Original Research

Comparison of Clinical Outcomes of Single-Incision Versus Conventional Multiport Laparoscopic Distal Pancreatectomy: A Single Institution Experience

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Abstract

Objectives: Single-incision laparoscopic procedures have been gaining popularity in recent years due to their minimal incisional morbidity and improved cosmetic outcomes. Herein, we will compare the feasibility and outcomes of single-incision and conventional multiport laparoscopic distal pancreatectomy.

Methods: This study involves consecutive patients who underwent either single-incision or conventional multiport laparoscopic distal pancreatectomy from March 2007 to February 2014. The patients were divided into two groups, based on the surgical approach: single-incision laparoscopic surgery (Group 1) and conventional multiport laparoscopic surgery (Group 2). The parameters evaluated included estimated blood loss, operative time, postoperative pain, duration of hospital stay, complications, conversion, and final pathology.

Results: There were a total of 20 patients, 10 in each study group. Baseline characteristics were similar, and there was no mortality in either of the groups. The low-flow pancreatic fistula was the most commonly seen morbidity, but it was ceased spontaneously in each group by a ratio of 30%. The operative time was significantly shorter in Group 2, with a mean of 116 minutes versus a mean of 180 minutes for Group 1 (p<0.001). One of the procedures in Group 2 was converted to open surgery due to peroperative bleeding. The median follow-up periods of the patients were 22 months and 56 months. The spleen was preserved in only 1 patient from Group 1, whereas in Group 2, the spleen preservation was achieved in 5 patients.

Conclusion: The single-incision laparoscopic technique is a safe and effective alternative to standard laparoscopic distal pancreatectomy.

Keywords: Laparoscopic surgery; laparoscopik distal pancreatectomy; minimally invasive surgery; pancreas resection; single-incision laparoscopic surgery.

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Minimally invasive techniques represent a technology-dependent surgical revolution, generally performed by experienced surgeons. In recent years, these surgical techniques have become feasible and safe for many surgical procedures worldwide. Compared to conventional operations, laparoscopic pancreatic surgery has been gaining more acceptance as a surgical option for the treatment of pancreatic diseases since it was first reported in literature

(1994).[1] Every day, an increasing number of centers publish articles on laparoscopic distal pancreatectomy due to positive outcomes, such as improved cosmetic results, a shorter hospital stay, and the decreased morbidity of minimally invasive techniques.[2–4]

Due to the rising expectations of patients regarding cosmetic results, surgeons have started to perform techniques involving fewer trocars and smaller incisions. One of these procedures is single-incision laparoscopic surgery (SILS), advancing one step ahead to minimize the scarring of conventional multi-incisional laparoscopic surgery. SILS was for the first time used for laparoscopic cholecystectomy in 1997 by Navarre. Afterwards, it was successfully implemented in many other procedures.[5] The purpose of the SILS technique was to reduce the number of incisions from a standard of 3 to 5 trocars to a single small incision. The technique was previously used in other advanced surgical procedures such as liver resection, splenectomy, colectomy, and bariatric surgery.[6, 7] The SILS technique requires the performance of complex movements due to the proximity and collusions of the instruments. It is possible to facilitate maneuvers by using articulated gadgets and trocars of various length, therefore increasing the distance between hands. Until now, studies had not reported a significant advantage of SILS in comparison to standard multitrocar laparoscopy, other than an enhanced cosmetic appearance.[4, 8]

To the best of or knowledge, our group performed the first SILS splenectomy and then the first distal pancreatectomy ever in literature.[6, 9] In this study, our aim was to compare the clinical outcomes of multiport laparoscopic distal pancreatectomy with single-incision laparoscopic distal pancreatectomy.

Methods

A total of 20 patients who underwent laparoscopic distal pancreatectomy between March 2007 and February 2014 were included in the study. Patients were divided into two groups according to laparoscopic techniques used, which included SILS (Group 1) and standard multi-trocar laparoscopic surgery (Group 2). All of the patients were informed thoroughly, and consent was taken before their operation.

