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Robotic Assisted Distal Pancreatectomy: Learning Curve

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1. Abstract

1.1. Introduction

Use of minimally invasive surgery for distal pancreatectomy has been demonstrated with improvement in the length of hospitalisation, blood loss and splenic preservation rate. Current literature concerning operating time with robotic assistance is divergent. The aim of our study is to analyse the learning curve and the evolution of operating time in robotic assisted distal pancreatectomies.

1.2. Patients and Methods

From 2014 to 2021, in a single center performing 60 robotic-assisted digestive surgeries procedures per year, all patients who underwent robotic assisted distal pancreatectomy were included. A descriptive analysis of peri-operative data has been made as well as an analysis of the learning curve concerning operating time, intraoperative blood loss, splenic preservation rate, length of hospitalization, rate of pancreatic fistula, and grade III and IV Clavien-Dindo's complications.

1.3. Results

35 patients were included. The number of spleno-pancreatectomies and distal pancreatectomies with splenic preservation were respectively 28 and 7. Mean operating time was 178 minutes. Rate of Grade III and IV Clavien Dindo's complications was 5.7%. There was no death within the 90 post operating days. During the inclusion period, the same surgeon performed 318 other robotic assisted digestive surgeries. The operating time was the criteria that improved the most. It decreased from a mean of 236 minutes for the first 8 procedures, to 165 minutes from the 9th intervention onwards. 5 out of 7 of splenic preservations were performed from the 26th procedure. Rate of blood loss, length of stay and post-operative complications did not improve during the study period.

1.4. Conclusion

Our analysis suggests a notable decrease in operating time from the 9th robotic assisted distal pancreatectomy and leans on the importance of global robotic expertise of the surgeon.

1.5. Highlights

▪ Robotic assisted surgery is a safe approach in distal pancreatectomies

▪ Current literature often suggests a longer operating time with robotic assistance but recent studies report a steep learning curve with shorter operating time after 10 procedures

▪ Global experience in robotic surgery seems to impact more on operating time

- Splenic preservation requires advanced skills and experience in general robotic surgeries, as well as pancreatic surgeries.

2. Introduction

The minimal invasive approach for pancreatectomy is still being debated especially concerning cephalic duodeno-pancreatectomy. However, its application in distal pancreatectomy is more widely accepted [1, 2]. Compared to laparoscopic approach, robotic assistance offers the same advantage, with less technical difficulties, especially with the improvement in the 3-dimensional vision and free amplitude of robotic instruments. In current literature, minimal invasive distal pancreatectomy improved intraoperative blood-loss, length of hospitalization, and splenic preservation rate [3-5]. Robotic assisted pancreatic procedures require advanced skills, not only in pancreatic surgeries, but also in global robotic surgeries. Concerning the surgeon's robotic learning curve, several reports have analysed its repercussion on operative time, blood loss, pancreatic fistula, length of stay and splenic preservation rate in robotic-assisted distal pancreatectomies [6-8]. Nevertheless,

these data are exclusively retrospective and no threshold of significant progression in the operator's learning curve exists at present. Herein, we report a retrospective analysis of a single operator's learning curve in robotic assisted distal pancreatectomies conducted in our center, where 60 robotic-assisted digestive surgeries are performed per year, 15 of which are distal pancreatectomies.

3. Matherials and Methods

3.1. Population

Patients were retrospectively included from the 1st January 2014 to 1st January 2021. Inclusion criteria were all patients above 18 years who underwent robotic-assisted distal pancreatectomy with or without splenic preservation. The procedures were performed in a single center by a single surgeon.

3.2. Descriptive data

Demographic and pre-operative characteristics were age, BMI, sex, ASA score, comorbidities and surgical history. Perioperative data such as occupation time in the operating room, installation, operating time, intraoperative blood loss, blood transfusion, and conversion rate were systematically retrieved. Surgical data collected were the type of surgery (distal pancreatectomy with or without splenic preservation), failure of splenic preservation, mesenteric vein preservation, associated organ resection, modality of pancreatic resection and drainage.

3.3. Surgical procedure

Each procedure was performed with robotic assistance of the Da Vinci Surgical System®. A distal pancreatectomy with or without splenic preservation was performed. Splenic preservation was done according to either Kimura's or Warshaw's technique.

3.4. Learning curve

All robotic-assisted digestive surgeries as well as robotic-assisted distal pancreatectomy performed by the operator were retrieved. Learning curves were established after studying the evolution of operative time, blood loss, splenic preservation, length of stay, rate of pancreatic fistula and post-operative complications (Clavien-Dindo ≥III). These characteristics were analysed taking into account the operator's total number of robotic-assisted interventions.

