REVIEW ARTICLE

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Minimally Invasive (Laparoscopic or Robotic) Reduced Port (Single Port) Distal Pancreatectomy

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In spite of lack of randomized control study, laparoscopic distal pancreatectomy (DP) is regarded as appropriate treatment in managing benign and low grade malignant tumor in distal part of the pancreas. With the advance of laparoscopic skills, innovative instruments, and perioperative management, clinical effort to reduce the access injury for laparoscopic DP has been attempted to enhance the cosmetic effect and the benefit of minimally invasive surgery. Due to inborn technical limitation of laparoscopic surgical system, it is not easy to perform laparoscopic reduced port-or single port-distal pancreatectomy (LRP/LSP-DP) in daily routine clinical practice, however, surgical technique for safe and effective LRP/LSP-DP has been developed. Till now, only a few experts reported the technical feasibility and safety of LRP/LSP-DP in selected patients. According to literature review, the number of the patients who underwent LRP/LSP-DP seems to gradually increase. In this moment, surgical experiences may be too limited to reach the conclusion, but, with the help of robotic surgical system, LRP/LSP-DP has potential room for further investigation. Therefore, minimally invasive surgeons need to pay attention to this innovative movement. In this review, currently available surgical techniques for LRP/LSP-DP has been summarized with some future perspectives on this technique.

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INTRODUCTION

Minimally invasive elective surgery, both laparoscopic and robotic, has replaced most traditional surgical procedures; however, because the pancreas is located in the retroperitoneal space behind the stomach, it is difficult to access using a laparoscopic approach. In addition, there are several important blood vessels around the pancreas, including the splenic artery, common hepatic artery, superior mesenteric vein, splenic vein, and portal vein. Even small tributary vessels emerging from these major vessels supplying the pancreas can be critical sources of massive bleeding during a laparoscopic dissection, which then obscure the operative field. This can potentially increase intraoperative risk. These are reasons why laparoscopic pancreatic surgery started later and advanced slowly compared to other general surgical fields.[1,2] However, with the advance of laparoscopic techniques and instruments, laparoscopic pancreatectomy has become increasingly common. More specifically, laparoscopic distal pancreatectomy (DP) is regarded as an appropriate surgical option to treat benign and low-grade malignant lesions presenting in the left side of the pancreas. Even though there are no randomized controlled studies comparing laparoscopic DP and open DP, an increasing number of case reports and literatures strongly suggest that the perioperative outcomes after laparoscopic DP are better than those after open DP in terms of hospital stay length and

Table 1. Recently published meta-analysis comparing LDP with open DP

Author, year	N (study)	N (patients)	Op time, *p* value	EBL, *p* value	LOH *p* value	Morbidity *p* value	POPF *p* value	Mortality *p* value
Mehrabi, et al. 2015[4]	29	3,701	LDP=OPD 0.22	LDP<ODP <0.01	LDP<OPD <0.01	LDP=ODP0. 0.50	LDP=ODP 0.46	LDP=ODP 0.33
Nakamura, et al. 2013[21]	24+3	2,904	LDP=OPD 0.11	LDP<ODP <0.0001	LDP<ODP <0.0001	LDP<ODP 0.018	LDP=ODP 0.87	LDP=ODP 0.16
Jin, et al. 2012[22]	15	1,456	LDP=OPD 0.19	LDP<ODP <0.00001	LDP<ODP <0.00001	NA	LDP=ODP 0.11	LDP=ODP 0.46
Sui, et al. 2012[23]	19	1,935	LDP>OPD 0.02	LDP<ODP <0.001	LDP<ODP <0.001	LDP<ODP 0.001	LDP=ODP 0.66	LDP=ODP 0.61
Xie, et al. 2012[24]	9	1,341	LDP>OPD 0.005	NA	LDP<ODP 0.00	LDP=ODP0. 0.178	LDP=ODP 0.983	NA
Venkat, et al. 2012[25]	18	1,814	LDP=OPD 0.30	LDP<ODP 0.003	LDP<ODP <0.001	LDP<ODP0. 0.01	LDP=ODP 0.50	LDP=ODP 0.43
Jusoh, et al. 2011[26]	13	1,091	LDP=OPD NS	LDP<ODP <0.001	LDP<ODP <0.001	LDP<ODP0. 0.007	LDP=ODP 0.154	LDP=ODP 1.000
Nigri, et al. 2011[27]	10	729	LDP=OPD 0.17	LDP<ODP NA	LDP<ODP NA	LDP<ODP NA	LDP=ODP NA	LDP=ODP NA

