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ORIGINAL CONTRIBUTIONS

Reduced-Port Sleeve Gastrectomy for Morbidly Obese Japanese Patients: a Retrospective Case-Matched Study

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Abstract

Background Reduced-port laparoscopic surgery remains controversial due to technical challenges that can lead to suboptimal outcomes, and data pertaining to operative and clinical outcomes of reduced-port sleeve gastrectomy (RPSG) vs. conventional laparoscopic sleeve gastrectomy (CLSG) are lacking.
Aims This retrospective case-matched study aimed to compare midterm (2-year) outcomes of RPSG and of CLSG.
Methods Patients included in the study had undergone laparoscopic bariatric surgery at our center between 2010 and 2017. Thirty-one consecutive female patients who underwent RPSG were compared to a sex-, age-, body mass index–matched group of 31 patients who underwent CLSG. Outcomes were evaluated and compared between groups.
Results Estimated blood loss volume, incidences of intraoperative and postoperative complications, and length of postoperative hospital stay did not differ significantly between the 2 groups. Operation time was significantly greater in the RPSG group than in the CLSG group (148.7 ± 22.6 vs. 120.2 ± 25.9 min, respectively; $p < 0.001$). Excess weight loss at 1 year was 105.9% and 109.7%, respectively ($p = 0.94$) and at 2 years was 101.1% and 105.3%, respectively ($p = 0.64$). One RPSG patient required placement of additional trocars because of bleeding from short gastric vessels, but conversion to open surgery was not required.
Conclusions RPSG is feasible in carefully selected bariatric patients and results in midterm outcomes comparable to those observed after CLSG. Good cosmesis is a potential benefit of RPSG.

Keywords Bariatric surgery · Sleeve gastrectomy · Reduced-port surgery

Introduction

Bariatric surgery for severe obesity is associated with long-term weight loss and decreased overall mortality [1]. Of the various procedures available, laparoscopic sleeve gastrectomy (LSG) has gained popularity to become the most frequently performed bariatric surgery worldwide [2], and in Japan, approximately 90% of bariatric procedures performed in 2017 were LSGs [3].

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Single-incision laparoscopic surgery (SILS), a surgical technique first reported in the 1990s and aimed at minimizing the esthetic sequelae of such procedures as appendectomy [4], cholecystectomy [5], colectomy [6], nephrectomy [7], splenectomy [8], and fundoplication [9], is now used in patients undergoing sleeve gastrectomy. For this procedure, a transumbilical approach is most often selected because the surgical scar is almost completely hidden.

Though data are scarce, there are reports that single-incision sleeve gastrectomy (SISG) is as feasible and safe as conventional laparoscopic sleeve gastrectomy (CLSG) [10–16]. In morbidly obese patients with central obesity, the umbilicus is inferiorly displaced, and this reduces feasibility of the transumbilical approach. Furthermore, operating with rigid instruments through a single incision in such patients is challenging not only because the abdominal wall is thick but also because of the presence of intraabdominal fat deposits and an enlarged fatty liver. The technical difficulties can result in incomplete removal of the fundus at the time of SISG.

Andrea et al. compared lengths of the surgical specimens between SISG and CLSG reported that the SISG specimens were significantly shorter than the CLSG specimens [15]. The difference could be important because the residual fundus can cause both weight regain and gastroesophageal reflux disease (GERD) in the long term [17]. To avoid these disadvantages, we choose to perform reduced-port sleeve gastrectomy (RPSG) which is executed with an extra 5-mm trocar in the left upper quadrant.

We conducted a retrospective case-matched study in which we compared outcomes of RPSG and CLSG.

Methods

Patients

Included in the study were patients who underwent laparoscopic bariatric surgery at Yotsuya Medical Cube between 2009 and 2017. The case group comprised 31 consecutive female patients who underwent RPSG. The control group comprised 31 patients who underwent CLSG and were matched by sex, age (±5 years), and body mass index (BMI) (± 3 kg/m^2) to the case group.

Eligibility for laparoscopic bariatric surgery at our center is based on the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) Guidelines for Clinical Application of Laparoscopic Bariatric Surgery. That is, the patient is between 18 and 65 years of age, the patient's BMI is > 30 kg/m^2, the patient's obesity is medically uncontrolled, and one or more obesity-related comorbidities are present [18]. RPSG is offered to female patients who are concerned about the cosmetic outcome of the weight-loss surgery. A BMI > 40 kg/m^2, presence of a hiatal hernia or GERD, and height > 170 cm are contraindications for RPSG.