3.5. Statistical analysis

Statistical analysis was performed using the Excel software program. Parameters of learning curves were analysed with linear regression for quantitative data.

4. Results

4.1. Descriptive data

A total of 35 patients were included in the analysis. Pre-operative characteristics are described in (Table 1). The majority of patients included were women (65.7%). Average age of patients was 60 years. The mean body mass index was 26. The rate of spleno-pancreatectomy and distal pancreatectomy with splenic preservation were, respectively, 28 (80%) and 7 (20%), shown in (Table 2). One patient underwent a laparo-conversion because of a suspicion of superior-mesenteric-vein invasion. There were no laparo-conversion in patients with splenic preservation. The rate of successful splenic preservation was 7 out of 9 cases. The mean operating time was 178 min with an installation time ranging from 5 to 25 min. Mean intraoperative blood loss was 113 mL. One patient required intraoperative blood transfusion. Concerning the postoperative data, described in (Table 3), two patients (5.7%) developed grade III and IV Clavien-Dindo (CD) complications, one of which required to be reoperated for a hematoma after splenic artery embolization, and the other developing a grade C pancreatic fistula. Mean length of hospitalisation was 11 days (min=6, max=55). No death occurred in the first 90 post-operative days. Histological analysis showed 100% complete resection, independently of the final histology. Neuroendocrine tumours and pancreatic adenocarcinomas were the two most represented types. Nine patients developed a local or metastatic recurrence. Both specific and overall survivals were 91.5%.

Table 1: Pre-operative patient characteristics

	N = 35	%	Mean;[stand dev. (min; max)]
Demographic data			
men	12	34.3	
women	23	65.7	
Age			60 [12.2 (40; 81)]
ASA			
I	3	8.6	
II	24	68.6	
III	8	22.9	
BMI			26 [5 (15; 39)]
Comorbidities			
Diabetes	13	37.1	
Hypertension	19	54.3	
Ischemic cardiopathy	3	8.6	
COPD	1	2.9	
Renal insufficiency	1	2.9	
Smoking	11	31.4	
Anticoagulation	2	5.7	
Important surgical background	13	37.1	

Table 2: Intraoperative data

	N = 35	%	Mean; [stand dev (min; max)]
Spleno-pancreatectomy	28	80	
Considered splenic preservation before surgery	9	25.7	
Distal pancreatectomy with splenic preservation	7	20	
Kimura's technique	5	14.3	
Warshaw's technique	2	5.7	
Associated resection	6	17.1	
Posterior RAMPS	2	5.7	
Cholecystectomy	3	8.6	
Partial gastrectomy	1	2.9	
Pancreatic section			
stappling	34	97.1	
scalpel	1	2.9	
Drainage	35	100	
Inferior mesenteric vein preservation	26	74.3	
Laparo-conversion	1	2.9	
Blood loss (mL)			113 [182 (10; 1000)]
Installation time (min)			7.6 [4.4 (5; 25)]
Operating time (min)			178 [53 (110; 330)]
Operating room occupancy time (min)			301 [69 (200; 500)]

Table 3: Post-operative data

	N = 35	%	Mean; [stand dev (min; max)]
Length of hospitalisation (days)			11 [8.8 (6; 55)]
Post operative complications			
Clavien I - II	23	65.7	
Clavien III - IV	2	5.7	
Pancreatic fistula			
Grade A	19	54.3	
Grade B	3	8.6	
Grade C	1	2.9	
Post operative transfusion	2	5.7	
Surgical re-intervention within 90 days	1	2.9	
30 and 90-day mortality	0	0	
Relapse	9	25.7	
local	2	5.7	
metastatic	7	20	
Mortality after 90 days	3	8.6	
Histological data			
Pre-operative biopsies	15	42.9	
Lesion size (mm)			31 [18.6 (8; 70)]
Complete resection	35	100	
Number of lymph nodes removed			
Spleno-pancreatectomy			11 [7.1 (0; 32)]
Left pancreatectomy with spleen preservation			0.7 [1.5 (0; 4)]
Neuro-endocrine tumours	9	25.7	
Adenocarcinomas	9	25.7	
mucinous cystadenoma	4	11.4	
Benign cyst	1	2.9	
Frantz' tumours	1	2.9	
Mixed amphicrine tumour	1	2.9	
TIPMP	6	17.1	

4.2. Learning curve analysis

Between 2014 and 2020, 35 robotic-assisted distal pancreatectomies were performed. During the same period, the surgeon performed a total of 353 other robotic-assisted digestive surgeries. The operating time for left pancreatectomies decreased over time with an average of 236 minutes for the first 8 procedures, and less than 165 minutes from the 9th procedure (Figure 1).

