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COMPLICATIONS PROFILE AFTER ROBOTIC PANCREATIC SURGERY

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Abstract
Introduction: General acceptance of the robotic platform in pancreatic surgery is poor. One of the main concerns regarding this technique is that the likelihood of complications is greater compared to other approaches.
Material and Methods: We performed a retrospective analysis of our database on robotic pancreatic surgery.
Results: A total of 22 patients (12 male) underwent robotic pancreatic surgery. 6 pancreatoduodenectomies (PD 27.3%), 12 distal pancreatectomies (DP 54.5%), 2 tumor

enucleations (9.1%) and 2 pseudocyst-gastrostomy (9.1%) were performed. The overall operative time was 425 (390–620) min, the median blood loss was 150 ml (70–600). We observed 10/22 (45.4%) overall postoperative morbidity, with 4 grade III to V complications according to the Clavien-Dindo classification system. The Clinically relevant pancreatic fistula rate was 3/22 (13.6%): 2 in DP group, 1 in the PD group. The reoperation rate was 2/22, one in the PD group, the other in the PG group; while the readmission rate was 18.6%. There was no postoperative death during the 30 days post surgery.
Conclusion: Robotic pancreatic surgery seems to be safe and feasible and it is associated with an acceptable risk of complications, low estimated blood loss and low conversion rate.

Key words: pancreatic surgery, robotic surgery, complications

Introduction

Despite the increasing frequency of robotic surgery, pancreatic surgery using this technique is still relatively uncommon. The first robotic DP (distal pancreatectomy) and PD (pancreatoduodenectomy) were described over a decade ago [1,2].

Robotic surgery is more expensive compared to laparoscopy and distant oncological results are unknown, but its advantage is its technical superiority over laparosocopic and open surgery [3,4]. The data currently available show positive results regarding patients who undergo robotic DP. These outcomes are faster recovery, a lower blood loss and conversion rate, improved negative margin resection, better lymph node yield and a higher spleen preservation rate [5,6]. In addition, intraoperative blood loss is lower, patients are discharged faster, the percentage of R0 negative resection margin is higher and the interval to the start time of adjuvant chemotherapy is shorter [7–10].

In this paper we analyze the data on 90-day post-operative complications after robotic pancreatic resections performed by a single surgeon.

Material and Methods

We analyzed our database on robotic pancreatic surgery retrospectively. All 22 consecutive patients who underwent RAPS (Robotic Assisted Pancreatic Surgery) from January 2015 to August 2017 were included in our study. The Data on patients described in this paper were part of a wider study of robotic pancreatic surgery described elsewhere [11].

Pre-operative staging included a CT-scan, Abdominal Ultrasound, upper endoscopy and MRI, which were carried out on all patients.

All patients were discussed at MDT meetings during which the indication for surgery and type of operation (robotic vs. open) were established (Table 1).

Table 1. Exclusion Criteria for RAPS (Robotic Assisted Pancreatic Surgery)

Tumor size > 3 cm
Personal choice of patient
Lymph nodes metastases
Clear vascular involvement
Previous major surgery in abdominal upper quadrant
BMI > 35 Kg/m^2
ASA score > 3
No sustainability to pneumoperitoneum
Unavailability of the robotic platform

BMI: Body Mass Index; ASA: American Society of Anaesthesiologists.

During operations a careful intraoperative inspection of the pancreatic gland was always performed using a Robotic ultrasound probe after full exposure of the pancreas in order to confirm the location of the tumor (Figure 1).

All postoperative complications occurring within 90 days of surgery were recorded prospectively and classified according to the Clavien-Dindo classification system [12]. Postoperative pancreatic fistulae and delayed gastric emptying were defined following the classification proposed by the International Study Group of Pancreatic Fistula and Pancreatic Surgery (ISGPF–ISGPS) [13,14].

The resection margin was considered positive (R1) after the tumor had been confirmed within 1 mm of each of the six margins of resection examined, as suggested by a standardized protocol [15].

The pancreatic transection was performed using an Ultrasound Dissector or EndoWrist Monopolar Scissors (Figure 2).

Results

A total of 22 patients underwent RAPS in our Tertiary Care Center during the study period. Table 2 presents the basic characteristic of these patients.