Outcomes Measured

Patients' records were reviewed for preoperative clinical characteristics, including age, body weight, BMI, visceral fat area, subcutaneous fat area, and obesity-related comorbidities. Intraoperative and postoperative outcomes including operation time, estimated blood loss, conversion to open surgery, length of the hospital stay, postoperative complications, reoperation, and readmission data were also noted, with postoperative complications graded according to Clavien-Dindo classification system. Early complications were defined as complications that occurred within the first 30 days after the surgery, and late complications were defined as those that occurred after 30 days. Excess weight loss (EWL, reported as a percentage) at 2 years was also noted, with a patient's ideal weight considered the weight necessary for a BMI of 25 kg/m^2. Whether patients' diabetes, hypertension, and dyslipidemia had remitted by 2 years was also determined, with remission defined as HbA1c < 6.5% without medication, blood pressure < 140/90 mmHg without medication, and LDL < 140 mg/dL and HDL ≥ 40 mg/dL and TG < 150 mg/dL without medication, respectively.

CLSG Technique

Preparation for the CLSG technique is illustrated in Fig. 1. A 12-mm trocar is inserted directly into the abdominal cavity at the midline 18 cm below the xiphoid process under endoscopic guidance. Pneumoperitoneum is established at 15 mmHg, and five laparoscopic trocars are

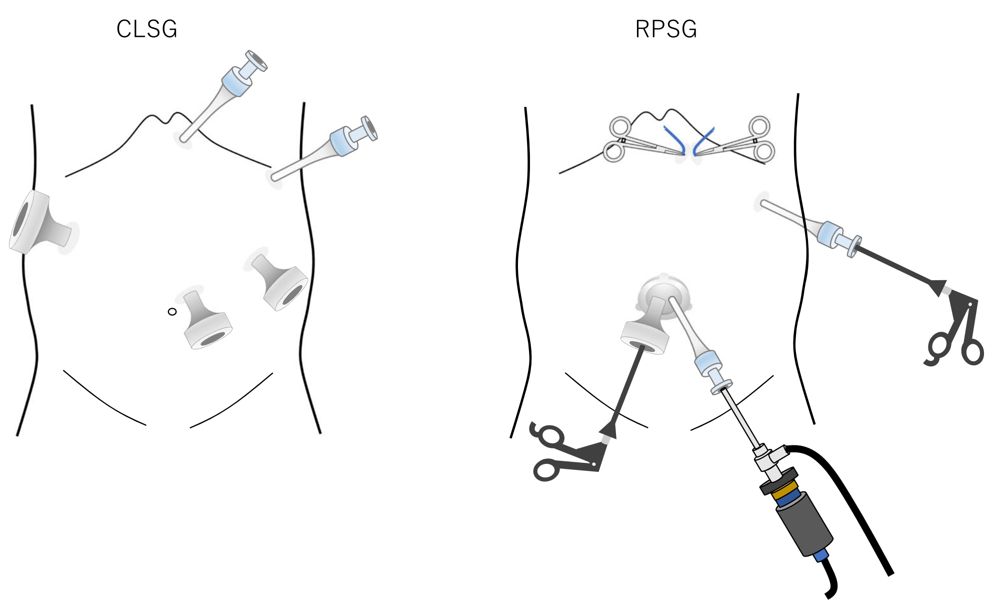


Fig. 1 Port placement for CLSG and RPSG

then placed in the upper abdomen. Starting 4 cm from the pyloric ring, the omentum along the greater curvature of the stomach is progressively freed up to the gastroesophageal junction, with use of an ultrasonic energy device to divide the branches of the gastroepiploic vessels. The gastric fundus is fully mobilized, the left crus is exposed, and the posterior wall of the stomach is separated from the pancreas. A 36Fr. or 37.5Fr. bougie is advanced transorally along the lesser gastric curvature. A 60-mm endoscopic linear stapler is then used to divide the stomach. The bougie is kept in place, and the staple line is imbricated with 2–0 nonabsorbable suture material. The integrity of the staple line is confirmed endoscopically. The surgical specimen is extracted through the 15-mm trocar site, which is closed with monofilament nonabsorbable suture material.

