

Review Article



Current Issues in Reduced-Port Gastrectomy: A Comprehensive Review

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Conflict of Interest

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ABSTRACT

Reduced-port gastrectomy (RPG) includes all procedures derived from various efforts to minimize surgical invasiveness, with single-incision laparoscopic gastrectomy (SILG) being the ultimate reduced-port technique. However, there are challenges related to its feasibility, oncological validity, training, and education. This review describes the current issues and challenges, as well as the future prospects of RPG for gastric cancer. Gastrectomy, which started as an open surgery, has evolved into a laparoscopic surgery. With the advancements in laparoscopic technology, SILG has been used to minimize surgical scarring. However, owing to the technical difficulties of SILG, cases involving the addition of 1 trocar or needle grasper alongside the multichannel port have also been reported. Additionally, 3-port laparoscopic gastrectomy (3PLG) using only 3 trocars is also being performed. RPG, as a concept, includes a range of approaches such as SILG, 2-port laparoscopic gastrectomy, and 3PLG. These techniques aimed to reduce the number of ports or incisions required for laparoscopic gastrectomy. Despite technical difficulties, RPGs offer numerous advantages, including minimal invasiveness, excellent cosmetic outcomes, and the potential for improved post-operative recovery, such as reduced length of hospital stay and post-operative pain. It could be considered similar to conventional laparoscopic gastrectomy, and may not be oncologically inferior. Ongoing studies, such as the KLASS 12, are required to gain further insights.

Keywords: Stomach neoplasms; Gastrectomy; Laparoscopy

INTRODUCTION

Gastrectomy techniques for gastric cancer have evolved from extensive procedures to minimally invasive approaches, with a focus on reducing morbidity and mortality, while maintaining or improving oncological outcomes. Laparoscopic gastrectomy is currently acknowledged as one of the standard treatments in gastric cancer management guidelines [1]. This evolution has led to the development of techniques such as laparoscopic and robot-assisted gastrectomies, which offer advantages such as reduced pain, shorter hospital stays, and faster recovery [2,3]. Reduced-port gastrectomy (RPG) is a minimally invasive surgical technique that has been increasingly popular in recent years for the treatment of gastric

cancer. It involves fewer ports than standard laparoscopic surgery, which can lead to reduced pain, lower morbidity, and shorter hospital stay [4,5].

The concept of RPG includes all procedures derived from various efforts to minimize surgical invasiveness, with single-incision laparoscopic gastrectomy (SILG) as the ultimate reduced-port technique [4]. However, there are still challenges related to its feasibility, oncological validity, training, and education [4,6]. This review describes the current issues and challenges as well as the future prospects of RPG for gastric cancer in the light of literature.

HISTORICAL PERSPECTIVE

Minimally invasive gastrectomy has gained popularity owing to the early detection of early gastric cancer [7]. Laparoscopic distal gastrectomy was introduced as one such method for early gastric cancer in 1994 by Kitano et al. [8]. It was quite different from the current method, as it did not create a pneumoperitoneum, used a mini-laparostomy and a U-shaped retractor, and only involved a perigastric lymph node dissection [8]. The 5-port system, currently called conventional laparoscopic gastrectomy (CLG), was announced in 1999, and has been implemented since 1994 [9]. Laparoscopic techniques have evolved for use in less invasive but highly technical procedures, such as totally laparoscopic gastrectomy (TLG), in which the anastomosis is performed intracorporeally without mini-laparotomy [10]. TLG has gained popularity since Kanaya et al. [11] reported the first delta-shaped anastomosis. With the advancements in laparoscopic technology, single-incision laparoscopic distal gastrectomy has been performed to minimize surgical scarring. In the first report in 2011, surgery was assisted by the insertion of two 2 mm boxing glove-shaped retractors [12]. In 2014, it was also developed into a pure single-port laparoscopic distal gastrectomy, performed using only a single port, without the help of other tools such as a needle grasper [13]. However, due to the technical difficulties of SILG, cases of adding 1 trocar or needle grasper to a multichannel port have also been reported since 2012 [4,14,15]. Additionally, 3-port laparoscopic gastrectomy (3PLG) using only 3 trocars is also being performed since 2015 [16]. As mentioned earlier, the use of 5 trocars is considered CLG. However, the method involving only 4 trocars was already in practice early on, and hence it is not accepted as an RPG [9,17]. Reports on RPG in robotic gastrectomy began in 2017 [18].