LDP = laparoscopic distal pancreatectomy; ODP = open distal pancreatectomy; EBL = estimated blood loss; LOH = length of hospital stay; POPF = postoperative pancreatic fistula; NA = not available.

estimated intraoperative blood loss. Above all, cosmetic effects from laparoscopic port incisions have not been evaluated and need to be considered when interpreting meta-analysis data (Table 1). It is still being debated whether randomized controlled studies are needed to provide scientific evidence for which surgical approach is superior.[3,4]

Recently, some expert surgeons have tried to reduce the number of trocars in conventional laparoscopic surgery to enhance LDP cosmetic and minimally invasive effects. It seems that reduced-port or single-port laparoscopic surgery is frequently performed for standard laparoscopic procedures including appendectomies, cholecystectomies, and colectomies.[5-7] Barbaros et al.[8] reported the first single-incision laparoscopic DP performed in a 59-year-old female to treat pancreatic metastasis from renal cell carcinoma. Since then, the number of cases treated with laparoscopic single port (LSP) or laparoscopic reduced port (LRP) DP procedures has increased (Fig. 1).

In this review, we summarize the currently available literatures reporting laparoscopic single-port or reduced-port distal pancreatectomy, including current technical advances and future trajectories of these procedures.

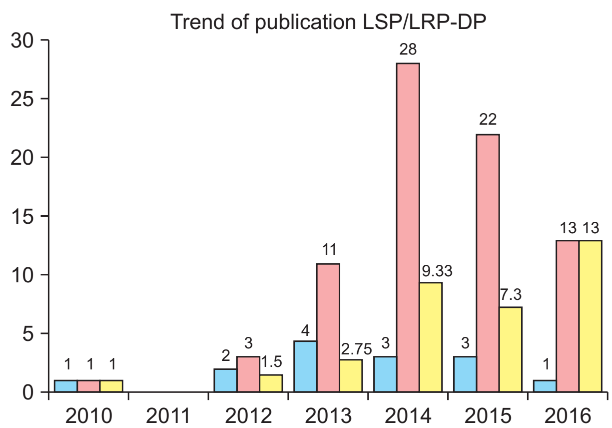

Fig. 1. Chronological trends for publications reporting LSP/LRP-DP on PubMed and KoreaMed. Scientific reports on laparoscopic DP are gradually increasing. Of note, the number of patients per published report during one year is also increasing (yellow). Four recent publications present a comparative analysis with conventional LDP. Blue column = number of publications; Red column = number of patients; Yellow column = average patients per publication.

CURRENTLY AVAILABLE SURGICAL PLATFORMS AND SHORT-TERM OUTCOMES

When reviewing the publications reporting laparoscopic

Table 2. Review of published case series for laparoscopic single-port or reduced-port DP

