Spleen-Preserving Versus Spleen-Sacrificing Distal Pancreatectomy in Laparoscopy and Open Method-Perioperative Outcome Analysis—14 Years Experience

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Abstract We analyzed perioperative outcome of distal pancreatectomies with or without splenic preservation both in laparoscopic and open method to determine best approach. Retrospective data was collected from 1999 to 2013. We divided all distal pancreatectomies into four groups. Group 1—laparoscopic spleen-preserving distal pancreatectomy (LSPDP). Group 2—laparoscopic splenectomy + distal pancreatectomy (LSDP). Group 3—open spleen-preserving distal pancreatectomy. Group 4—open splenectomy + distal pancreatectomy. We recorded demographic data, intra and post operative complications, operative time, estimated blood loss, length of stay, pancreatic leak rate, and final pathology result. A total of 38 distal pancreatectomies were included. In group 1, patients were significantly younger (mean 29 vs 47 to 50 in other groups, $p=0.014$). Tumor size (average 2.5 vs 5 to 9.5 cm in other groups, $p=0.023$) and operative time (average 98 min vs 125 to 141 in other groups, $p=0.004$) and hospital stay (average 6 vs 8 to 19 days in other groups, $p=0.009$) in LSPDP were all significantly less than other groups taken together. However, intra-operative blood loss was equivalent. We further analyzed that between LSPDP and LSDP, age and tumor size were significantly less in LSPDP. Further we analyzed between spleen-preserving (groups 1+3) vs spleen-sacrificing (groups 2+4) distal pancreatectomies and between overall laparoscopic (groups 1+2) vs open (groups 3+4). Laparoscopic spleen-preserving distal pancreatectomy has all the

advantages of minimal access surgery especially in small lesions and low-grade malignancy.

Keywords Distal pancreatectomy · Spleen preservation · Laparoscopy · Splenectomy with pancreatectomy

Introduction

Spleen preservation can be safely done during distal pancreatectomy [1]. It is established in benign and low-grade malignancy of distal pancreas though lymphatic clearance is a concern in high grade malignancy [2]. Possibility of opportunistic post splenectomy infection (OPSI) and potential increased risk of malignancy after splenectomy make spleen-preserving distal pancreatectomy (SPDP) a preferable technique [3].

Laparoscopic approach has been successful in SPDP [4]. It has the advantages of minimal access surgery but is technically more demanding. Laparoscopic SPDP, especially with splenic vessel preservation technique, is associated with longer operative time or blood loss. Few studies show more blood loss in open group [4, 5]. There is no difference in open procedures among spleen-preserving and spleen-sacrificing groups [6]. Robot-assisted technique is evolving [7]. Warshaw technique, where splenic vessel is sacrificed and spleen survives on short gastric artery is technically easier, but it has more chance of splenic ischemia and abscess formation [5].

In this study, we have looked into the perioperative outcome of distal pancreatectomy with or without splenic preservation both in laparoscopic and open approach. We tried to find out the suitability and best possible outcome depending on patient and tumor characteristics and the technique used.

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Materials and Methods

Retrospective data were collected on distal pancreatectomies from September 1999 to September 2013 at our center. We divided all distal pancreatectomies into four groups.

Group 1—laparoscopic spleen and splenic vessel preservation. Group 2—laparoscopic splenic and distal pancreatectomy. Group 3—Open procedure with spleen and splenic vessels preserved. Group 4—Open splenectomy and distal pancreatectomy.

It is a retrospective study; hence, there is no scope for randomization. However, as the same surgical team performed all the procedures, one of our goals were to determine what factors influenced the choice of operation among these four methods.

We recorded demographic data, intra and post operative complications, operative time, estimated blood loss, length of stay, pancreatic leak rate, and final pathology result. In most cases, no drain was kept and none presented with significant pancreatitis. Helsinki protocol was maintained.

Operative Technique

For laparoscopic spleen-preserving distal pancreatectomy (LSPDP), we followed a technique similar to that described by Kimura et al.[8]. After opening the lesser sac and reaching the inferior border of pancreas, splenic vein was dissected from the body of pancreas towards the spleen after dissecting the fusion fascia of Toldt. The splenic artery was dissected towards pancreatic head. The smaller branches were secured with energy sources (LigasureR/ThunderbeatR/Ultrasonic). We believe extensive use of energy sources and minimal clip (hem-o-lok) not only reduced operative time but also helped in stapler application.

Result

A total 38 distal pancreatectomies done over the last 14 years were included. Group 1 had eight patients. Laparoscopic resection was possible in all without conversion. Six had splenic vessel preserved. In two, splenic supply was maintained through short gastric arteries as splenic vessels had to be sacrificed. In one, during adhesion clearance, there was bleeding and in the other case for proper tumor clearance (both biopsy came as serous cyst-adenoma of pancreas). One of them had splenic infarct and required splenectomy on the fifth post operative day. Group 2 had 12 patients, group 3 had 4 patients, and group 4 had 14 patients.