TYPES OF RPG

As mentioned earlier, various types of RPG have been introduced and are currently being performed. These types can be categorized into pure SILG, needle grasper-assisted SILG, addition of 1 trocar to a multichannel single-port device, and use of 3 trocars [12-16]. Because RPGs include many different methods, it is necessary to distinguish and organize the terms. Although the classification method presented in the review by Inaki et al. [4] is acceptable, it can be confusing because RPG is sometimes used as a concept, including SILG, and sometimes refers to RPG excluding SILG, necessitating the introduction of a new term. Therefore, reduced multiport gastrectomy should be used to describe RPGs excluding SILG, emphasizing that ports are still multiple even after the number of ports is reduced (**Fig. 1**).

The terms 'Duet' surgery or 'Solo' surgery are used in the field of RPGs, although to be more precise, these terms pertain to the participating manpower, and not to describe an RPG that

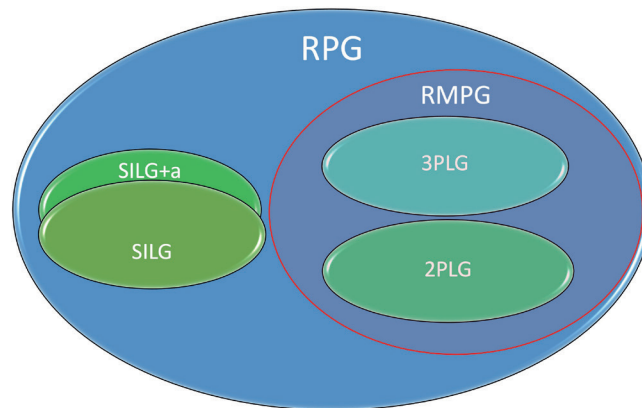


Fig. 1. Types of reduced port gastrectomy.

RPG = reduced-port gastrectomy; RMPG = reduced multiport gastrectomy; SILG = single-incision laparoscopic gastrectomy; SILG+a = needle grasper-assisted single-incision laparoscopic gastrectomy; 3PLG = 3-port laparoscopic gastrectomy; 2PLG = 2-port laparoscopic gastrectomy.

focuses on the number or size of wounds [16,19]. Therefore, it is not advisable to use ‘Duet’ surgery or ‘Solo’ surgery as terms describing an RPG, unless the intention is to mention the number of participants along with RPG, in which case, it would be better to use the 2 terms together.

Reduced multiport gastrectomies include surgeries that add 1 trocar to a multichannel port or those that use 3 trocars. Pure single-incision robotic gastrectomy has not yet been reported. However, robotic gastrectomy that adds 1 or 2 trocars to a multichannel single-port device has been revealed and can be considered a reduced multiport robotic gastrectomy [20,21].

To minimize scarring, SILG usually involves a surgical incision across the navel and the insertion of a multichannel, single-port device into the wound. Therefore, the camera, operator's instruments, and assistant's instruments are inserted into a single narrow space and severely interfere with each other. Interference can be reduced by using curved graspers or tools of different lengths; however, it cannot be eliminated. Additionally, because the surgeon's instruments enter the navel, pressure is applied to the pancreas, thus increasing the risk of damage. If surgery is performed by inserting a needle grasper (needle grasper-assisted SILG) or trocar (2-port laparoscopic gastrectomy, 2PLG) into the right upper abdomen and one of the operator's instruments enters that area, it is easier to receive assistance from an assistant, and interference between instruments can also be reduced [14,15]. When 3 trocars are used without a multichannel single-port device, no such assistance is possible; therefore, the operator needs to use excessive traction to create a dissection plane. However, because the operator's active instruments are accessed from the patient's right upper abdomen, the pressure applied to the pancreas may be less than that in SILG. Because traction and countertraction are lacking in all types of RPG, a needle grasper or organ retractor can be used to compensate for this [15,22].