Authors, year	Age	Gender (1:male 2:female)	Diagnosis	Tumor size	Opname	Optime	EBL	Transfusion	POPF	LOH	System	Position	Gatric retraction
Barbaros, et al. 2010[8]	59	2	Pancreatic metastasis	3	DPS	330	100	0	1	7	SILS	Reverse Trendelenburg	Polyprepelene suture
Chang, et al. 2012[28]	40	2	Pancreatic cyst	3.5	SpDP	233	100	0	0	3	SILS		Prolene suture
Morales-Conde, et al. 2013[29]	39	NA	NET	6	DPS	140	35	0	0	2	SILS		EndoGrab device
Kim, et al. 2015[30]	32	1	SPN	3.3	SpDP	143	50	0	0	7	Glove port + additional 5-mm port		Direct retraction with grasper
Machado, et al. 2013[13]	33	2	NET		SpDP	174	Minimal	0	1	4	GelPoint		NA
Misawa, et al. 2012[31]	53	2	MCN	6.5	DPS	240	0	0	0	7	SILS		NA
	40	2	SCN	3.5	SpDP	225	240	0	0	5	SILS		NA
Srikanth, et al. 2013[32]	46	1	NET	3.5	DPS	NA	NA	NA	1	5	Single incision with multiports		Gastric retraction suture
Machado, et al. 2015[33]	33	2	NET	2	SpDP	174	50	0	0	2	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	32	2	NET	1.2	SpDP	117	50	0	0	2	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	45	1	IPMN	2	SpDP	110	50	0	0	1	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	44	2	NET	3.5	DPS	300	250	0	1	3	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	71	1	IPMN	6	DPS	340	200	0	1	4	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	60	1	NET	0.9	SpDP	135	50	0	0	1	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture

Table 2. Continued 1

Authors, year	Age	Gender (1:male 2:female)	Diagnosis	Tumor size	Opname	Optime	EBL	Transfu-sion	POPF	LOH	System	Position	Gatric retraction
	37	2	NET	3	SpDP	179	50	0	0	2	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	47	2	MCN	3.7	SpDP	120	100	0	0	1	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	57	1	IPMN	7	SpDP	189	100	0	0	2	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	42	2	NET	4.5	SpDP	210	100	0	0	2	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	39	1	IPMN	5.2	SpDP	196	50	0	1	2	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	43	2	SCN	3.3	SpDP	198	50	0	0	1	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	29	2	NET	2.3	SpDP	200	100	0	0	1	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	51	2	MCN	4	SpDP	189	50	0	1	3	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	28	1	NET	1.7	SpDP	178	50	0	0	1	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	55	2	IPMN	3.2	SpDP	149	50	0	0	2	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	20	1	SPN	2.7	SpDP	120	50	0	0	1	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	69	1	NET	1.3	SpDP	170	50	0	0	2	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
	40	2	SCN	3.4	SpDP	110	50	0	0	3	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture

Table 2. Continued 2

Authors, year	Age	Gender (1:male 2:female)	Diagnosis	Tumor size	Opname	Optime	EBL	Transfu-sion	POPF	LOH	System	Position	Gatric retraction
	49	2	NET	2.8	SpDP	140	50	0	0	5	GelPOINT® + additional 5-mm port	Reverse Trendelenburg	Gastric retraction suture
Yao, et al. 2013[12]	46	2	MCN	5	DPS	300	500	NA	0	8	Single incision with multi-ports	Reverse Trendelenburg	Gastric encircling plastic tube
	20	2	Fibromatosis	3.5	SpDP	240	500	NA	0	9	Single incision with multi-ports	Reverse Trendelenburg	Gastric encircling plastic tube
	36	2	SCN	4.5	DPS	150	10	NA	1	7	Single incision with multi-ports	Reverse Trendelenburg	Gastric encircling plastic tube
	42	2	Pancreatic cyst	4.5	DPS	125	100	NA	0	8	Single incision with multi-ports	Reverse Trendelenburg	Gastric encircling plastic tube
	22	2	Arterial Aneurysm	3.5	DPS	170	10	NA	0	6	Single incision with multi-ports	Reverse Trendelenburg	Gastric encircling plastic tube
	34	2	MCN, SPN	3.5	SpDP	110	30	NA	0	6	Single incision with multi-ports	Reverse Trendelenburg	Gastric encircling plastic tube
	34	2	Pancreatic cyst	3.5	SpDP	115	50	NA	0	8	Single incision with multi-ports	Reverse Trendelenburg	Gastric encircling plastic tube
	39	2	MCN	3	SpDP	165	100	NA	0	10	Single incision with multi-ports	Reverse Trendelenburg	Gastric encircling plastic tube
	73	2	NET	1.2	SpDP	170	50	NA	0	8	Single incision with multi-ports	Reverse Trendelenburg	Gastric encircling plastic tube
	27	2	MCN	4	DPS	155	200	NA	0	7	Single incision with multi-ports	Reverse Trendelenburg	Gastric encircling plastic tube
	45	2	MCN	6.2	SpDP	95	200	NA	0	5	Single incision with multi-ports	Reverse Trendelenburg	Gastric encircling plastic tube
Zang, et al. 2015[34]	8	1	Nesidioblastosis	NA	SpDP	140	Minimal	0	0	6	Single incision with multi-ports	Supine, reverse Trendelenburg	Gastric retraction suture