We do not put drains routinely to reduce morbidity, and any symptomatic collection can be drained with image-guided pigtail if required. In our series, one image-guided aspiration and one image-guided drain placement with extended

drainage were required with both responding to conservative treatment. Group 1 had no such incidence. Patient demographics and results are outlined in Tables 1 and 2.

In group 1, patients were significantly younger (mean 29 vs 47 to 50 in other groups, $p=0.014$). Tumor size (average 2.5 vs 5 to 9.5 cm in other groups, $p=0.023$); operative time (average 98 vs 125 to 141 min in other groups, $p=0.004$); and hospital stay (average 6 vs 8 to 19 days in other groups, $p=0.009$) in LSPDP were all significantly less than other groups taken together. However, intra-operative blood loss was equivalent.

We further analyzed between LSPDP and LSDP which showed age and tumor size were significantly less in patients in LSPDP. Further, we analyzed between spleen-preserving (groups 1+3) vs spleen-sacrificing (groups 2+4) distal pancreatectomies. There was a trend of preserving spleen in younger patients ($p=0.09$). Analysis between overall laparoscopic (groups 1+2) vs open (groups 3+4) distal pancreatectomy was also done. It showed a trend towards choosing laparoscopy in younger group ($p=0.06$). Laparoscopy group had significantly shorter hospital stay ($p=0.05$). We did not analyze between groups 3 and 4 as group 3 had very few cases.

Discussion

During distal pancreatectomy, attempt to preserve spleen, especially in laparoscopic surgery is controversial. Benotti et al. showed trying to preserve spleen causes increased morbidity. The study from Sloan Kettering contradicts this and actually shows reduction in hospital stay and complications [9, 10]. For malignant pathology, nodal clearance is a concern but for benign condition, SPDP is becoming a preferred approach. Several series showed laparoscopic SPDP is growing in popularity. A splenectomy has up to 5 % chance of OPS I with mortality of 70 % [11]. Also, there is an increase of lung and ovarian cancers (up to 40 %) [12].

Splenic preservation is done either by skeletonization of splenic vessels and preserving them (SVP) or dividing them both at the pancreatic transection point and splenic hilum (Warshaw technique). Splenic blood supply comes from short gastric arteries in the second technique [13, 14].

It is argued that laparoscopic skeletonization is technically more challenging and takes a longer time. The advantage is it reduces the immediate post operative risk of splenic infarction as blood supply in Warshaw technique drop to half and needs 10 days to recover. There is chance of varix formation and increased post operative chronic abdominal pain later [2]. Of note, if only splenic artery needs to be sacrificed, complications are less likely from splenic ischemia [14, 15].

Of the eight in LSPDP group, we had two cases where vessels could not be preserved. One of them required splenectomy on fifth POD for infarct. In the original description of

Table 1 Perioperative detail

	Group 1	Group 2	Group 3	Group 4
Number	8	12	4	14
Age–mean (range)	29 (12–53)	47 (11–70)	48 (43–53)	50 (41–73)
Intra-operative complication	1	0	0	0
Size (cm)–mean (range)	2.5 (1–5)	7.5 (3–12)	9.6 (7.5–14.1)	5 (2–8)
Operative time (min)–mean (range)	90 (90–120)	125 (105–180)	150 (120–180)	141 (90–240)
EBL (ml)–mean (range)	166 (50–400)	117 (50–300)	175 (50–300)	425 (50–1250)
Complications	Splenectomy 1 splenic infract 1 intra op bleed			2 pancreatic leakage
Length of stay (days)–mean (range)	6 (4–7)	8 (7–10)	11 (8–14)	10 (6–18)
Operative time (min)–mean (range)	90 (90–120)	125 (105–180)	150 (120–180)	141 (90–240)
EBL (ml)–mean (range)	166 (50–400)	117 (50–300)	175 (50–300)	425 (50–1250)
Complications	Splenectomy 1 splenic infract 1-intra op bleed			2 pancreatic leakage
Length of stay (days)–mean (range)	6 (4–7)	8 (7–10)	11 (8–14)	10 (6–18)
Pathology	3 serous cystadenoma 2 neuroendocrine 2 mucinous cystadenoma 1 pseudopapillary tumor	4 serous cystadenoma 4 mucinous cystadenoma 3 neuroendocrine 1 congenital simple solitary cyst	1 anaplastic ca 1 serous cystadenoma 2 ducatal adeno carcinoma	4 ductal adeno carcinoma 3 neuroendocrine 4 pancreatitis 2 papillary serous cystadenoma 1 trauma

Group 1 laparoscopic spleen and splenic vessel preservation, *Group 2* laparoscopic splenic and distal pancreatectomy, *Group 3* open procedure where spleen and splenic vessels were preserved, *Group 4* open spleen and distal pancreatectomy

Warshaw, approximately 5 % had such complications while other series have around 10 % [5, 13].