COMPARATIVE STUDIES ON RPG AND CLG

The most important issues regarding surgical methods are safety and effectiveness. To review the safety and efficacy of RPG, studies comparing RPG and CLG have been reviewed.

Table 1 shows retrospective studies comparing distal gastrectomy performed with SILG and CLG. There was no difference in the body mass index (BMI) between the 2 groups in any of the studies. The estimated blood loss (EBL) was significantly lower in the SILG group in all studies and no difference was observed in morbidity or mortality, as well as in the lengths of stay after surgery between the 2 groups, indicating that SILG is safer compared to CLG. There was no difference in the operation time between the 2 groups in 2 studies, and 2 recent reports suggested that SILG had a significantly shorter operation time; therefore, SILG is not likely associated with a prolonged operation time. There was no difference in the number of resected lymph nodes between the 2 groups, although only one study reported no difference in the 5-year overall survival (OS) between the 2 groups (RPG vs. CLG, 95.8% vs. 94.2%, $P=0.96$) [23].

Table 2 summarizes the retrospective studies on 2PLG or 3PLG or SILG with the addition of needle graspers, excluding pure SILG in distal gastrectomy. Seven studies were identified in total. In 3 studies, the operation time was shorter in the RPG group; however, in 2 others, the RPG group showed a longer operation time, thus indicating inconsistent results. All studies that reported longer operation times used 2PLG. EBL was reported to have no significant difference in any study or to be lower in the RPG group. The number of resected lymph nodes was greater or showed no difference in the RPG group. No significant difference was observed in the length of hospital stay between the RPG and CLG groups. There were no significant differences in the postoperative morbidity or mortality rates between the 2 groups. Survival analysis was performed in 2 studies, and there was no significant difference in 3-year OS (100% vs. 100%, $P=1.000$) or 3-year relapse-free survival (RPG vs. CLG, 99.4% vs. 98.1%, $P=0.42$) between the 2 groups [26,27].

As seen above in the retrospective comparative studies reported to date, RPG, including SILG, can be considered safer and more effective compared to CLG.

Prospective randomized controlled trials (RCT) comparing RPG and CLG in distal gastrectomy have also been published, but the number of studies as well as the number of subjects is still small. As summarized in **Table 3**, there have been 2 reports on 2PLG and 2 on SILG. In general, there was no significant difference between the RPG and CLG. The 2 studies on 2PLG reported conflicting results regarding the operation time. One study showed that 2PLG had a significantly longer operation time, and the other showed that the operation time was significantly shorter. .

In an RCT by Kunisaki et al. [14], there was no difference in the number of painkillers used between the 2PLG and CLG groups, and cosmetic satisfaction was significantly higher in the 2PLG group. In an RCT by Teng et al. [32], the pain score on the third day after surgery was significantly lower in the 2PLG group. Meanwhile, Omori et al. [33] reported that there was consistently, significantly lesser pain in the SILG group after surgery, while Kang et al. [34] reported no significant difference between the SILG and CLG groups in terms of postoperative pain and quality of life. Although they were prospective and randomized, they were single-center studies, and the number of subjects was relatively small, making it difficult to draw conclusions. The KCLASS12, a large-scale multicenter study comparing RPG and CLG for distal gastrectomy, which is currently underway in Korea, could give a more conclusive outcome.