RPSG Technique

Preparation for the RPSG technique is also illustrated in Fig. 1. Under general anesthesia, the patient is placed supine. The surgeon stands between the patient's legs, and the camera assistant stands at the patient's right side. A Lap Protector Mini (LP, Hakko, Co., Ltd., Nagano, Japan) is inserted into a 2.5-cm transumbilical incision, an EZ-Access port (Hakko, Co., Ltd.) is mounted onto the LP, and a 5-mm trocar and 12-mm trocar are introduced through the EZ-Access. A 5-mm trocar is then inserted in the left upper quadrant. The liver is retracted (Fig. 2), as described by Zachariah et al. [19]. Standard laparoscopic instruments are used for the majority of the RPSG procedure, and the operative steps are much the same as those in standard CLSG. If the distance from the umbilicus to the esophagogastric junction is long, the left-handed instrument is exchanged for a longer one. The surgical specimen is extracted through the umbilical incision, and the fascia is closed with monofilament nonabsorbable suture material.

Statistical Analysis

Mean ± standard deviation (SD) values, median and range values, or number and percentage of patients are shown. Between-group differences in quantitative variables were analyzed by Student's *t* test or Mann-Whitney *U* test, and between-group differences in qualitative variables were analyzed by chi-square test or Fisher's exact test. A probability (*p*) value < 0.05 was considered statistically significant. Microsoft Excel (Microsoft Excel for Office 365 MSO, Microsoft COP., Redmond, WA, USA) was used for the analyses.

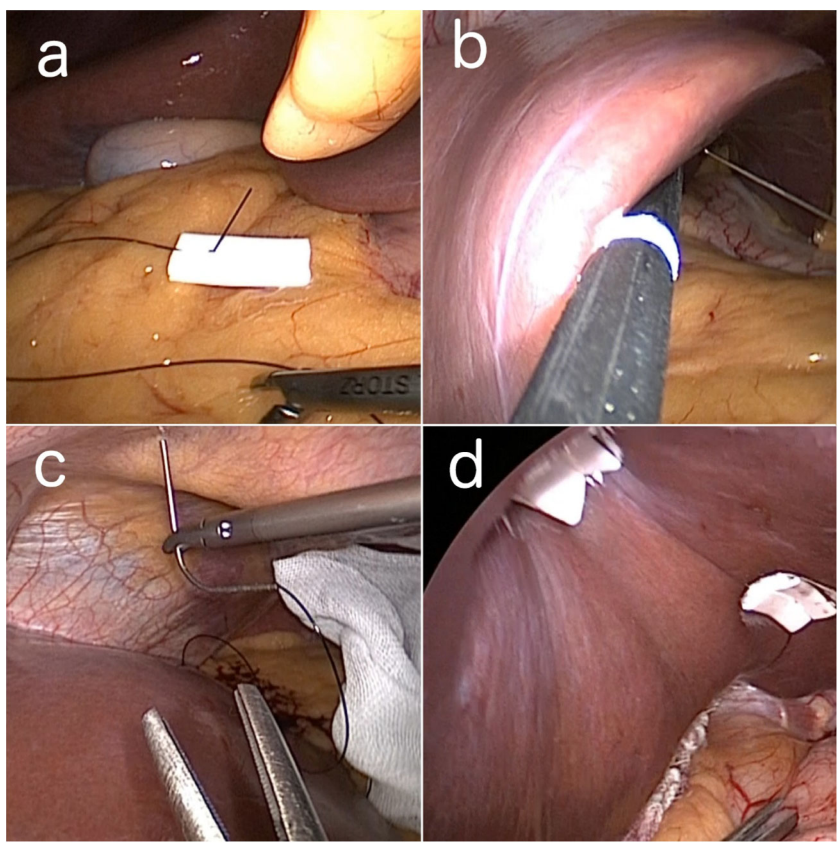


Fig. 2 Liver suspension technique. **a** We use a silicon drain attached to 2–0 polypropylene suture on a long straight needle. **b** A needle is used to puncture the liver about 2 cm from its edge. **c** The needle is then brought out of the abdomen and secured with clamps. **d** We apply 2 such suspensions to retract the liver

Results

Patient Characteristics

Characteristics of the study patients are shown per group in Table 1. Age ($p = 0.23$), body weight, ($p = 0.42$), BMI ($p = 0.33$), visceral fat area ($p = 0.18$), and the number of comorbidities did not differ significantly between the 2 groups. The mean subcutaneous fat area was significantly smaller in the RPSG group than in the CLSG group (350.5 ± 94.2 cm^2 vs. 407.8 ± 87.3 cm^2, respectively; $p = 0.004$).