Table 2. Continued 3

Authors, year	Age	Gender (1:male 2:female)	Diagnosis	Tumor size	Opname	Optime	EBL	Transfusion	POPF	LOH	System	Position	Gatric retraction
Kuroki, et al. 2014[35]	79	1	Pancreatic metastasis	NA	SpDP	345	20	0	0	NA	SILS + 2-mm additional port	Reverse Trendelenburg	"Stomach-hanging method"
	63	2	Chronic pancreatitis	NA	SpDP	271	60	0	0 (bleeding)	NA	SILS + 2-mm additional port	Reverse Trendelenburg	"Stomach-hanging method"
	60	2	NET	NA	SpDP	232	70	0	0	NA	SILS + 2-mm additional port	Reverse Trendelenburg	"Stomach-hanging method"
	68	2	Pancreatic metastasis	NA	SpDP	235	20	0	0	NA	SILS + 2-mm additional port	Reverse Trendelenburg	"Stomach-hanging method"
	64	1	NET	NA	SpDP	238	200	0	0	NA	SILS + 2-mm additional port	Reverse Trendelenburg	"Stomach-hanging method"
Lee, et al. 2016[18]	71	1	IPMN	2.3	SpDP	144	NA	0	0	8	Glove port + /- additional 5-mm port	Right semidecubitus	Intraperitoneal retractor
	41	2	SPN	2.2	SpDP	164	NA	0	0	7	Glove port + /- additional 5-mm port	Right semidecubitus	Intraperitoneal retractor
	49	2	ipmc	1.2	SpDP	137	NA	0	0	6	Glove port + /- additional 5-mm port	Right semidecubitus	Intraperitoneal retractor
	36	1	mcn	6	SpDP	149	NA	0	0	8	Glove port + /- additional 5-mm port	Right semidecubitus	Intraperitoneal retractor
	43	1	mcn	2.1	SpDP	185	NA	0	0	8	Glove port + /- additional 5-mm port	Right semidecubitus	Intraperitoneal retractor
	70	2	Squamoid cyst	2	SpDP	126	NA	0	0	7	Glove port + /- additional 5-mm port	Right semidecubitus	Intraperitoneal retractor
	73	1	NET	0.9	SpDP	253	NA	0	0	10	Glove port + /- additional 5-mm port	Right semidecubitus	Intraperitoneal retractor
	53	1	NET	3.5	SpDP	120	NA	0	0	6	Glove port + /- additional 5-mm port	Right semidecubitus	Intraperitoneal retractor

Table 2. Continued 4

Authors, year	Age	Gender (1:male 2:female)	Diagnosis	Tumor size	Opname	Optime	EBL	Transfusion	POPF	LOH	System	Position	Gatric retraction
	20	2	PSN	5	SpDP	178	NA	0	0	6	Glove port +/- additional 5-mm port	Right semidecubitus	Intraperitoneal retractor
	64	2	MCM	1.7	SpDP	165	NA	0	0	7	Glove port +/- additional 5-mm port	Right semidecubitus	Intraperitoneal retractor
	69	2	SCM	5.8	DPS	127	NA	0	0	6	Glove port +/- additional 5-mm port	Right semidecubitus	Intraperitoneal retractor
	31	1	squamoid cyst	2.5	SpDP	175	NA	0	0	6	Glove port +/- additional 5-mm port	Right semidecubitus	Intraperitoneal retractor
	46	1	NET	1.7	SpDP	157	NA	0	0	6	Glove port +/- additional 5-mm port	Right semidecubitus	Intraperitoneal retractor