Patients' demographics, surgery duration, estimated blood loss, drain volume, tumor size, the length of hospital stay, conversion to open technique, and complications were evaluated retrospectively from their medical records and hospital automation program. The surgical technique was chosen by the patient, after being explained the risks and complications associated with each surgical proce-

dure. During their hospital stay, patients' degree of pain was evaluated by a visual analog scale. Our evaluations of the pain degree were numerically scaled from "no feeling of pain" to "unbearable." The pain was evaluated at postoperative 6th and 24th hours. All operations were performed by a sole senior endocrine surgeon (UB). All patients received the same analgesic (intravenous lornoxicam 8 mg twice a day). In all cases, drain amylase was measured on postoperative Day 2. Drains were removed if the amylase levels were within normal limits. However, if the drain amylase result was 3 times above the normal serum amylase, the drain was not removed due to possible formation of a pancreatic fistula.

Statistical Analysis

Data were retrospectively extracted from the institutional databases and patients' charts. The SPSS version 18 (IBM Corp. Armonk, NY) software was used to perform the t-test, chi-squared, and univariate regression analysis. Continuous variables were expressed as mean±standard deviation. Categorical variables were compared with Fisher's exact test or chi-squared test. Statistical significance was defined as $p < 0.05$.

Surgical Techniques

Single-Incision Laparoscopic Pancreatectomy

Supine and reverse Trendelenburg (30 degrees) in the leg open position was used in this surgery, and the monitor was placed on the head of the patient. The primary surgeon was positioned between patient's legs, and the assistant was on the right side of the primary surgeon. Under general anesthesia, a 2 cm trans-umbilical incision was performed, and a multichannel trocar was inserted through the incision. We used a 30-degree-angled 5 mm telescope and three 5 mm instruments. Alternatively, we also used conventional laparoscopic trocars from a 2 cm incision trans-umbilical, and three 5 mm trocars were inserted at the 1 cm distance so as to form a triangle. At least one of the instruments was reticulated during all steps of the procedure. After a brief period of diagnostic viewing, the gastrocolic ligament was dissected using the LigaSure (Valleylab, Boulder, CO, USA). We placed a loop surrounding the gastric corpus, extending from the lesser curvature to the greater curvature, to ensure sufficient retraction before starting the pancreatic dissection. Moreover, we used a drip-coated polypropylene suture material to prevent a possible injury that may occur then the stomach is retracted with the loop. The sutures were taken out of both ends of the abdominal wall using a suture passer. We routinely performed intraoperative laparoscopic ultrasonography in all the cases.

One of the 5 mm trocars was replaced with a 12 mm one for the insertion of an ultrasound probe. After the exposure of the lesion, the dissection was performed medially to laterally. Peritoneal leaflets inferior to the pancreas were dissected until the end of the transection field. At this level, the splenic vein had been dissected from the pancreatic bed using Ligasure. After the mobilization of the distal pancreas, a 5 mm trocar was replaced with a 15 mm trocar to use a linear stapler. The pancreas was cut by either two 45 mm or one 60 mm cartridge Endo GIA (4.5 mm) (US Surgical Corp., Norwalk, CT, USA). The specimen was removed in one piece from the umbilical port incision with the ENDO-Cath 15 (US Surgical Corp., Norwalk, CT, USA).

Multiport Laparoscopic Distal Pancreatectomy

This technique was performed from 5 ports. Ports included three 10 mm trocars, one at the umbilicus, one 5 cm below the xyphoid process, and the other at the intersection of the left mid-axillary line and the umbilicus. A 12 mm trocar was placed at the mid-clavicular line. We routinely used a 30 degree telescope. The gastrocolic ligament was dissected using Ligasure. Either a spleen-preserving technique or distal pancreatectomy was used, and the splenectomy technique was selected according to tumor's proximity and invasion to the adjacent tissues.

The gastrosplenic ligament was dissected, and the spleen was retracted anteriorly. The pancreas was cut with one 60 mm Endo GIA cartridge (4.5 mm) (US Surgical Corp., Norwalk, CT, USA), and the stump was closed. The specimen was removed as one piece using the ENDO-Catch 15 endoscopic plastic bag (US Surgical Corp., Norwalk, CT, USA). One aspiration drain was placed in the resection area, and the operation was completed.