Studies comparing RPG and CLG in total gastrectomy are summarized in **Table 4**. All studies were retrospective. Even in relatively recent studies, the number of cases remained small. No

Table 1. Retrospective comparative studies of SILG to CLG in distal gastrectomy

Author/ country	Year	Study type	Group	LN dissection (D1/D1+/D2/D2+)	Pt. (kg/ m ²)	BMI	OP time (min)	P-value	EBL (mL)	No. of retrieved LN	P-value	LOH (day)	Morbidity P-value	Mortality P-value	5 year OS P-value						
Ahn et al. [13] Korea	2014	Retrospective	SILG	0/47/3/0	50	23.0	0.096	144.5	0.561	50.5	0.007	51.7	0.836	5.98	0.435	6	0.478	0	NA	NA	NA
			CLG	0/44/6/0	50	24.1	140.3		87.5	52.4		52.4		6.48		5		0	NA	NA	NA
Omori et al. [24] Japan	2016	PSM	SILG	0/0/50/0	50	22.7	0.386	261.4	0.172	44.8	0.001	60.8	0.710	9.7	<0.001	4	0.148	0	NA	NA	NA
			CLG	0/0/50/0	50	23.2	276.8		119.2	59.2		59.2		15.4		10		0	NA	NA	NA
Lee et al. [25] Korea	2021	PSM	SILG	4/41/54/0	99	25.3	0.409	120	0.001	24.6	0.004	57.1	0.823	6.00	0.270	21	0.240	1	>0.999	NA	NA
			CLG	7/148/43/0	198	23.8	178.6		46.7	60.6		60.6		5.48		47		2	NA	NA	NA
Kang et al. [23] Korea	2022	PSM	SILG	5/215/156/2	378	23.1	0.601	147.2	<0.001	34.9	<0.001	56.3	0.056	5*	0.720	21	1.000	0	NA	95.8	0.96
			CLG	3/229/146/0	378	23.2	170.8		84.1	53.6		53.6		5*		22		0	NA	94.2	0.96

SILG = single-incision laparoscopic gastrectomy; CLG = conventional multiport laparoscopic gastrectomy; LN = lymph node; BMI = body mass index; OP = operation; EBL = estimated blood loss; LOH = length of hospital stay; OS = overall survival; PSM = propensity score matching; NA = not accessible.
*Median value.

Table 2. Retrospective comparative studies of RMP/LG to CLG in distal gastrectomy

Author/ country	Year	Study type	Group	LN dissection (D1+/D2)	Pt. (kg/m ²)	BMI	OP time (min)	P-value	EBL (mL)	No. of retrieved LN	P-value	LOH (day)	Morbidity P-value	Mortality P-value	Survival P-value						
Kim et al. [16] Korea	2015	Retrospective	3PLG	NA	102	23.4	0.015	121.1	<0.001	91.4	0.506	36*	0.570	7*	0.423	16	0.294	0	NA	NA	NA
			CLG	NA	100	22.4	153.0		85.4	34*		34*		7*		10		0	NA	NA	NA
Kunisaki et al. [28] Japan	2018	PSM	2PLG (MCP+12 mm)	43/31	74	NA	265*	0.001	48*	0.001	38*	0.002	11*	0.790	8	0.624	0	1.000	NA	NA	NA
			CLG	43/31	74	NA	239*		68*	31*		31*		11*		11		1	NA	NA	NA
Oh and Oh [29] Korea	2018	PSM	3PLG	0/48	48	24.3	0.378	230*	0.036	68*	0.005	49*	0.714	13*	0.472	4	0.504	0	1.000	NA	NA
			CLG	0/48	48	24.5	250*		80*	48*		48*		13*		6		0	NA	NA	NA
Seo et al. [30] Korea	2018	Retrospective	3PLG	33/39	72	23.3	0.494	148.2	0.024	120.8	0.438	39.0	0.059	7.7	<0.001	2	0.085	0	0.498	NA	NA
			4 port	44/30	74	24.5	162.4		115.1	35.4		35.4		8.5		9		0	NA	NA	NA
			5 port	44/61	105	23.8	159.9		109.6	42.7		42.7		10.1		15		1	NA	NA	NA
Doden et al. [26] Japan	2021	PSM	SILG+3N	11/7	18	20.9	0.49	216	0.82	5*	0.13	41.5*	0.22	11*	0.59	0	1.000	0	NA	100†	1.000
			CLG	13/5	18	21.5	220		10*	57*		57*		12*		0		0	NA	100†	1.000
Du et al. [31] China	2022	Retrospective	2PLG (MCP+12 mm)	NA	23	22.58	0.270	232.39	0.028	221.74	0.478	25.17	0.065	7.35	0.197	1	1.000	0	NA	NA	NA
			CLG	NA	25	23.18	193.8		200.00	19.12		19.12		9.84		2		0	NA	NA	NA
Kim et al. [27] Korea	2022	PSM	3PLG	NA	158	23.7	0.160	161.8	<0.001	52.6	<0.001	32.8	0.34	7.6	0.04	14	1.000	NA	99.4†	0.42	0.42
			CLG	NA	158	24.1	189		73.7	31.2		31.2		9.1		14		NA	98.1†	0.42	0.42

