 20.23 0.58	11 44 16 5	14.47 57.89 21.05 6.58	0.037
Neoadjuvant chemotherapy	no yes	225 19	92.21 7.79	129 18	87.76 12.24	0.145
Adjuvant chemotherapy	no yes	77 165	31.82 68.18	72 75	48.98 51.02	<0.001

The χ^2 test was used; * the Yates's correction was used.

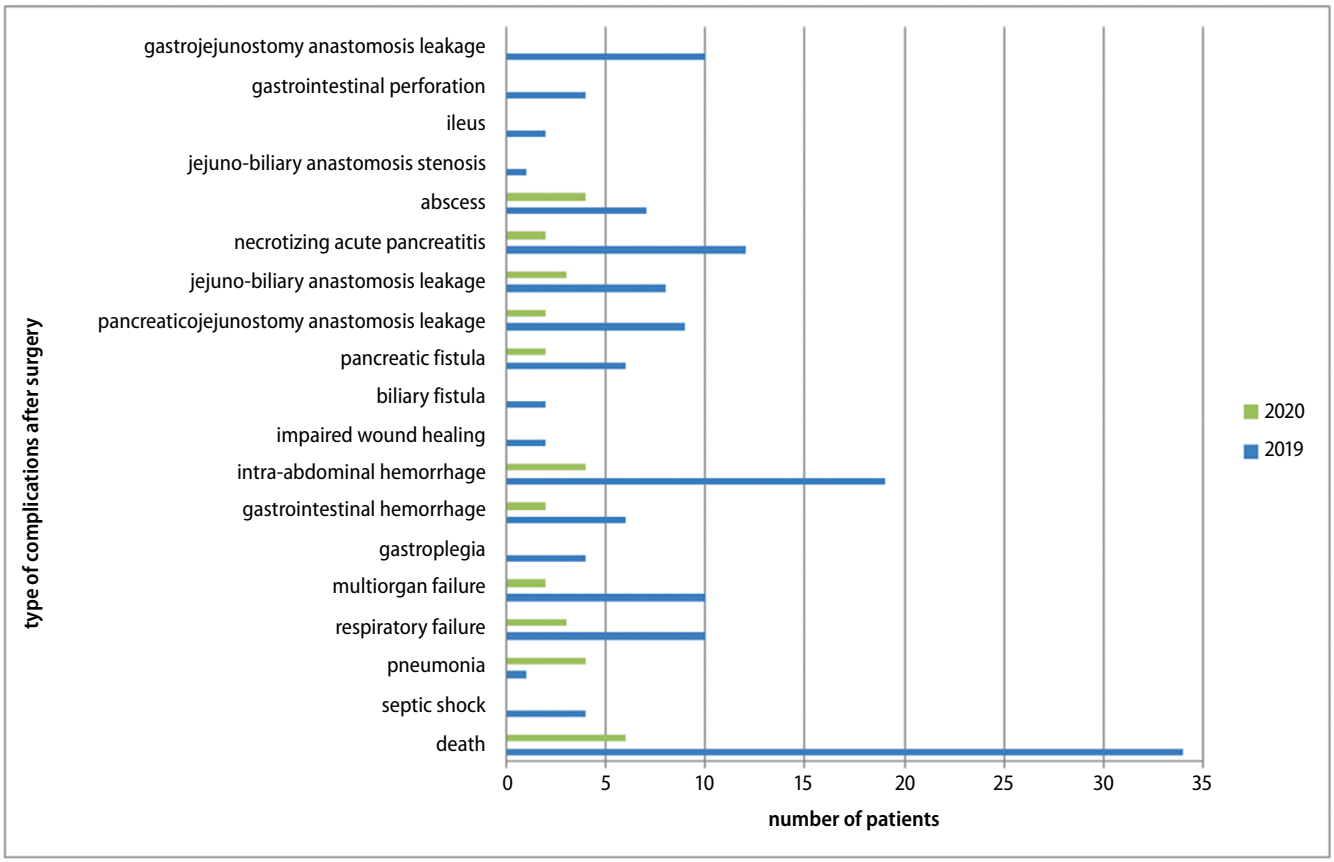

Fig. 3. All-cause mortality and complications after surgery according to type in 2019 compared to 2020. Other complications, not presented in this figure, include: mesenteric venous thrombosis, mesenteric artery thrombosis, pulmonary embolism, intraperitoneal hernia, acute gastritis, hydrothorax, transient ischemic attack, acute kidney failure, lymphocele, gastric ulcer, and atrial fibrillation.

observed that the larger the size of the primary tumor, the more frequently operations with venous reconstruction were performed (R = 0.129, p < 0.014). Moreover, the invasion of lymph nodes was diagnosed more often (R = 0.197, p < 0.001) and splenectomy was more often required (R = 0.146, p = 0.006).