Results

A total of 20 patients (10 from each group) were involved in the study. Conversion to laparotomy in 1 of the patients from Group 2 was required due to intraoperative bleeding. However, there was no surgical conversion in Group 1. Both of the study groups were similar in terms of demographics. The mean age of the patients in Group 1 was 43.5±2.3 (27–59), while in Group 2, the mean age was 48.2±4.0 (26–65). The female-to-male ratio was 6/4 in Group 1, while it was 7/3 in Group 2. The mean operative time was 180.4±34.5 (120–330) minutes in the SILS group, while in the multi-trocar group, it was 116.4±14.1 (100–180) minutes. By comparison, postoperative pain scores of the patients in Group 1 were found to be less than those of patients in Group 2 (p=0.008) (Table 1). Mortality was not observed in either group.

Table 1. Comparison of study groups

Study Groups	Single Incision (n=10)	Multi-trocar (n=10)	p
Age	43.5±2.3	48.2±4.0	0.374
Gender (Female/Male)	6/4	7/3	0.876
Body mass index	29.4±3.1	31.2±2.4	0.220
Tumor size (cm)	2.2±0.2	2.8±0.6	0.477
Operaive time (minute)	180.4±34.5	116.4±14.1	<0.001
Estimated blood loss (ml)	142	110	0.097
Hospital stay (day)	8	10	0.411
Pain score (Postoperative 6th hour)	2.5±0.3	4.5±0.4	0.008
Pain score (Postoperative 24th hour)	1±0.2	1.5±0.5	0.334
Complication	5	4	0.572
Final pathology			0.706
Insulinoma	3	4	
Neuroendocrine tumor	4	3	
Other*	3	3	

*Adenoma, cyst, adenocarcinoma, metastasis.

Group 1 (Single-Incision Laparoscopic Surgery)

Diagnosis of the patients included neuroendocrine tumors (n=4), insulinoma (n=3), adenocarcinoma (n=1), renal cell carcinoma metastases (n=1), and pancreatic pseudocysts (n=1). The average body mass index of the patients was 29.4±3.1. The mean operative time was 180.4±34.5 (120–330) minutes. However, subgroup analysis revealed that the average operative time for the first 5 and the last 5 patients differed significantly: 142 and 218 minutes, respectively (p=0.035). When comparing the last 5 patients in Group 1 with the average of the patients in Group 2 regarding operative time, the result was statistically insignificant as 142 minutes (Group 1) vs. 116 minutes (Group 2) (p=0.086). Estimated blood loss was 142 ml (30–500). The average amount of drainage was 80.8±62.3 ml (25–200). The mean hospital stay was 8 days (5–20). The complication rate was 50% (n=5), consisting of spontaneously closing low-volume pancreatic fistula (n=3), gastric atony (n=1), and trocar herniation (n=1). The spleen was preserved in 1 patient in this group. Patients were followed up for a median period of 48 months.

Group 2 (Multi-trocar Laparoscopy)

Diagnosis of patients from this group included insulinoma (n=4), neuroendocrine tumors, (n=3) and adenocarcinoma (n=1), ectopic spleen (n=1), and mucinous cystadenoma (n=1). The average body mass index of the patients was 31.2±2.4. The mean operative time was 116.4±14.1 (100–180) minutes. The estimated blood loss was 110 (25–250)

ml. Laparotomy was performed in one case due to intra-operative bleeding. The average amount of drainage was 75.2±52.3 (25–200) ml. The mean hospital stay was 10 (4–24) days. Complications occurred in 4 patients who were spontaneously closing low-volume pancreatic fistula (n=3), intra-abdominal abscess (n=1), and the splenic artery aneurysm (n=1). The spleen was preserved in 5 patients from this group. Patients were followed up for a median period of 56 months.