single port (LSP) or reduced port (LRP)-DP, a total of eight case reports and eight case series were identified in PubMed and KoreaMed. Among them, 12 publications described individual patient short-term perioperative outcomes, and a total of 58 patients were selected to evaluate perioperative outcomes after LSP/LRP-DP (Table 2). There were four retrospective[9–12] comparative analyses between LSP/LRP-DP and conventional LDP. The most frequently used surgical system for LRP- DP was single-port with an additional 2-mm or 5-mm assist port. Pure LSP-DP was performed in only 14 patients (24.1%). The success rate for LSP/LRP-DP was very high. Conversion to multiport conventional laparoscopic DP was reported in just two patients (3.4%). Several methods for facilitating pancreas exposure were described. These included using sutures for gastric retraction, a plastic tube for gastric circling, and the use of an intraperitoneal retractor, or direct retraction with a laparoscopic grasper. Spleen-preserving DP is known to be a time and labor consuming procedure, and thus, an advanced laparoscopic technique is required for preserving the spleen during LDP. However, it is interesting to note that a spleen-preserving procedure was performed even in 46 patients (78%).

A summary of perioperative outcomes showed that 20 patients were male, and 37 were female with a mean age of 45.9 ±16.0 years (gender information was missing in one report[13]). Most pathologic diagnoses were benign or borderline malignant tumors of the pancreas with a mean tumor diameter of 3.4±1.6 cm. Only four patients (6.9%) were found to have malignant tumors (intraductal papillary mucinous neoplasm with cancerous transformation (n=1) and pancreatic metastasis (n=3)). The mean operation time was 181.5±60.8 min, and

Table 3. Comparative analysis of laparoscopic single-port and reduced-port DP

	LSP-DP (N = 28)	LRP-DP (N = 30)	*p* value
Age	43.3 ± 15.9	48.2 ± 16.0	0.250
Gender (Male:Female)	8/19*	12/18	0.413
Tumor size	3.3 ± 1.5	3.4 ± 1.7	0.855
Spleen preservation (Yes/No)	19/9	27/3	0.038
Operation Time (min)	175.5 ± 58.4	186.9 ± 63.3	0.484
EBL (ml)	139.1 ± 158.2	75.8 ± 56.6	0.141
LOH (days)	6.6 ± 1.9	3.0 ± 2.2	<0.001
POPF (Yes/No)	4/24	26/4	1.000
Conversion to conventional DP	2	0	0.229

*Missing gender data in one report.

the mean estimated intraoperative blood loss was 99.9±109.9 ml. No patients required intraoperative transfusion. The mean hospital stay was 4.9±2.7 days. There was no surgery-related mortality. Comparative analysis between LSP-DP and LRP-DP showed that the spleen preserving rate was much higher (p=0.038) and that the hospital stay was reduced (6.6±1.9 days, vs. 3.0±2.2 days, p<0.001) in LRP-DP (Table 3). This suggests that LRP-DP may be more reliable in selected DP cases requiring advanced surgical techniques. There were no significant differences between the two groups in terms of age, gender, tumor size, and postoperative pancreatic fistula formation. In LSP-DP, only two patients (7.1%) were found to convert to conventional laparoscopic DP, and four cases (14.3%) required an additional port (conversion to LRP-DP) for safe completion of the operation.

After taking potential publication bias into account, current published data on LSP/LRP-DP carefully suggest that (1) both LSP-DP and LRP-DP are feasible and safe in select patients and that (2) LRP-DP seems to be more effective in spleen-preserving procedures and enhances postoperative recovery.