The results of (Figure 2) confirm this trend with a mean operating time of 165 minutes starting from the 9th procedure, which corresponds with the 125th robotic assisted digestive surgery performed by the surgeon. Most of splenic preservations occurred after the 26th procedure (5 out of 7). However, concerning intraoperative blood loss, length of stay and post-operative complications, no evolution was noted with the simultaneous improvement of the surgeon's learning curve.
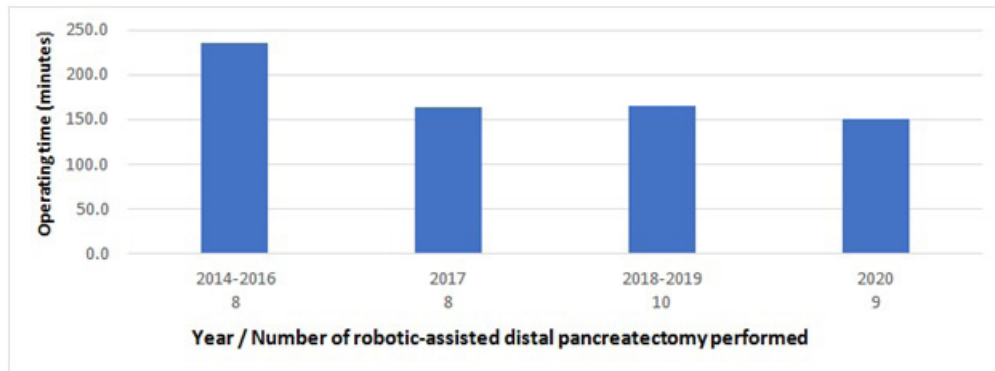
Figure 1: Evolution of average operating time considering time and number of robotic-assisted distal pancreatectomies performed by the surgeon.
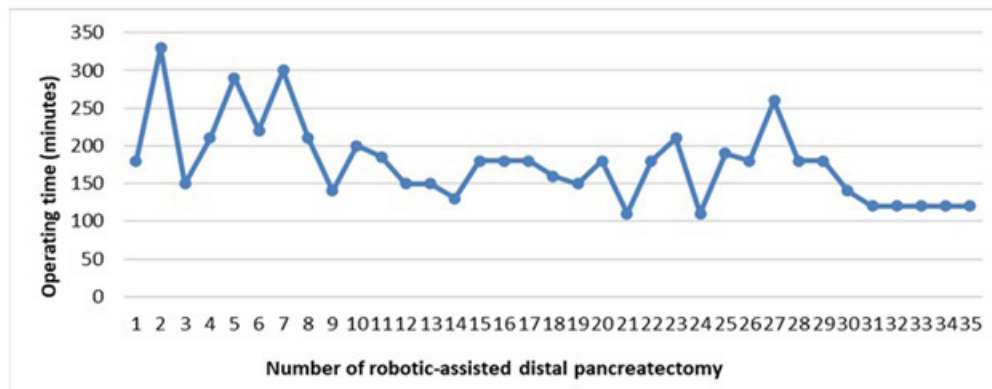

Figure 2: Operating time of each robotic-assisted left from 2014 to 2020

5. Discussion

Our results are consistent with the current literature. High-grade complication rate in our study is 5.7%, within the lower limits of current literature (25% of Grade III and IV Clavien Dindo's complications in the LEOPARD study [1]). This result is partly explained by the small number of events in a small sample size, but suggests a benefit provided by robotic assistance compared with the laparoscopic approach. The same observation was made concerning histological results with 100% complete resection [9,10]. Our data reinforce current studies in favour of robotic assistance in distal pancreatectomies. The analysis of the surgeon's learning curve shows that operating time tends to decrease along the study. Mean operating time during the first two years of practice is 236 minutes where 8 robotic assisted distal pancreatectomies were performed. It was reduced to 165 minutes for the rest of the analysis, showing notable reduction of operating time after the 9th procedure. Moekette et al described in their review a significant reduction of operating time from the 22nd intervention (n=44), with a mean operating time reduced from 217 minutes to 127 minutes (p=0.02) [11]. These different results are partly explained by the heterogeneity of patients' characteristics. In our study, we can also explain a rapid improvement of operating time due to the global robotic experience of the operator who performed 353 robotic-assisted interventions during the study. So in a center with a high volume of robotic assisted surgeries, we could expect to have a faster learning curve, and shorter operating time.