Discussion

The first laparoscopic distal pancreatectomy was performed using an animal model in 1994 by Soper et al.,[10] and subsequently, many surgeons have used this technique on patients confidently.[11] Today, technique is performed for many lesions including benign, malign, and inflammatory lesions, and even for pancreatic transplant donors by various centers.[12, 13]

The first SILS splenectomy and SILS distal pancreatectomy were contributed to literature by our group respectively in 2009 and 2010.[6, 9] However, there are still limited data and debate regarding single-incision techniques.[9, 14–16] The main reason why traditional multiple-trocar laparoscopic surgery is more commonly used as a standard technique is the steep learning curve of the SILS technique. Therefore, a large part of reports concerning SILS pancreatic surgery consists of case reports and limited experience comprising short-term results.

When we compared the techniques, one of the most basic problems was the length of the operative time. Although it was reported in literature that the duration of operation gets significantly longer in laparoscopic pancreatic surgery,[17] Song et al.[18] stated in their 359 patient series, which is one of the largest series in the literature, that the duration of operation shortens as the experience of the surgeon increases. In this report, they noted that although the operation duration was 4 hours at the beginning of the learning curve, it was lowered to 2.5 hours at the last quarter of the case series. In addition, no significant difference was detected between the operation times of laparoscopic and open distal pancreatectomy in Kooby et al.'s widest multicenter study.[4] Similar results were obtained when the durations of SILS and multi-trocar laparoscopic distal pancreatectomy cases were compared in literature, with a range from 95 to 330 minutes.[9, 14]

The most important indication for this technique is generally endocrine neoplasia. The small size of the lesion makes it convenient for laparoscopic excision.[17] Ultrasonography is also a useful modality for localizing small lesions intraoperatively.[17–19] Such lesions, which are small and distant from the pancreatic duct, can be removed with enucleation and the tumors that are localized in the distal part of the pancreas can be removed with SILS pancreatectomy.[16] In our case series, we routinely benefited from intraoperative ultrasonography as well.

The conditions for converting to open surgery involved technical problems or the oncological features of the tumor, which affected the safety of the laparoscopic procedure. Some authors indicated that laparoscopic resection of malign pancreatic tumors is a contraindication due to oncological safety issues. Up-to-date literature reveals scant data regarding minimally invasive pancreas surgery including standard multiple-trocar laparoscopic or SILS distal pancreatectomy cases.[9, 20, 21] Song et al.[22] obtained 91% R0 resection rate and similar survival rates in one of these studies. In another study, Kooby et al.[20] detected no difference between the techniques regarding the surgical margin positivity, duration of operation, length of hospital stays, and complications. We had 2 cases of pancreatic malignancy, including an adenocarcinoma and a metastatic cancer, and in both of these cases, we achieved negative surgical margins corresponding to oncological principles.

Another benefit of minimally invasive surgery along with decent cosmetic results are improved pain levels. The evaluation of pain is a subjective issue that varies from one patient to another and is evaluated by different techniques. All patients in both groups were administered the same analgesic regimen, and postoperative 6th hour results of the SILS group were observed to outrival at a statistically significant level compared to the other group (p<0.05).

It is known that the preservation of the spleen is harder in minimally invasive techniques. The frequency of spleen preservation is noted to range between 31% and 85% in selected cases from the current series.[23] Some studies, Warshaw et al.'s foremost, reported that the spleen-preserving technique prevented splenectomy and all related intra-operative and postoperative complications.[24, 25] They also emphasized that unless there is a tumor invasion, splenic vessels can be preserved, and the potential morbidity resulting from the splenectomy can be prevented. However, other authors have indicated that there is no significant advantage in preserving the spleen and that it also increases the blood loss due to a more difficult technique, prolonging the operation time.[26, 27]

Chang et al.[15] reported that spleen-preserving distal pancreatectomy, which lasts for 233 minutes, is comparable to traditional multiple-trocar laparoscopic distal pancreatectomy with regard to the mean operation time. In our opinion, a longer duration of operation is required, and ap-

propriate equipment is necessary for supporting advanced techniques to preserve the spleen successfully. We could only preserve the spleen in 1 patient (10%). This is why we believe that the Warshaw technique is more convenient than dissecting and preserving the splenic artery and vein, and thus we agree with Warshaw.[24]