COMPARATIVE ANALYSIS BETWEEN LSP/RP-DP AND CONVENTIONAL LDP

There are only four studies which compared the perioperative outcomes between LSP/LRP-DP and conventional DP, including the most recent report by Lee.[11] Among them, two[10,11] were reported by members of Korean Society of Endoscopic and Laparoscopic Surgery (KSELS).[14] The perioperative outcomes investigated in each study are summarized in Table 4. Even though the conclusions derived from these studies were based on a limited number of the cases and retrospective study designs associated with unintended selection bias, all studies indicated that LSP/LRP-DP was comparable to conventional DP in patients who required DP for benign and borderline (low grade) malignant tumors in distal pancreas.

The technical difficulty of the procedure and the resulting stress for the surgeon were not evaluated in these studies, which will continue to be the main obstacles to make LRP/LSP-DP routine in clinical practice. Technical advances and more surgical experiences are needed to define the potential role of LSP/LRP-DP in minimally invasive pancreatic surgery.

Table 4. Review of comparative analyses between LSP-DP/ LRP-DP and conventional LDP (C-LDP)

	Haugvik, et al. 2013[9]		Yao, et al. 2014[12]		Han, et al.* 2014[10]		Lee, et al.* 2016[11]		
	LSP-DP (n=8)	C-LDP (n=16)	LSP-DP (n=14)	C-LDP (n=76)	LSP-DP (n=12)	C-LDP (n=28)	LSP-DP (n=8)	LRP-DP (n=5)	C-LDP (n=27)
Surgical System	Multi-instrument access port		Single incision with multiport technique		Glove port		Custom-made glove port		
Age	65 (35～74)	61 (44～81)	40.2 (20～73)	50.4 (35～65)	61.3±17.2	49.1±15.8†	50.8±14.4	52.0±22.8	55.0±14.9
BMI	25.1 (20.2～32.2)	25.0 (18.5～30.1)	22.6 (18.4～27)	23.3 (21.3～25.2)	23.5±4.6	23.6±4.0	23.1±1.8	23.4±5.1	23.3±3.0
Tumor size (cm)	2.1 (1.0～4.5)	3.1 (1.0～6.5)	4.3 (1.2～11)	3.7 (0.7～6)	3.8±1.8	3.4±2.5	1.9±0.9	4.2±2.0	3.2±2.1
Operation time (min)	145 (98～223)	137 (73～196)	166.4±57.4	202.1±122.5	279.8±52.0	186.9±86.6	142±35	152±20	180±48
EBL (ml)	225 (30～400)	200 (50～500)	157.1±162.4	168.6±157.4	185±125	334±468	100±41§	152±20	180±48
Conversion	None		1 (to C-DPS)		2 (to C-LDP)		4 (to LDR-DP), & 1 (to C-LDP)		
Complication	4	5	1	0	5	7	1	3	5
POPF	2	2	NA	NA	2	2	0	0	0
LOH (days)	6 (3～5)	6 (2～16)	7.6±1.4	9.0±3.0	12.2±5.4	8.3±4.7‡	6.9±0.9	7.0±1.0	6.5±1.5

*Data from the members of KSELS. †p=0.035, ‡p=0.028, §p=0.035.

POTENTIAL TECHNIQUE: ROBOTIC SINGLE SITE PLUS ONE PORT DISTAL PANCREATECTOMY

Despite the increasing number of laparoscopic DPs being performed and the advance of laparoscopic instruments, the fatigue and stress resulting from limited motion for instrument manipulation in the narrow surgical space (in current single port system) needs to be considered when performing LSP/LRP-DP. Therefore, in order to improve intraoperative surgical quality, technical innovation is essential. In theory, robotic surgical systems can overcome the limitations of laparoscopic surgery.[15,16] This technology may work even with LSP/RP-DP.