Operation Time and Complications

Intraoperative and postoperative variables are shown in Table 2. Mean operation time was 148.7 ± 22.6 min in the RPSG group and 120.2 ± 25.9 min in the CLSG group, and these differed significantly ($p < 0.001$). There was, however, no significant between-group difference in intraoperative complications ($p = 1.00$) or estimated blood loss ($p = 0.98$). Placement of 2 additional trocars was necessary for 1 (3.2%) patient during RPSG because of gastric bleeding. The total blood loss, in this case, was 1300 mL, but conversion to open surgery was not necessary. Postoperative hospital stay ($p = 0.83$) and the incidences of early ($p = 1.00$) and late ($p = 1.00$) complications were comparable between the 2 groups. Reoperation was required in 1 patient (3.2%) in the RPSG group. This was due to a staple line leak that occurred on postoperative day 4. The patient recovered well without further adverse events. Surgical site infection (SSI) developed in 1 patient (3.2%) in the RPSG group, and refractory GERD developed in another (3.2%), requiring revision laparoscopic Roux-en-Y gastric bypass (LRYGB) 6 years after the RPSG.

Table 1 Patient characteristics, per study group

	RPSG ($n = 31$)	CLSG ($n = 31$)	p value
Age (years)	39.1 ± 8.7	39.7 ± 9.0	0.23
BW (kg)	84.9 ± 7.9	85.9 ± 7.4	0.42
BMI (kg/m^2)	33.5 ± 2.6	33.7 ± 2.0	0.33
VFA (cm^2)	129.5 ± 44.1	142.9 ± 46.6	0.18
SFA (cm^2)	350.5 ± 94.2	407.8 ± 87.3	0.004
V/S ratio	0.41 ± 0.23	0.37 ± 0.16	0.50
Comorbidities			
Diabetes	9 (29.0%)	8 (25.8%)	0.78
Hypertension	11 (35.5%)	11 (35.5%)	1.0
Dyslipidemia	19 (61.35)	21 (67.7%)	0.60

Mean ± SD values or number (%) of patients are shown, unless otherwise indicated

RPSG reduced-port sleeve gastrectomy, *CLSG* conventional laparoscopic sleeve gastrectomy, *BW* body weight, *BMI* body mass index, *VFA* visceral fat area, *SFA* subcutaneous fat area, *V/S* VFA/SFA

SSI developed in 1 patient (3.2%) in the CLSG group, and dumping syndrome developed in conjunction with reactive hypoglycemia in another patient (3.2%) in this group.

EWL

EWL data are given in Table 3 and Fig. 3. BMI at 1 year was 24.9 ± 3.1 in the RPSG group and 24.6 ± 3.4 in the CLSG group ($p = 0.97$), and BMI at 2 years was 25.4 ± 4.2 and 24.9 ± 4.9 ($p = 0.61$), respectively. EWL at 1 year was 105.9% in the RPSG group and 109.7% in the CLSG group ($p = 0.94$) and at 2 years was 101.1% and 105.3% ($p = 0.64$), respectively.

Comorbidities

Comorbidities were assessed during follow-up at 1 year and 2 years. Remission of comorbidities in each group is shown in Table 4. At 1 year, remission of diabetes was 100% in the RPSG group and 66.7% in the CLSG group ($p = 0.14$), and at 2 years, remission of diabetes was 100% and 75% ($p = 0.36$), respectively. Remission of hypertension at 1 year was 63.6% in the RPSG group and 60% in the CLSG group ($p = 1$) and at 2 years was 42.9% and 33.3% ($p = 1$), respectively. Remission of dyslipidemia at 1 year was 44.4% in the RPSG group and 64.7% in the CLSG group ($p = 0.19$) and at 2 years was 58.3% and 50% ($p = 1$), respectively.

Cosmetic Outcomes

In all patients who underwent RPSG, the umbilical scar was almost completely hidden, and only the scar resulting from the 5-mm accessory port was visible to the naked eye. An example of such a scar is shown in Fig. 4.