6 pancreatoduodenectomies (PD 27.3%), 12 distal pancreatectomies (DP 54.5%) (9 with splenectomy), 2 tumor enucleations (9.1%) and 2 Pseudocyst-gastrostomy (9.1%) were performed.

According to the pathology report 13 resected tumors were malignant and 9 benign. There were 7 ductal adenocarcinomas, 3 cases of chronic pancreatitis, 3 neuroendocrine tumors (including 1 cancer), 2 pancreatic mucinous cystoadenomas, 1 cystoadenocarcinoma, intraductal papillary mucinous neoplasia in 2 cases, 1 periampullary carcinomas, 1 cholangiocarcinoma of the distal common bile duct and 2 pancreatic pseudocysts.

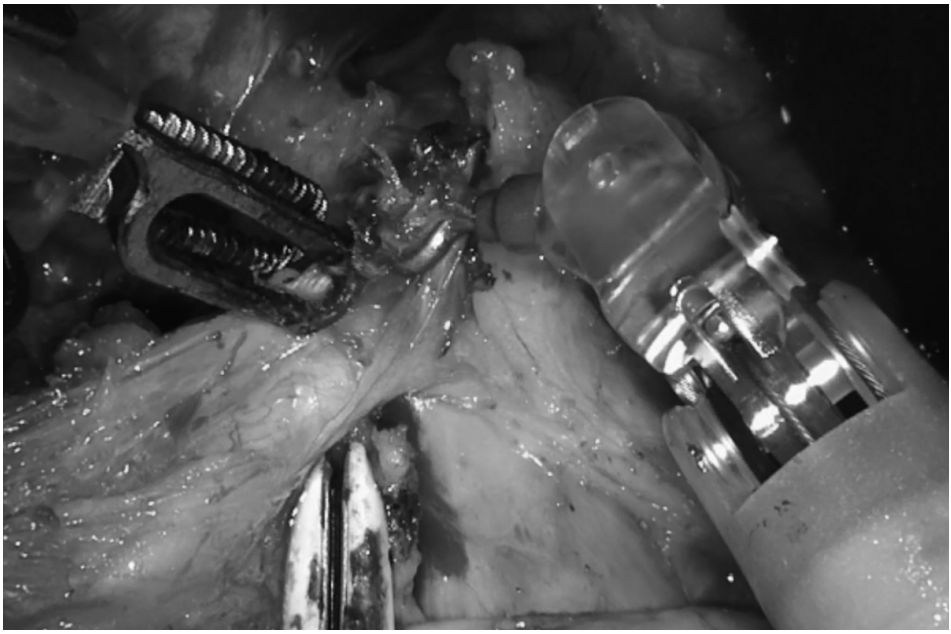

Fig. 1. Gastroduodenal artery dissection

Fig. 2. Uncinate Process dissection

Table 2. Demographic Aspects and Procedures

Number of Patients (total)	22
Gender:	
Male	12
Female	10
Age, Median (Range) years	62 (35–79)
BMI median, Kg/m2	26.5
18.5–24.9	6
25–29.9	10
30– 34.9	6
ASA score	
I	8
II	8
III	6
Previous Abdominal Surgery	4/22 (18.2%)
Type of Operation:	
PD	6 (27.3%)
DP	12 (54.5%)
Enucleation	2 (9.1%)
Pseudocyst/Gastrostomy	2 (9.1%)

BMI: Body Mass Index; ASA: American Society of Anaesthesiologists; PD: Pancreaticoduodenectomy; DP: Distal Pancreatectomy.

The overall operative time was 425 (390–620) min, 260 (190–315) min for DP and 540 (480–620) min for PD, 160 (70–275) min for enucleation and 585 (482–655) for Total Pancreatectomy (TP), while for pseudocyst-gastrostomy the operative time was 130 (90–210) min. The median operative time for the first eight PD procedures was 590 min and 530 min for the last six.

Conversion to open surgery was performed in 2/22 (9.1%) patients: 1 in DP and 1 in the PD group. The reasons for conversion were portal or superior mesenteric vein involvement with failure to progress during a PD, and a severe pancreatitis with massive disruption of the pancreatic parenchyma which caused a major bleeding from the splenic artery during DP.