A robotic single-site surgical system has been introduced to facilitate laparoscopic single-port surgery.[17-19] Additionally the stable, 3-D operation field can enhance a surgeon's ergonomic environment. This enables surgeons to avoid the situation of right and left disorientation for triangular configuration during laparoscopic single-port surgery. It is thought that most intraoperative stress and fatigue results from the mechanics of the laparoscopic single-port surgical system. However, the robotic surgical system automatically calculates the movement of the surgeon's console with the help of specially designed curved trocars and semi-flexible instruments, making it possible for the surgeon's right and left hand to control the right- and left-sided screen instruments even if the instrument is attached to the left and right robotic arm, respectively.[18,20] If an additional robotic arm is added through another trocar in the abdomen, a wrist-like motion of instrument can be produced in the robotic single-site surgical system allowing for a more

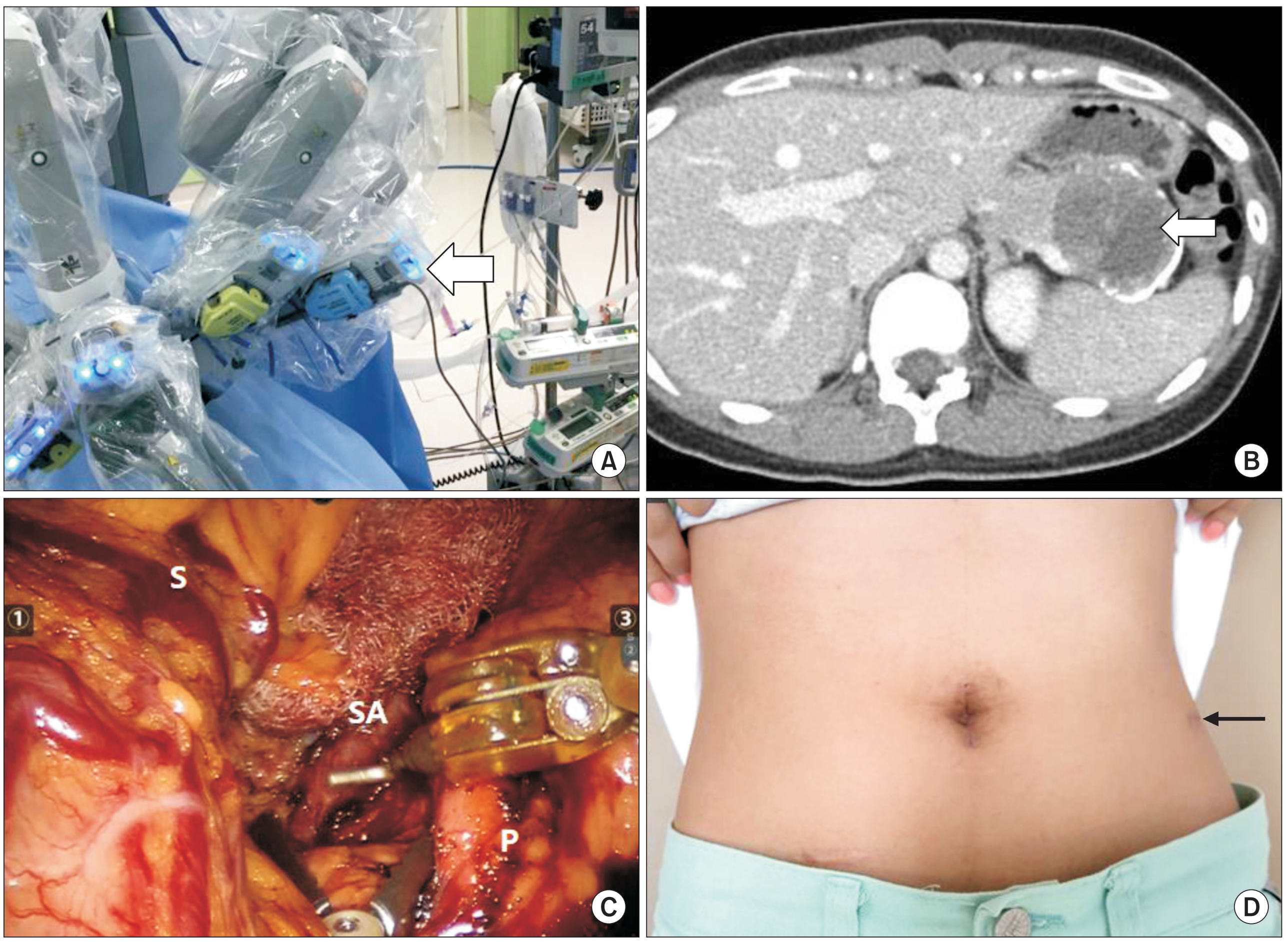

Fig. 2. Technical innovation of the robotic surgical system for LSP/RP DP. Robot setting for robotic single-site plus ONE port DP. Note a third robotic arm (white thick arrow) in the left lateral flank of the patient (three left-sided robotic arms) (A). Large pancreatic tumor with marginal calcification (white thin arrow) (B). The stomach was retracted with a single site robotic arm, and the splenic artery was effectively dissected using another robotic arm from the single-site robotic surgical system. A third robotic arm allowed for angulating wrist motion (C). Postoperative wound. Left lateral flank wound from the third robotic arm is away from the midline. The operative wound is hardly visible (black arrow) (D). S = stomach; SA = splenic artery; P = pancreas.

effective reduced-port surgery (Fig. 2A). Considering there is no wrist like-motion in pure robotic single site robotic surgical system, this technical advantages from additional port will be great helpful. In addition, preoperative surgical rehearsal is another advantage of robotic surgery. Surgical procedures can be simulated and techniques modified before applying them to patients, which allows for improved surgical quality and safety. Beginning in October 2015, we have been applying our *robotic single-site plus ONE port DP* technique in selected cases. A total of six cases, including a recent case of pancreatic enucleation, have already been performed safely using this new technique (*unpublished*).