RMP/LG = reduced multiport laparoscopic gastrectomy; CLG = conventional multiport laparoscopic gastrectomy; PSM = propensity score matching; LN = lymph node; BMI = body mass index; OP = operation; EBL = estimated blood loss; LOH = length of hospital stay; 3PLG = 3-port laparoscopic gastrectomy; 2PLG = 2-port laparoscopic gastrectomy; MCP = multichannel port; SILG+3N = single-incision laparoscopic gastrectomy plus 3 needle graspers; NA = not accessible.
*Median value; †3-year overall survival; ‡3-year relapse-free survival.

Table 3. Prospective randomized controlled studies of RPG to CLG in distal gastrectomy

Author/country	Year	Group	LN dissection (D1+/D2)	No. of Pt.	BMI (kg/m ²)	P-value	OP time (min)	P-value	EBL (ml)	P-value	No. of retrieved LN	P-value	LOH (day)	Morbidity	P-value	Mortality	P-value
Kunisaki et al. [14] Japan	2012	2PLG (MCP+12 mm)	NA	20	21.1	0.24	278.8	<0.001	66.0	0.325	36.8	0.898	15.6	3	0.459	0	0.999
		CLG	NA	18	22.1		228.7		84.2		36.3		14.8	3		0	
Teng et al. [32] China	2022	2PLG (MCP+12 mm)	0/58	58	22.9	0.592	185.1	0.005	95.0	0.358	31.2	0.484	8.4	4	0.743	0	
		CLG	0/59	59	23.3		207.0		110.1		33.0		9.2	6		0	
Omori et al. [33] Japan	2021	SILG	12/38	50	22.1	0.390	169*	0.040	12.9	0.445	48.3	0.743	7*	4	0.527	0	1.000
		CLG	21/30	51	22.7	182*		43.8		49.3		7*		6		0	
Kang et al. [34] Korea	2023	SILG	19/24	43	24.3	0.904	148.9	0.631	14.2	0.515	57.3	0.298	5*	9	0.858	0	NA
		CLG	26/14	40	24.4	154.3		18.0		62.9		5.5*		10		0	

RPG = reduced-port gastrectomy; CLG = conventional multiport laparoscopic gastrectomy; LN = lymph node; BMI = body mass index; OP = operation; EBL = estimated blood loss; LOH = length of hospital stay; 2PLG = 2-port laparoscopic gastrectomy; MCP = multichannel port; SILG = single-incision laparoscopic gastrectomy; NA = not accessible.

*Median value.