The most frequent complication following a laparoscopic distal pancreatectomy is the formation of a low-flow pancreatic fistula with an occurrence rate of 12%–40%.[4, 22, 28] Therefore, the prevention of a pancreatic fistula following laparoscopic distal pancreatectomy has been investigated in various studies. The pancreatic stump closure technique, underlying chronic pancreatitis, malignant tumors, and concomitant splenectomy, etc., can be found to be at fault for the potential formation of a fistula. The automatic closure technique is usually used at the stage of pancreas transection in laparoscopic distal pancreatectomy. In a multi-centered European study, it was observed that 35% of the cases in which a linear stapler was used resulted in pancreatic complications.[29]

As far as we know, one of the largest SILS distal pancreatectomy series consisting of 11 cases was published by Yao et al.[14] In this study, a pancreatic leak that ceased spontaneously was observed as a postoperative complication. The authors reported that no complications such as postoperative bleeding, venous thrombosis, or infection were observed. In our series of 10 cases of SILS distal pancreatectomy, the rate of low-flow pancreatic fistulas that were followed up by a drainage tube only and closed spontaneously was 30% in the postoperative 1st month. In addition to this, gastric atony in 1 of the patients and a trocar site hernia in another patient were detected. Although there are still scant data regarding prospective randomized studies, our results have shown that single-incision laparoscopic distal pancreatectomy is safe and applicable. Nevertheless, there are no benefits of the SILS technique compared to the traditional multiple-incision laparoscopic distal pancreatectomy technique, except for aesthetic healing and decreased pain. As a center of innovation and advanced surgical techniques, we prefer to use minimally invasive surgical techniques.

Disclosures

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References

1. Gagner M, Pomp A. Laparoscopic pylorus-preserving pancreatoduodenectomy. Surg Endosc 1994;8:408–10. [CrossRef]

2. DiNorcia J, Schrope BA, Lee MK, Reavey PL, Rosen SJ, Lee JA, et al. Laparoscopic distal pancreatectomy offers shorter hospital stays with fewer complications. J Gastrointest Surg 2010;14:1804–12.

3. Palanivelu C, Shetty R, Jani K, Sendhilkumar K, Rajan PS, Maheshkumar GS. Laparoscopic distal pancreatectomy: results of a prospective non-randomized study from a tertiary center. Surg Endosc 2007;21:373–7. [CrossRef]

4. Kooby DA, Gillespie T, Bentrem D, Nakeeb A, Schmidt MC, Merchant NB, et al. Left-sided pancreatectomy: a multicenter comparison of laparoscopic and open approaches. Ann Surg 2008;248:438–46. [CrossRef]

5. Navarra G, Pozza E, Occhionorelli S, Carcoforo P, Donini I. One-wound laparoscopic cholecystectomy. Br J Surg 1997;84:695.

6. Barbaros U, Dinççağ A. Single incision laparoscopic splenectomy: the first two cases. J Gastrointest Surg 2009;13:1520–3. [CrossRef]

7. Kong J, Wu SD, Su Y. Translumenal single-incision laparoscopy radical gastrectomy with D2 lymph node dissection for early gastric cancer-primary experience with less invasive surgery in China. J Laparoendosc Adv Surg Tech A 2013;23:141–5. [CrossRef]

8. Cho CS, Kooby DA, Schmidt CM, Nakeeb A, Bentrem DJ, Merchant NB, et al. Laparoscopic versus open left pancreatectomy: can preoperative factors indicate the safer technique? Ann Surg 2011;253:975–80. [CrossRef]

9. Barbaros U, Sümer A, Demirel T, Karakullukçu N, Batman B, Içscan Y, et al. Single incision laparoscopic pancreas resection for pancreatic metastasis of renal cell carcinoma. JSLS 2010;14:566–70.