Discussion

SILS is a relatively new surgical approach that minimizes abdominal wall trauma. It improves cosmesis without compromising outcomes, but it can be challenging in certain patients and for certain procedures. Reduced-port laparoscopic surgery (RPLS) avoids the technical challenges of the single-port approach and maintains the principles of the conventional multiport laparoscopic approach. The transumbilical approach is also chosen in RPLS approach because the resulting scar is almost completely hidden. In morbidly obese patients with central obesity, the umbilicus displaces inferiorly, and this makes the transumbilical approach difficult. Mittermair et al. proposed limiting SISG to patients with a BMI of 35–45 kg/m^2 [20], and Fernández et al. proposed that the xiphoid-umbilicus distance should not exceed 22–25 cm [21]. In keeping with these recommendations, we offer our

Table 2 Intraoperative and postoperative complications per study group

	RPSG ($n = 31$)	CLSG ($n = 31$)	p value
Operation time (minutes)	148.7 ± 22.6	120.2 ± 25.9	< 0.001
Estimated blood loss (mL)	0 (0–1385)	0 (0–367)	0.98
Intraoperative complication	1 (3.2%)	1 (3.2%)	1.0
Conversion to open surgery	0 (0%)	0 (0%)	–
Postoperative complications			
Total	3 (9.7%)	2 (6.5%)	1.0
Early	2 (6.5%)	1 (3.2%)	1.0
Late	1 (3.2%)	1 (3.2%)	1
CD grade ≤ 2	1 (3.2%)	2 (6.5%)	1.0
CD grade ≥ 3	2 (6.5%)	0 (0%)	0.49
Readmission	0 (0%)	0 (0%)	–
Reoperation	1 (3.2%)	0 (0%)	1.0
Postoperative hospital stay (days)	3 (3–7)	3 (3–3)	0.83
Operative mortality	0 (0%)	0 (0%)	–

Mean ± SD values, median (range) values, or number (%) of patients are shown, unless otherwise indicated. Mean follow-up time was 36.2 ± 24.7 months and 25.7 ± 18.8 months, respectively, and did not differ significantly

RPSG reduced-port sleeve gastrectomy, *CLSG* conventional laparoscopic sleeve gastrectomy, *Early* within 30 days, *Late* after 30 days, *CD* Clavien-Dindo

RPSG technique to female patients with a BMI ≤ 40 and height ≤ 170 cm, and we perform it in "takers" by transumbilical approach and a lateral 5-mm accessory port.

Retraction of a fatty liver is important because a compromised view of the hiatus reduces the quality of the bariatric surgery and increases the possibility of complications. Several liver retraction techniques have been reported for patients undergoing SILS [22]. We use the liver suspension technique reported by Zachariah et al. [19]. This technique can be used without much difficulty, even for large livers. Although liver retraction poses a risk of bleeding or intrahepatic bile duct injury at puncture points, we did not encounter any such problem when using this technique. However, if exposure is poor due to an enlarged fatty liver, an additional trocar should be placed to retract liver.

Table 3 Weight-related variables at 1 year and 2 years postoperatively per study group

	RPSG ($n = 27$)	CLSG ($n = 26$)	p value
BW at 1 year (kg)	62.9 ± 7.5	63.1 ± 10.3	0.92
BMI at 1 year (kg/m^2)	24.9 ± 3.1	24.6 ± 3.4	0.97
EWL at 1 year (%)	105.9 ± 39.3	109.7 ± 40.0	0.94
	($n = 18$)	($n = 16$)	
BW at 2 years (kg)	63.3 ± 9.5	63.7 ± 14.7	0.56
BMI at 2 years (kg/m^2)	25.4 ± 4.2	24.9 ± 4.9	0.61
EWL at 2 years (%)	101.1 ± 51.9	105.3 ± 60.6	0.64