Table 4. Comparative studies between RPG and CLG in total gastrectomy

Author/country	Year	Study type	Group	LN dissection (D1+/D2)	No. of Pt.	BMI (kg/m ²)	P-value	OP time (min)	P-value	EBL (mL)	P-value	No. of retrieved LN	P-value	LOH (day)	Morbidity	P-value	Mortality	
Kawamura et al. [36] Japan	2013	Retrospective	2PLG (MCP+5 mm)	10/0	10	23.8	0.862	253.0	0.119	33.4	0.759	31.6	0.205	NA	NA	0	1.000	
			CLG	10/0	10	23.6		235.5		39.8		40.9		NA	NA	1		0
Kim et al. [35] Korea	2016	Retrospective	3PLG	NA	30	22.2*	0.728	222*	0.807	100*	0.249	47*	0.338	8*	0.333	11†	0.103	0
			CLG	NA	24	22.7*		233*		175*		41*		7*		4		0
Kunisaki et al. [28] Japan	2018	PSM	2PLG (MCP+12 mm)	36/27	63	NA		305*	0.012	75*	0.026	35*	0.772	13*	0.215	12	0.104	0
			CLG	36/27	63	NA	285*		110*				34*	16*		21		0
Du et al. [31] China	2022	Retrospective	2PLG (MCP+12 mm)	NA	20	22.95	0.802	273.03	0.021	215	0.861	19.05	0.232	8.60	0.358	3	1.000	0
			CLG	NA	22	22.74		216.71		209.09		15.05		10.41		3		0
Teng et al. [37] China	2023	Retrospective	MCP+12 mm or MCP + 12 mm + 5 mm	0/45	45	21.6	0.130	190.3	0.231	131.1	0.275	39.6	0.062	10.5	0.299	4	0.27	0
			CLG	0/65	65	22.5		196.8		121.5		34.6		12.0		11		0

RPG = reduced-port gastrectomy; CLG = conventional multiport laparoscopic gastrectomy; LN = lymph node; BMI = body mass index; OP = operation; EBL = estimated blood loss; LOH = length of hospital stay; PSM = propensity score matching; 2PLG = 2-port laparoscopic gastrectomy; MCP = multichannel port; 3PLG = 3-port laparoscopic gastrectomy; NA = not accessible.

*Median value; †Higher anastomosis complications.

significant differences were reported in EBL, hospital stay, morbidity, and mortality, although the operation time was reported to be either not different or significantly longer in the RPG. Additionally, in a study by Kim et al. [35], there was no difference in the overall morbidity; however, complications related to anastomosis were significantly higher in the RPG group. To date, there are no reports on the prospective RCTs on total gastrectomy.

CURRENT ISSUES

Safety of RPG

When comparing the morbidity or mortality rates of RPG with those of CLG, there were no differences in most studies. Intraoperative EBL was lower in the RPG group, with no significant difference between the 2 groups. Therefore, RPG can be considered safe. However, in the report by Kim et al. [35], in the case of total gastrectomy, anastomosis-related complications were high, and the attributed cause for the higher complication rate was identified as the learning curve effect. However there were no reports of an increased incidence of anastomosis-related complications in distal gastrectomy. The complexity and technical challenges associated with esophagojejunostomy during a total gastrectomy make it a critical and delicate procedure. The transition to new approaches, such as those involved in the RPG (presumably including SILG), can have a significant impact on outcomes, particularly during the learning curve. Given these considerations, surgeons and surgical teams undertaking new approaches such as RPG in total gastrectomy should be aware of the intricacies involved in the esophagojejunostomy. Adequate training, experience, and careful patient selection are crucial for minimizing complications and ensuring safe and effective outcomes.

Oncological outcomes

No difference has been reported in the number of lymph nodes resected between RPG and CLG groups. In the meta-analyses by Lin et al. [38] and Zhu et al. [39], there was no significant difference in the LN yield between SLG and CLG. This applies to both distal gastrectomy and total gastrectomy. A lack of difference in long-term survival outcomes has been reported, although only by 3 studies, indicating that the available data might still be insufficient. However, in a meta-analysis by Zhu et al. [39], there was no difference in long-term survival between the SLG and CLG groups.