10. Soper NJ, Brunt LM, Dunnegan DL, Meininger TA. Laparoscopic distal pancreatectomy in the porcine model. Surg Endosc 1994;8:57–60. [CrossRef]

11. Cuschieri SA, Jakimowicz JJ. Laparoscopic pancreatic resections. Semin Laparosc Surg 1998;5:168–79. [CrossRef]

12. Kooby DA, Chu CK. Laparoscopic management of pancreatic malignancies. Surg Clin North Am 2010;90:427–46. [CrossRef]

13. Fisichella PM, Shankaran V, Shoup M. Laparoscopic distal pancreatectomy with or without splenectomy: how I do it. J Gastrointest Surg 2011;15:215–8. [CrossRef]

14. Yao D, Wu S, Tian Y, Fan Y, Kong J, Li Y. Transumbilical single-incision laparoscopic distal pancreatectomy: primary experience and review of the English literature. World J Surg 2014;38:1196–204.

15. Chang SK, Lomanto D, Mayasari M. Single-port laparoscopic spleen preserving distal pancreatectomy. Minim Invasive Surg 2012;2012:197429. [CrossRef]

16. Srikanth G, Shetty N, Dubey D. Single incision laparoscopic distal pancreatectomy with splenectomy for neuroendocrine tumor of the tail of pancreas. J Minim Access Surg 2013;9:132–5. [CrossRef]

17. Pierce RA, Spitler JA, Hawkins WG, Strasberg SM, Linehan DC, Halpin VJ, et al. Outcomes analysis of laparoscopic resection of

pancreatic neoplasms. Surg Endosc 2007;21:579–86. [CrossRef]

18. Ayav A, Bresler L, Brunaud L, Boissel P; SFCL (Société Française de Chirurgie Laparoscopique); AFCE (Association Francophone de Chirurgie Endocrinienne). Laparoscopic approach for solitary insulinoma: a multicentre study. Langenbecks Arch Surg 2005;390:134–40. [CrossRef]

19. Spitz JD, Lilly MC, Tetik C, Arregui ME. Ultrasound-guided laparoscopic resection of pancreatic islet cell tumors. Surg Laparosc Endosc Percutan Tech 2000;10:168–73. [CrossRef]

20. Kooby DA, Hawkins WG, Schmidt CM, Weber SM, Bentrem DJ, Gillespie TW, et al. A multicenter analysis of distal pancreatectomy for adenocarcinoma: is laparoscopicresection appropriate? J Am Coll Surg 2010;210:779–85. [CrossRef]

21. Shoup M, Conlon KC, Klimstra D, Brennan MF. Is extended resection for adenocarcinoma of the body or tail of the pancreas justified? J Gastrointest Surg 2003;7:946–52. [CrossRef]

22. Song KB, Kim SC, Park JB, Kim YH, Jung YS, Kim MH, et al. Single-center experience of laparoscopic left pancreatic resection in 359 consecutive patients: changing the surgical paradigm of left pancreatic resection. Surg Endosc 2011;25:3364–72. [CrossRef]

23. Taylor C, O'Rourke N, Nathanson L, Martin I, Hopkins G, Layani L, et al. Laparoscopic distal pancreatectomy: the Brisbane experience of forty-six cases. HPB (Oxford) 2008;10:38–42. [CrossRef]

24. Warshaw AL. Conservation of the spleen with distal pancreatectomy. Arch Surg 1988;123:550–3. [CrossRef]

25. Lee SE, Jang JY, Lee KU, Kim SW. Clinical comparison of distal pancreatectomy with or without splenectomy. J Korean Med Sci 2008;23:1011–4. [CrossRef]

26. Richardson DQ, Scott-Conner CE. Distal pancreatectomy with and without splenectomy. A comparative study. Am Surg 1989;55:21–5.

27. Aldridge MC, Williamson RC. Distal pancreatectomy with and without splenectomy. Br J Surg 1991;78:976–9. [CrossRef]

28. Thomsen SK, Green DJ. Predator-mediated effects of severe drought associated with poor reproductive success of a seabird in a cross-ecosystem cascade. Glob Chang Biol 2019;25:1642–52.

29. Takeuchi K, Tsuzuki Y, Ando T, Sekihara M, Hara T, Kori T, et al. Distal pancreatectomy: is staple closure beneficial? ANZ J Surg 2003;73:922–5. [CrossRef]