The median blood loss was 170 ml (80–700 ml) in the PD group, 100 ml (20–230 ml) in DP group and less than 30 ml (10–150 ml) in enucleation group. Only one patient required intraoperative blood transfusion (the threshold for transfusion was hemoglobin level < 6.5 mg/dl).

In 10 patients (45.4%) we observed postoperative complications (11 adverse events in general), 4 of them classified as serious (III to V) according to the Clavien-Dindo scale (table 3).

Table 3. Histological findings

	Robotic PD	Robotic DP	Enucleation	P/G	Overall
	6	12	2	2	22
Malignancies					13/22 (59.1%)
– Ductal Adenocarcinoma	4	3			7
– Neuroendocrine Carcin.		1			1
– Cystoadenocarcinoma		1			1
– Periampullary Carcinoma	1				1
– IPMN main-duct		2			2
– Cholangiocarcinoma CBD	1				1
Benign Tumor					9/22 (40.9%)
– Chronic Pancreatitis		3			3
– Neuroendocrine tumor			2		2
– Mucinous cystoadenoma		2			2
– Pancreatic Pseudocyst				2	2

P/G: Pseudocyst Gastrostomy; IPMN: Intraductal Papillary Mucinous Neoplasm; CBD: Common bile duct; GIST: Gastrointestinal Stromal Tumor.

The class I complications were 2 cases of Grade A pancreatic fistula spontaneously solved, one case of grade A delayed gastric emptying and one of jejunal paralytic occlusion, both treated with an antiemetic drug and prolonged maintenance of a naso-gastric tube.

The class II complications were 2 cases of Grade B pancreatic fistula treated with Somatostatine and Total Parental Nutrition.

The class III complication was a case of abdominal collection treated by percutaneous drainage.

The class IV complications were 1 case of Grade C pancreatic fistula and two cases of abdominal hemorrhage; these patients underwent reoperation and required intensive care unit management.

The only class V complication was cardiorespiratory failure resulting in an unplanned intensive care unit recovery. When classifying the complications depending on the procedures performed we noticed that 3/6 (50%) complications occurred in the PD group and 5/12 (41.7%) in the DP group, two complications occurred in the four patients who underwent enucleation or pseudocyst-gastrostomy (50%).

Altogether, we observed 3 clinically relevant pancreatic fistula and 2 biochemical leaks.

Excluding patients who converted to open surgery, the rate of clinically-relevant pancreatic fistula after robotic-sewn jejuno-pancreatic anastomosis was 1/5 (20%).

The two biochemical leaks (grade A) (all diagnosed on the 5^{th}–6^{th} postoperative day) were treated conservatively by performing a serial pancreatic function examination and abdominal ultrasound, the two cases of grade B pancreatic fistula (both in the DP group) were treated by administration of a total parenteral

nutrition and antibiotic-therapy, finally a grade C pancreatic fistula (observed in the PD group) required a reoperation on postoperative day 10 involving the creation of a new anastomosis.

The reoperation rate for all patients was 2/22 (9.1%), a patient in the PD group and another in the pseudo-cysto gastrostomy group required a second-look laparotomy for the following indications:

– the former for a clinically significant pancreatic fistula associated with retroperitoneal bleeding and peritonitis syndrome at postoperative day 10;
– the latter for one intrabdominal hemorrhage from a branch of the SMA at postoperative day 6 after unsuccessful angiographic embolization.

All complications, except one, were identified in the first ten days after surgery and it was easier to manage the post-operative course thanks to the mini-invasive surgical approach.

One patient who underwent reoperation for a grade C pancreatic fistula manifested a post-operative cardiorespiratory failure associated to severe pneumonia. The patient was readmitted to the Intensive Care Unit where he was treated by mechanical ventilation before the referral to a specialized care center.

No other complications were recorded during the 90 days following the operations. Tables 4, 5 and 6 describe in detail perioperative and oncological outcomes, as well as all recorded complications.