Furthermore, the multicenter retrospective study by Lee et al. [40] is currently regarded as the most reliable investigation of long-term outcomes and encompasses the largest number of subjects. This study included both distal and total gastrectomies. A total of 460 (distal gastrectomy/total gastrectomy, 427/39) and 657 (distal gastrectomy/total gastrectomy, 607/50) 3PLG and CLG subjects, respectively, were included. While the BMI in the 3PLG group was significantly higher, parameters such as EBL and operation time did not differ. The 5-year OS rates and 5-year disease-free survival (DFS) of the 3PLG and CLG groups were not significantly different (OS: 94.3% and 96.7%, $P=0.138$; DFS: 94.3% and 95.9%, $P=0.231$) [40]. Based on the available data and current understanding, it seems reasonable to conclude that RPG (including SILG) is as good as CLG in terms of oncological outcomes. Evidence suggests that there is no significant difference in the number of resected lymph nodes, and the initial findings do not indicate disparities in the long-term oncological outcomes between RPG and CLG.

Technical difficulties

There are some unique challenges associated with RPG compared to CLG, particularly concerning the creation of a surgical field and the absence of an assistant for traction countertraction. In SILG, where multiple instruments pass through a single incision, there can be issues with collisions and interference between instruments. Traction can be achieved by utilizing gravity, such as tilting the patient table, or by creating space using gauze. Adapting to RPG may involve exploring alternative traction methods to ensure proper exposure and visualization. Collision and interference between instruments in SILG can be mitigated using a combination of long and short instruments or by employing instruments with a bend. The transition to RPG may require a certain adaptation period. Surgeons and surgical teams may need to become accustomed to new methods and techniques to optimize outcomes.

Ahn et al. [13] reported approximately 33 cases as the learning curve of SILG based on operation time. In a study evaluating the surgical outcomes and feasibility of RPG using learning curve analysis in a small-volume center, the operative outcomes of RPG were found to be comparable to those of CLG, with a relatively short learning curve of approximately 30 cases. The transition from conventional to RPG has been found to be feasible and safe, with comparable surgical outcomes [5]. The latter reports the experience of doctors at a small-volume center. Therefore, any surgeon can safely perform RPG after a certain adaptation period. Until surgeons acquire the necessary skills, they need to select an appropriate candidate to perform RPG and should not hesitate to insert additional ports, if necessary. To compensate for insufficient traction-counter traction mechanism of an RPG, a needle grasper or organ retractor can be used [15,22].

Advantages of RPG

According to meta-analyses conducted by Alarcon et al. [41], Lin et al. [38], Fu et al. [42], and Zhu et al. [39], a common significant advantage of RPG is the reduction in the length of stay. However, because most of the studies included in the meta-analyses were retrospective, there may have been an impact of changes in institutional postoperative care policy over time. There were no significant differences in the prospective studies shown in **Table 3**. Therefore, large-scale prospective studies are required.

In a prospective study conducted by Kunisaki et al. [14], cosmetic satisfaction was significantly higher in the RPG group. In another retrospective study, cosmetic satisfaction with RPG was significantly higher (9.00 vs. 6.09, $P < 0.001$) [13]. It is generally expected that RPGs would offer several cosmetic advantages. The reduction in the number of incisions or the placement of incisions in less visible locations compared with CLG may contribute to improved cosmetic outcomes. However, the cosmetic advantages of RPG over CLG may seem very small compared to those of CLG over open surgery. The presentation of objective data on the cosmetic advantages of RPGs is important to provide a comprehensive understanding of the benefits associated with these surgical approaches. Objective data can contribute to evidence-based decision making and help both surgeons and patients make informed choices. However, the evaluation of cosmetic benefits has been overlooked in a few prospective studies [32-34].