A case of robotic single-site plus ONE port DP case is briefly introduced in this review. A 24-year-old female patient was admitted to the hospital due to the incidental finding of a mass in the pancreatic tail (Fig. 2B). Based on the presumed diagnosis of a solid pseudopapillary pancreatic neoplasm, she underwent robotic single-site plus ONE port DP. Total operation time was 160 minutes, and the estimated intraoperative blood loss was less than 50 ml. When dissecting splenic vessels, angulating motion of surgical instrument through additional port made surgical procedure effective and easy (Fig. 2C). No POPF was noted. She was discharged on the seventh postoperative day. Postoperatively, the wound appeared to be healing well (Fig. 2D). This case suggests that the main obstacles of the LSP/LRP system, which include surgical stress and ineffective instrument manipulation, can be resolved by using a robotic surgical system. More experience is required to determine the exact role of the robotic single-site surgical system for performing LSP/LRP-DP.

CONCLUSION AND FUTURE PERSPECTIVES

Despite the lack of randomized controlled studies, the accumulating number of LDP cases strongly suggests that LDP is a safe and effective surgical option for treating benign and borderline malignant tumors of the left pancreas. Currently, some efforts are being made to reduce the number of external wounds resulting from LSP/LRP-DP. LSP/LRP-DP is an emerging technique, and only a limited number of cases have been performed, however, the currently available published data show that LSP/LRP-DP is feasible, safe, and even comparable to conventional LDP. According to the literatures, a spleen-preserving procedure can be performed without increasing perioperative risk by this approach. It is difficult to estimate the limitations of instrumental movement and the surgeon's intraoperative stress and fatigue during LSP/LRP-DP. However, these technical limitations may be obstacles to the widespread use of LSP/LRP-DP. Further technical innovation and advances are required for reliable minimally invasive LDP. It is expected that more reliable clinical data based on a larger number of patients will be published from expert laparoscopic surgeons in the near future. Minimally invasive surgeons will continue to work to reduce postoperative pain and number of external wound, increasing the quality of life associated with laparoscopic procedures.

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