The operative time was the shortest for open biopsy of a pancreatic tumor (R = –0.187, p < 0.001) and distal pancreatic resection with splenectomy (R = –0.225, p < 0.001), and the longest for Whipple procedure (R = 0.255, p < 0.001), Whipple procedure with venous reconstruction, and total pancreatic resection with venous reconstruction (R = 0.144, p < 0.004, and R = 0.149, p < 0.003, respectively).

The extended duration of the procedure was an important factor correlating with numerous parameters, including: the length of ICU stay (R = 0.119, p = 0.017), extended hospitalization time (R = 0.276, p < 0.001) and early mortality during the first hospitalization (R = 0.149, p = 0.003).

Shorter surgery time correlated with distal pancreatic resection with splenectomy (R = –0.225, p < 0.001).

Intensive care unit stay positively correlated with patients' older age (R = 0.109, p < 0.029), early mortality (R = 0.618; p < 0.001) and with the presence of complications such as sepsis (R = 0.141, p < 0.004), pneumonia (R = 0.173, p < 0.001), respiratory failure (R = 0.454, p < 0.001), multiple organ failure (R = 0.418, p < 0.001), and anastomotic leakage of pancreatic anastomosis (R = 0.303, p < 0.001). Moreover, similar correlations were observed when the hospitalization time was concerned. A negative correlation was stated between the length of the hospitalization and the type of surgery – distal pancreatectomy with splenectomy (R = –0.250, p < 0.001) (Table 5).

Discussion

In our clinic, we follow the actual National Comprehensive Cancer Network® (NCCN®) guidelines,[17] and we do not assess clinical TNM stage. According to those guidelines, a suspicion of pancreatic cancer or the evidence of dilated pancreatic and/or bile duct (stricture) are an indication for surgery, and the most important finding is the presence or absence of metastases. If there are no metastases in the diagnostic imaging, the next step is to check the vessel invasion. When metastases are present, this is an automatic contraindication to resection surgery and an indication for the biopsy and chemotherapy. In case of vessel invasion, depending on the kind of vessel and the experience of the high-volume center, a patient is qualified for resection surgery or neoadjuvant therapy.

Table 5. The list of most relevant correlations between obtained data

Correlated data	R	p-value
Primary tumor size & Whipple procedure + venous reconstructions	0.129	0.014
Primary tumor size & lymph node invasion	0.197	<0.001
Primary tumor size & splenectomy	0.146	0.006
Procedure time & open biopsy of the pancreatic tumor	–0.187	<0.001
Procedure time & Whipple procedure	0.255	<0.001
Procedure time & Whipple procedure + venous reconstruction	0.144	0.004
Procedure time & total pancreatic resection + reconstruction	0.149	0.003
Procedure time & distal with splenectomy	–0.225	<0.001
Procedure time & ICU stay	0.119	0.017
Procedure time & hospitalization time since surgery	0.276	<0.001
Procedure time & lymph node invasion	0.160	0.002
Procedure time & death	0.149	0.003
Procedure time & splenectomy	–0.146	0.003
ICU stay & age	0.109	0.029
ICU stay & total pancreatic resection + reconstruction	0.115	0.020
ICU stay & hospitalization time from surgery	0.242	<0.001
ICU stay & death	0.618	<0.001
ICU stay & 1 – sepsis	0.141	0.004
ICU stay & 2 – pneumonia	0.173	<0.001
ICU stay & 3 – respiratory failure	0.454	<0.001
ICU stay & 4 – organ failure (shock)	0.418	<0.001
ICU stay & 7 – hemorrhage into the peritoneal cavity	0.507	0.000
ICU stay & 12 – leakage of pancreatic anastomosis	0.303	<0.001
ICU stay & 13 – leakage of the biliary anastomosis	0.407	<0.001
Hospitalization time since surgery & distal with splenectomy	–0.250	<0.001

ICU – intensive care unit. Spearman's rank correlation was used.

It seems that the low number of postoperative complications and the low 30-day all-cause mortality rate in the group of oncological patients in 2020 is the result of a more precise selection of patients with pancreatic cancer before the admission, the observance of the newly developed procedures and the organization of the operating room during the COVID-19 pandemic. What's more, a decreased 30-day all-cause mortality in 2020 in our Center may be the result of a number of palliative surgeries (e.g., triple bypass anastomosis of intestines) in patients with advanced pancreatic cancer. In 2019, we performed much more extensive surgery procedures, e.g., Whipple pancreatectomy (125 (47.5%) in 2019 compared to 53 (36.3%) in 2020 ($p = 0.037$)). We have also noticed a much more frequent diagnosis of low-differentiated G3 and G4 anaplastic tumors in 2020, which tend to reach a larger size in a shorter time ($p = 0.037$). In 2020, our patients had much greater advancement of the disease, illustrated by the increased tumor size (median 3.0 cm in 2019 and 3.5 cm in 2020), although it did not reach statistical significance ($p = 0.073$). The diagnosis of a more advanced tumor influenced the decision of adjuvant chemotherapy administration. In 2020, the qualification rate for adjuvant treatment significantly decreased – 51% of patients in 2020 received such treatment compared to 2019, when as many as 68% of patients underwent adjuvant treatment ($p < 0.001$). It should be emphasized that in our center, there was not a single case of an oncological patient infected with the SARS-CoV-2 virus during the stay at the clinic.