Because the RPG wound is small, there may be less pain after surgery than in CLG. However, pain is subjective which makes it difficult to evaluate. Owing to the nature of surgical clinical studies, blinding is difficult, making comparative evaluation difficult. According to a meta-analysis by Zhu et al. [39], the number of analgesic administrations was significantly lower

in the SLG group than in the CLG group. According to a prospective study, Kunisaki et al. [14] reported that there was no difference in the number of painkillers used between the 2 groups, and Teng et al. [32] reported that the pain score on the third day after surgery was significantly lower in the RPG group. Omori et al. [33] reported consistently significantly lesser postoperative pain in the SILG group after surgery. However, Kang et al. [34] reported no significant difference in postoperative pain between the 2 groups. As such, some studies show that pain after RPG is lower, while others show no difference. There is a possibility that pain after surgery will be reduced; however, it is difficult to draw a conclusion with the available data.

Furthermore, performing RPG may be advantageous in reducing the number of surgical personnel involved. In particular, there is no role for an assistant in 3PLG because there are 3 trocars: 1 for the camera and 2 for the operator. Therefore, the term "Duet" surgery has emerged and is used interchangeably with 3PLG [16,30,35]. It is preferable if a surgeon has become accustomed to RPG and can operate without an assistant. However, if a surgeon has no choice but to perform RPG because of the lack of personnel to participate in the surgery, the surgeon needs to approach it cautiously until he/she becomes familiar with RPG. Ensuring patient safety and optimal surgical outcomes should remain a priority, and decisions regarding the use of RPG without an assistant should be made with a thorough understanding of the surgical technique, surgeon's expertise, and the specific context of each case.

FUTURE PERSPECTIVES

There is a need for further research with a particular focus on RPGs. Currently, the KLASS12 study, a large-scale multicenter study, is actively underway in Korea, and the results may help clarify many unresolved aspects.

The strengths of RPGs are to be evaluated in further detail. For instance, RPG may reduce inflammatory reactions because it minimizes invasiveness. Therefore, further research is required to determine the best candidates for RPG by considering such concepts, which might prove advantageous [43]. As such, it is necessary to discover and evaluate the advantages of RPG. Moreover, advancements in surgical research often involve not only discovering advantages but also developing methodologies to systematically evaluate and measure them. This requires collaboration among researchers, surgeons, and other stakeholders to ensure that the evaluation methods align with the clinical relevance and patient outcomes.

RPGs are technically demanding and benefit from the development of specialized devices that address the challenges associated with reduced-port and single-incision approaches. The development of devices tailored for RPG surgery, such as multichannel ports, needle graspers, organ retractors, articulating devices, and scope holders, is crucial. These devices can aid surgeons in performing procedures more effectively and with higher precision. Collaboration between surgeons, engineers, and medical device manufacturers is critical for driving the development of innovative tools. Continuous feedback from the surgical community can inform the design and refinement of devices to meet the needs of practitioners better.

Although robotic surgery is recognized for its potential benefits, surgeons have highlighted that its widespread adoption in Korea is limited, possibly due to reimbursement issues. The

expectation that Da Vinci and similar robotic platforms will be actively used in the future, indicates recognition of the evolving role of robotics in RPG. The Da Vinci SP (Single Port) platform was specifically designed for single-port procedures, making it suitable for RPGs. The versatility and ability of the system to navigate challenging anatomical spaces contribute to the feasibility of single-incision and reduced-port approaches [21].

CONCLUSIONS

RPG, as a concept, includes a range of approaches such as SILG, 2PLG, and 3PLG. These techniques aimed to reduce the number of ports or incisions required for laparoscopic gastrectomy. Despite technical difficulties, RPGs offer numerous advantages, including minimal invasiveness, excellent cosmetic outcomes, and the potential for improved post-surgical recovery, such as reduced length of hospital stay and post-operative pain. Similar to CLG, RPGs are considered safe and are not oncologically inferior. Ongoing studies, such as the KLASS 12 study, are required to gain further insights.

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