For LSPDP, our study showed less operative time and blood loss than other studies both in vessel-preserving as well as vessel-sacrificing technique. Hospital stay was similar to other series [4, 5]. This questions the findings that ligation of splenic vessels reduces operative time and blood loss. We did not analyze between vessel preservation and vessel-sacrificing LSPDP group as small sample size was small and intention of surgery was splenic vessel preservation to start with. We think better selection of cases in LSPDP group (smaller size of the

tumor—average 2.5 cm, with benign histology) contributed to improved outcome.

Pancreatic fistula is a troublesome post operative complication in distal pancreatectomies. It is defined as drain fluid amylase three times the blood amylase on post operative day three [16]. Leak rate reported from 0 to 50 % and drain placement is optional [5]. In our series of 36 cases, we did not put drains routinely. Clinically significant collection (two cases where high amylase content in aspirated fluid confirmed pancreatic leak) responded to image-guided aspiration. Our leak rate (5.6 %) was lower than the European multi-center study

Table 2 Statistical comparison

Number	<i>p</i> value group 1 vs others	<i>p</i> value groups 1 vs 2	Groups 1+2 vs 3+4	Groups 1+3 vs 2+4
Age	0.014*	0.05*	0.062	0.09
Size	0.023*	0.04*	0.972	0.61
Operative time	0.004*	0.039*	0.109	0.34
Blood loss	0.515	0.71	0.126	0.37
Length of stay	0.009*	0.08	0.051*	0.39

*Significant ($p \leq 0.05$)

Group 1 laparoscopic spleen and splenic vessel preservation, *Group 2* laparoscopic splenic and distal pancreatectomy, *Group 3* open procedure where spleen and splenic vessels were preserved, *Group 4* open spleen and distal pancreatectomy

reported by Mabrut et al. (approx 17 %) [17]. As significant collection can be drained under image guidance post operatively, we chose not to use drain to avoid drain-related morbidity [18].

Studies have suggested ultrasonic scalpel is superior to stapling devices for laparoscopic pancreatic resection and routine oversewing of stump is beneficial to reduce pancreatic fistula [19]. We had closed the stump either with stapler only (three rows) or hand sewn or staple line (two rows) over sewn with hand suture. No particular technique appeared superior over others to reduce stump leak (of the two leaks, both in open pancreatoco-splenectomy group, one was hand sewn and other staple reinforce with suture). Where we used tristapleR, we did not over-suture to avoid stump ischemia. In hand sewn closure, we used polydioxanone in two layers. We did not use Peri-strip or fibrin glue as no definitive evidence exists of their advantage.

Bleeding from splenic vessels is another concern in spleen-preserving group. In our series, one case has dense adhesions which bled during attempted separation. This was promptly controlled by proximal clip application followed by tying off the vessel. The spleen survived on short gastric vessels. Post operative bleeding can be due to digestion of splenic vessels from pancreatic juice from cut end of pancreas. Risk of post operative splenic vein thrombosis (mostly from intra-operative venous injury) and varix development in splenic preservation, particularly with Warshaw technique exists [7]. In our group, no such complications occurred immediately post operative (within 30 days). Our mean follow-up was only 1 year for spleen-preserving groups (lap + open) but during this time, none had such complications. We did not analyze long-term outcomes for lack of regular follow-up data.

Laparoscopic SPDP is mostly described for benign lesion with comparable safety and advantages of minimal access surgery [20]. For malignant lesion tumor, clearance may be a concern [21]. However, even if splenic vessels are involved by malignancy away from celiac axis, Warshaw technique will allow adequate retroperitoneal dissection near porta and good marginal clearance [20].

Balcom et al. pointed out the importance of spleen preservation in distal pancreatectomy for immune surveillance in malignancy and recommended SPDP if spleen is not directly involved [22]. Splenectomy reduces long-term disease-related survival in pancreatic malignancy and spleen preservation is recommended if adequate marginal and lymph nodal clearance is achieved [23, 24]. All our LSPDP cases were non malignant with clear margin. Sixty percent of cases in this group were cystic neoplasm. Though in many series of cystic neoplasm of pancreas spleen was not preserved, some series attempted it with favorable outcome [25, 26].

We could not comment on lymph nodal clearance as though six specimens of group 1 had lymph nodes detected (all were benign); in malignant cases, the number may be

inadequate. In open spleen-preserving cases (all had splenic vessel preserved), three out of four had final diagnosis of malignancy but lymph nodal harvest (average 8—range 5–14) was considered adequate, and margin status were negative. We agree with the recommendation that spleen preservation should be attempted in pancreatic malignancy if adequate nodal and marginal clearance is possible [20].