Table 4. Perioperative outcomes of patients who underwent PD and DP

	Robotic PD	Robotic DP	Overall
Operative time, Median (Range) min	540 (480–620)	260 (190–315)	425 (390–620)
Conversion to open	1/6 (16.7%)	1/12 (8.3%)	2/18 (11.1%)
EBL, Median (Range) ml	170 (80–700)	100 (20–230)	150 (70–600)
Intraoperative transfusion rate	1/6 (16.7%)	/	1/18 (5.6%)
Morbidity rate	3/6 (50%)	5/12 (41.7%)	8/18 (44.4%)
Reoperation rate	1/6 (16.7%)	/	1/18 (5.6%)
Length of stay, Median (Range) days	13 (7–30)	8 (5–11)	10.5 (10–22)
Readmission rate 90-day	1/6 (16.7%)	2/12 (16.6%)	3/18 (16.7%)
Mortality rate 30-day	/	/	/

Table 5. Oncological findings

	Robotic PD	Robotic DP	Overall
R0 resection margins	5/6 (83.3%)	7/7 (100%)	12/13 (92.3%)
R1 resection margins	1/6 (16.7%)	/	1/13 (7.7%)
LN Harvested, Median (Range)	25 (18–35)	16 (12–22)	23.8 (12–45)
Tumor Size, Median (Range) mm	22 (10–29)	38 (18–59)	32 (12–59)
Recurrence at 24 months	1/6 (16.7%)	1/7 (14.3%)	2/13 (15.4%)

Table 6. Classification of all complications that occurred

	Robotic PD	Robotic DP	Enucleation plus PG	Cumulative of all population	Treatment
Overall Complication	3/6 (50%)	5/12 (41.7%)	2/4 (50%)	10/22 (45.4%)	
Minor Complications	1/6	4/12	1/4	6/22	
Clavien I					
– Pancreatic Fistula Grade A	1	1		2	Output drain control
– Delayed Gastric Emptying Grade A		1		1	Anti-emetic drug
– Jejunal Paralitic Occlusion			1	1	Prolonged Use of NasoGastricTube
Clavien II					
– Pancreatic Fistula Grade B		2		2	Anti-Secretive + Total Parenteral Nutrition + Antibiotics
Major Complications	2/6	1/12	1/4	4/22	
Clavien III					
– Abdominal Collection		1		1	Radiologic Intervention with percutaneous drainage
Clavien IV					
– Pancreatic Fistula Grade C	1*			1*	Reoperation + Postoperative ICU
– Abdominal Hemorrhage	1		1	2	Management
Clavien V					
– CardioRespiratory failure	1*			1*	/

* They occurred in the same patient.

The median hospital stay was 13 days (10–22) for all procedures. More precisely it was 15 in the case of patients who underwent TP, 13 days in the PD group (range 7–30) and 8 in the DP group (range 5–11), while in case of enucleations and pseudocysto-gastrostomy it was only 6 days [4–8].

We observed a clear benefit regarding the post-operative length of stay, and we believe we shall obtain better results when we introduce an ERAS (enhanced recovery after surgery) protocol, also for patients with pancreatic cancers.

The overall readmission rate was 3/22, 2 of them readmitted after DP, and 1 patient who belonged to the PD group.

The reasons for readmissions were subphrenic fluid collection which required percutaneous drainage, a postoperative pancreatic B fistula requiring TPN for 12 days, and pulmonary distress syndrome.

The R0 resection rate was achieved in overall 12/13 patients (92.3%). The mean number of harvested nodes was 25 (18–35) for PD and 16 (range 12–22) for the DP group.

The follow-up was carried out until 18 months after surgery. Of the 13 patients with malignant tumors we saw 2 recurrences, one of the recurrences was distant and one was regional.

Discussion

The robotic platform has been used in all fields of surgery including such surprising locations as the breast [16], head and neck [17] and inguinal hernia [18]. The most promising results have been achieved with abdominal robotic operations, especially in colorectal and gastric surgery [19].

Robotic resection boasts a lower complication rate, lower margin positivity rate, lower wound infection rate and a shorter hospital stay [10]. The rate of postoperative complications after robotic resections ranges from 29% to 68% with 6% to 38% experiencing pancreatic fistulae [20]. Indeed, we have seen similar numbers of pancreatic fistulae in our material and it does not seem that the robotic approach increases its risk [4,21].

There is no difference between robotic and open PD regarding delayed gastric emptying as we observed in our experience, even if some studies have reported a higher incidence of grade-C delayed gastric emptying but a lower incidence of grade A [10,22].