Authors from Italy showed that the prolonged waiting time for surgery significantly increased mortality in cancer patients.[18] They emphasized that special attention should be paid to patients who have completed neoadjuvant therapy, patients with an aggressive type of cancer and those without any other therapeutic options. At the same time, the authors stated that COVID-19-positive oncological patients should have their surgery postponed until the recovery.

Solving the problem of a limited access to medical services in times of a pandemic is conditioned by local customs and in each country different solutions are found, e.g., in the abovementioned study by Cavaliere et al.,[18] the eligibility criteria for the surgical procedure are based on COVID-19 incidence in a particular area. If the coronavirus infection and hospitalization rate due to COVID-19 is high – >75% – then the surgeries are performed only due to life-saving, necessary and urgent

indications. If the coronavirus infection and hospitalization rate ranges between 25% and 50%, then surgeries are performed in oncological patients who cannot undergo neoadjuvant therapy and patients whose 3-month survival will be significantly affected by the lack of surgery. If hospitalization of COVID-19-infected patients does not exceed 5%, surgeries can be performed in the standard mode.

Based on the COVID-19 status of the region/hospital and the availability of healthcare resources, the American College of Surgeons (ACS) has proposed 3 different phases that a healthcare setup can encounter: phase 1 – semi-urgent settings (preparation phase) – the disease is not in the rapid escalation phase and institutions have adequate resources such as hospital and ICU beds, ventilators and manpower to provide the services; phase 2 – urgent settings – limited availability of resources due to an increased number of COVID-19 patients; phase 3 – hospitals are overburdened with COVID-19 patients and the nonavailability of healthcare facilities, such as operating rooms, beds, ICUs, and ventilators.[19]

The recommendations of the Society of Surgical Oncology (SSO) concerning hepato-pancreato-biliary (HPB) cancer[20] state that HPB malignancies are typically biologically aggressive and should not be planned as elective operations. The decision on performing an operation during the COVID-19 pandemic needs to be considered in the context of the hospital resources, multidisciplinary providers, presence and severity of symptoms, and the biology of the disease. The following factors should also be weighed in the decision-making process: hospital resources of personal protective equipment (PPE), bed/ICU/ventilator capacity and utilization, number of COVID-19 patients and the projected trajectory of COVID-19 patient influx.

Since the beginning of the pandemic, various protocols on qualifying oncological patients for surgery have been developed. The mortality rate is extremely high in COVID-19 infected patients, reaching up to 75% in patients after recent surgery due to cancer or patients after chemotherapy.[19] For this reason, oncological patients should not undergo scheduled surgery if they have an active infection, and all the procedures should be postponed until recovery.[20]

According to the extensive Chinese guidelines, cancer patients admitted to the hospital should have an antigen and PCR test, as well as computed tomography (CT) of the lungs. After excluding the COVID-19 infection, they should stay in the isolation ward for 3–7 days, and only if they have no suspicious symptoms they can be transferred to the surgical ward and have a surgery.[16]

Limitations

In patients with advanced inoperable tumor who underwent percutaneous biopsies, open biopsies and/or bypass anastomoses, full staging according to TNM was impossible, therefore the data presented in Table 4 concerns only patients who underwent a tumor resection and had a complete histopathological examination of the tumor (TNM).

In our clinic, we follow the actual National Comprehensive Cancer Network® (NCCN®) 2021 guidelines, and we do not assess cTNM.

Conclusions

The coronavirus epidemic in Poland as well as worldwide has made it difficult to access the oncological treatment. For many diseases, delayed treatment does not have a significant impact on the prognosis, but this does not apply to oncological patients, especially patients with pancreatic cancer, who require adjuvant or neoadjuvant chemotherapy. Particular attention should be paid to patients with an aggressive type of cancer who have completed neoadjuvant therapy, as there are no other therapeutic options for them. The treatment of SARS-CoV-2-positive cancer patients should be postponed until their recovery. In the presented material, relatively few postoperative complications and low all-causes mortality are the result of a more careful selection of oncological patients before the admission to the surgical ward, as well as the compliance with the principles of planning the procedure and organization of the operating theater during the COVID-19 pandemic.

The most common location of the pancreatic tumor was in the head of the pancreas. We observed a significant increase of tumors located in the tail of the pancreas in 2020. In the same year, palliative procedures were performed more often, which resulted in a decrease in number of Whipple procedures. The most common histopathological finding was adenocarcinoma of the pancreas, accounting for almost 52% of all tumor types in 2019 and 50% in 2020. In a group of 148 patients operated on for a pancreatic tumor during the COVID-19 pandemic, only 6 patients died, which resulted in an early all-cause mortality rate of 4.1%. None of the patients became infected with SARS-CoV-2 during hospitalization.

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