Significant number of younger patients (mean 29 years) underwent LSPDP compared to other groups in our study ($p < 0.5$). Though elderly LSPDP is technically feasible, but overall practice bias (more chance of malignancy, less cosmetic demand, more risk of anesthesia with cardiovascular comorbidity etc.) and more risk of splenic infraction if Warshaw technique is required may have influenced the result [27]. Among groups 1 and 2 (laparoscopic spleen-preserving and non-preserving distal pancreatectomy) the age difference were significant but not so when all laparoscopic procedures (groups 1 and 2) were compared with all open (groups 3 and 4) or when splenic preservation was compared with splenic sacrifice (groups 1+3 vs 2+4). Of note, there was a trend towards splenic preservation in the younger group. The age bias was probably not related to pure laparoscopic consideration but due to long-term complications from asplenia in the younger group. Overall, smaller tumor size and predicted benign pathology in LSPDP group may also have contributed to the above finding.

The size of the lesion was significantly smaller in the LSPDP group. The difference was significant between laparoscopic groups (groups 1 and 2) but become non significant between lap vs open groups (groups 1+2 vs 3+4). Hence, we conclude that smaller lesion is more suitable for LSPDP but size did not influence the choice of laparoscopy or open approach in overall distal pancreatectomies. This agrees with some recent studies [28].

According to most of the literature, the time to do spleen-preserving surgery is more compared to spleen-sacrificing surgery both in laparoscopy and open groups [4, 5]. In our study, LSPDP took less time compared to other techniques. When compared between the laparoscopy groups, the less time in spleen preservation was still significant. This is in contrast to other studies [4, 5]. Of note, usual time to do LSPDP is longer in other studies (e.g., average 180 min in the study by Bruzoni et al. compared to our average time of 97 min). Younger patients and significantly smaller size of tumor may have contributed. Also extensive use of energy sources (ultrasonic, bipolar, LigasureR, ThunderbeatR) and staplers may have contributed. This may also explain over all less time in all distal pancreatectomy groups (mean ranges from 98 to 150) compared to more than 200 min in some studies [4, 29]. There was no significant difference in operative time overall laparoscopic (groups 1+2) vs open (groups 3+4) or spleen-preserving versus spleen-sacrificing distal pancreatectomies. This is in agreement with some studies but a few have concluded differently [4, 5, 29].

Intra-operative blood loss in LSPDP was significantly less from other groups. When compared within laparoscopy (groups 1 vs 2) groups, this remained significant. However, when compared with overall spleen-preserving vs spleen-sacrificing groups (groups 1+3 vs 2+4) or open vs lap (groups 1+2 vs 3+4), this was not significant. It shows specific advantage of laparoscopic spleen-preserving group rather than only splenic preservation or laparoscopic approach in distal pancreatectomy. This finding agrees with other studies [30].

Hospital stay was less ($p < 0.05$) in LSPDP group compared to other groups. However, when analyzed between groups 1 and 2 (laparoscopic spleen-preserving vs sacrificing), the difference became less significant ($p = 0.08$). Comparison between overall spleen-preserving and spleen-sacrificing groups (groups 1+3 vs 2+4) showed no significant difference. Of note, it became significant again when we compared between lap and open groups (groups 1+2 vs 3+4). These data suggest that the main advantage of reduced hospital stay was due to minimal access approach rather than spleen preservation. Other studies showed a trend of reduced hospital stay (non significant) in laparoscopic spleen preservation group like our study. However, no study has compared four separate arms together as we have done [28].

Limited number of cases, e.g., in open SPDP group having just four cases, may have biased the conclusions. Future studies comparing larger numbers in each arm are required. Also, we could not compare between Warshaw and vessel-preserving technique because of only two cases in the Warshaw arm.

Conclusion

Laparoscopic spleen-preserving distal pancreatectomy is safe and workable. It has all the advantages of minimal access surgery, more so in small lesions and in low-grade malignancy. It has lesser operative time and hospital stay compared to other methods.

Overall, In younger patients, we see a trend towards spleen preservation in the laparoscopy group. There is a bias towards attempt to save spleen in smaller tumors in the laparoscopy group. In open arm, tumor size did not influence splenic preservation. The credit for shorter hospital stay goes to laparoscopic rather than spleen-preserving approach. Of note, LSPDP group had a shorter operative time.

This data shows LSPDP is method of choice in distal pancreatectomies where adequate oncological margin can be achieved.

Conflict of Interest The authors declare that they have no competing interests.

Informed consent Informed consent was obtained from all individual participants included in the study.

Compliance with Ethical Standards For this type of study formal consent is not required. This article does not contain any studies with animals performed by any of the authors.

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