At the time of the surgeon's first robotic distal pancreatectomy, he already had performed 41 robotic assisted surgeries, and 125 other robotic surgeries before the 9th procedure. However, there are no current studies in the literature comparing the effect of global expertise in robotic surgery on the learning curve of distal pancreatectomy. Nevertheless, these data shows rapid improvement in operating time in robotic left pancreatectomy. Robotic assistance has not yet proved its advantage in terms of global operating time compared to laparoscopic approach, but a steep learning curve is promising for the future. Current studies suggest that at least 10 procedures of robotic-assisted left pancreatectomies are necessary to improve operating time [7], [11], [12]. Above all, global expertise in robotic surgery seems to influence the learning curve of this procedure.Most of splenic preservations were performed rather late, with 5 out of 7 made from the 26th procedure. This emphasises the importance of surgical experience to perform this intervention [13-15]. However, we could not obtain significant results due to the small sample size. Further studies need to evaluate factors influencing the intraoperative splenic preservations rates.

6. Conclusion

Distal pancreatectomy with or without splenic preservation is a procedure that can be safely performed under robotic assistance. Our study clearly showed a progressive evolution of operating time in accordance with the improvement of the surgeons learning curve. The learning curve seems to parallel the global robotic surgery experience of the surgeon. A larger analysis of a greater

sample size is necessary to support these results.

7. Conflict of Interest

None

8. Sources of Funding

None

References

1. Rooij TD. Minimally Invasive Versus Open Distal Pancreatectomy (LEOPARD): A Multicenter Patient-blinded Randomized Controlled Trial. Ann Surg. 2019; 269(1): 2-9.

2. Lee SQ, kabir T, Koh YX, Teo JY. A single institution experience with robotic and laparoscopic distal pancreatectomies. Ann Hepatobiliary Pancreat Surg. 2020; 24(3): 283-291.

3. Guerrini GP, Lauretta A, Belluco C. Robotic versus laparoscopic distal pancreatectomy: an up-to-date meta-analysis. BMC Surg. 2017; 17(1): 105.

4. Hong S, Song KB, Madkhali A. Robotic versus laparoscopic distal pancreatectomy for left-sided pancreatic tumors: a single surgeon's experience of 228 consecutive cases. Surg Endosc. 2020; 34(6): 2465-2473.

5. Iacobone M, Citton M, Nitti D. Laparoscopic distal pancreatectomy: Up-to-date and literature review. World J Gastroenterol. 2012; 18(38): 5329-5337.

6. Boone BA, Zenati M, Hogg ME, Steve J. Assessment of quality outcomes for robotic pancreaticoduodenectomy: identification of the learning curve. JAMA Surg. 2015; 150(5): 416-422.

7. Justin V, Fingerhut A, Khatkov I, Uranues S. Laparoscopic pancreatic resection-a review. Transl Gastroenterol Hepatol. 2016; 1: 36.

8. Timmermann L, Biebl M, Schmelzle M, Bahra M, Malinka T. Implementation of Robotic Assistance in Pancreatic Surgery: Experiences from the First 101 Consecutive Cases. J Clin Med. 2021; 10(2): 229.

9. Souche R, Herrero A, Bourel G, Chauvat J. Robotic versus laparoscopic distal pancreatectomy: a French prospective single-center experience and cost-effectiveness analysis. Surg Endosc. 2018; 32(8): 3562-3569.

10. Lyman WB, Passeri M, Sastry A. Robotic-assisted versus laparoscopic left pancreatectomy at a high-volume, minimally invasive center. Surg Endosc. 33(9): 2991-3000.

11. Moekotte AL, Rawashdeh A. Safe implementation of minimally invasive pancreas resection: a systematic review. HPB. 2020; 22(5): 637-648.

12. Strijker M, Santvoort HC, Besselink MG. Robot-assisted pancreatic surgery: a systematic review of the literature. HPB (Oxford). 2013; 15(1): 1-10.

13. Boselli C, Barberini F, Listorti C. Distal pancreatectomy with splenic preservation: A short-term outcome analysis of the Warshaw technique. Int J Surg. 2015; 21(1): S40-43.

14. Song J, He Z, Ma S. Clinical Comparison of Spleen-Preserving Distal Pancreatectomy With or Without Splenic Vessel Preservation: A Systematic Review and Meta-Analysis. J Laparoendosc Adv Surg Tech A. 2019; 29(3): 323–332.

15. Esposito A, Casetti L, Pastena MD. Robotic spleen-preserving distal pancreatectomy: the Verona experience. Updates Surg. 2021; 73(3): 923-928.