Blood loss during robotic PD is lower than after an open procedure (range 100–485ml) [20]. This may be caused by the use of 3D vision and a quick swap between monopolar and bipolar [23]. The risk of post-operative pseudoaneurysm is reduced due to the possibility of performing a hand-sewn ligation of the gastroduodenal artery (Figure 3) [7].

The rate of conversion varies from 0% to 18% for PD (mean 7.3%) and for DP (6.5%), because dissection is difficult and bleeding is likely [10,22,24]. The main reasons for the conversions were similar to our results. The overall conversion rate in robotic PD surgery is lower than in laparoscopic surgery [20]. Moreover, we expect to further reduce the conversion rate as we gain experience [25].

The robotic technique allows mild dissection to be performed and as a result the spleen preservation rate is high [25,26]. Complete control of the anatomy using the 7 degree of freedom instruments is also possible, which allows surgeons to reach complex anatomic zones.

Like the data from the literature, where the median number of harvested lymph nodes ranged from 13 to 32 [27] we did not observe any difference between the number of lymph nodes harvested and R0 resections compared to the laparoscopic approach.

The median length of postoperative stay in the series reported ranged from 9 to 23 days [28,29]. In our series we also observed relatively short postoperative stays with a median of 13 days with a 8.3% readmission rate. The reduced

hospital stay in respect to the laparoscopic and open procedures may be associated with a lesser immunological response and can lead to adjuvant chemotherapy being begun sooner. If confirmed, this may translate into better survival, as seen in other cancers [30].

We believe that a shorter hospital stay and faster start to chemotherapy may improve the oncologic outcome of patients, but the majority of reports are based on data from surgeons within their own learning curve and the impact of robots on oncologic outcomes requires further investigation.

Fig. 3. Pancreato-Jejunostomy

Conclusion

In conclusion, our data confirm that the robotic platform in pancreatic surgery can offer some advantages in terms of reducing the wound infection rate, hospital stay and minimizing blood loss.

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Profil powikłań pooperacyjnych po zabiegach robotowych w obrębie trzustki

Streszczenie

Wprowadzenie: Ogólny stopień akceptacji dla stosowania chirurgii robotowej w chirurgii trzustki jest niski. Jedną z podstawowych barier dla wprowadzania tej techniki jest obawa przed większym niż w przypadku innych technik operacyjnych ryzykiem wystąpienia powikłań pooperacyjnych.

Materiał i metody: Przeprowadzono retrospektywną analizę danych szpitalnych dotyczących zabiegów operacyjnych trzustki z dostępu robotowego.

Wyniki: Ogółem operowano 22 chorych (w tym 12 mężczyzn) z zastosowaniem systemu robotowego do operacji trzustki. Wykonano 6 pankreatoduodenektomii (27,3%), 12 pankreatektomii obwodowych (54,5%), 2 wyłuszczenia guza (9,1%) oraz 2 zespolenia pseudotorbieli trzustki ze światłem żołądka (9,1%). Czas operacji wyniósł średnio 425 min (390–620 min), a mediana utraty krwi – 150 ml (70–600 ml). Powikłania pooperacyjne stwierdzono u 10 z 22 chorych (45,4%) przy czym u 4 wystąpiły powikłania w stopniu III–V według skali Claviena-Dindo. Klinicznie istotna przetoka trzustkowa wystąpiła u 3 z 22 chorych (13,6%), w tym u 2 chorych po resekcji obwodowej trzustki i u 1 po pankreatoduodenektomii. Reoperacje były konieczne u 2 z 22 chorych: jedna po zabiegu pankreatoduodenektomii i jedna po zespoleniu pseudotorbieli ze światłem żołądka. Odsetek ponownych przyjęć do szpitala wyniósł 18,6%. Nie stwierdzono zgonów w okresie 30 dni po zabiegu operacyjnym.

Wnioski: Robotowa chirurgia trzustki wydaje się być techniką bezpieczną i wykonalną przy akceptowalnym ryzyku powikłań pooperacyjnych, niskiej śródoperacyjnej utracie krwi oraz niskim ryzyku konwersji.

Słowa kluczowe: chirurgia trzustki, chirurgia robotowa, powikłania