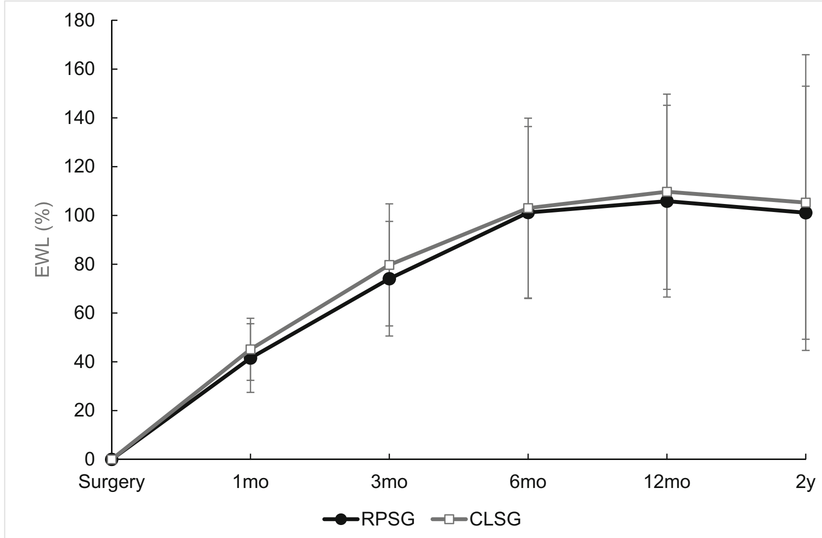
Mean ± SD values are shown

RPSG reduced-port sleeve gastrectomy, *CLSG* conventional laparoscopic sleeve gastrectomy, *BW* body weight, *BMI* body mass index, *EWL* excess weight loss

Some authors have reported that SISG takes longer than CLSG [10, 12], whereas other authors have reported similar operation times [11, 14, 15]. Sucher et al., however, reported a significantly lower total operation time for SISG than for CLSG [13]. RPSG was shown in our study to take longer than CLSG. We believe the longer time required for RPSG was attributable to closure of the umbilical fascia and umbilicoplasty, which together are more time-consuming than the port-site closure performed after CLSG. The estimated blood losses and incidences of intraoperative complications appear to be similar. However, bleeding from short gastric vessels necessitated placement of additional trocars in 1 of our patients. Gravity is usually relied upon for tissue tension during RPSG because traction is not provided by assistants. This sometimes makes the procedure exceptionally difficult. Therefore, dissection around the gastric fundus should be performed carefully. If any difficulties such as bleeding are encountered during the procedure, we do not hesitate to add more trocars so as not to compromise safety. Leakage occurred in 1 patient after RPSG, an occurrence we attributed to our limited experience (the case was only our third case of RPSG).

Postoperative hospital stay and the incidences of early and late complications were statistically comparable between our 2 patient groups. However, reoperation was required for 1 patient who had undergone RPSG. EWL at both 1 and 2 years was shown to be similar between the 2 groups; moreover, remission of comorbidities was comparable. EWL was actually increased among our patients in comparison to

Fig. 3 Excess weight loss



percentages reported by other investigators [12, 14, 23, 24]. In addition, our follow-up period was longer than that of other reported studies.

SILS is associated with a relatively high incidence of incisional hernia, an incidence as high as 5.8% in cases of SILS cholecystectomy, for example [25]. However, most incisional hernias associated with SILS cholecystectomy were reported in the first year of the procedure [26]. Because incisional hernia is related to a high BMI [27, 28], the umbilical incision in obese patients should be carefully closed. During the 2-year follow-up period after either RPSG or CLSG, no incisional hernia developed in any of our patients. Lakdawala et al. reported a 1% incidence of incisional hernia following SISG when nonabsorbable suture material was used to close the main wound [11]. We too used nonabsorbable suture material to prevent incisional hernia.

GERD is a concern following LSG. Refractory GERD developed in 1 of our patients who had undergone RPSG.

Table 4 Remission of comorbidities at 1 year and 2 years postoperatively per study group

	RPSG	CLSG	*p* value
1 year			
Diabetes	9/9 (100%)	4/6 (66.7%)	0.14
Hypertension	7/11 (63.6%)	6/10 (60.0%)	1.0
Dyslipidemia	8/18 (44.4%)	11/17 (64.7%)	0.19
2 years			
Diabetes	7/7 (100%)	3/4 (75.0%)	0.36
Hypertension	3/7 (42.9%)	2/6 (33.3%)	1.0
Dyslipidemia	7/12 (58.3%)	4/8 (50%)	1.0

Numbers and percentage of patients are shown

RPSG reduced-port sleeve gastrectomy, *CLSG* conventional laparoscopic sleeve gastrectomy

Possible causes of GERD after LSG include loss of the angle of His; creation of a high pressure, non-compliant gastric tube; damage to the sling fibers when the phrenoesophageal junction is dissected; and intrathoracic sleeve-migration. Soricelli et al. reported that repairing a hiatal hernia during LSG significantly decreased GERD symptoms [29]. At our center, posterior hiatal repair has been performed in addition to sleeve gastrectomy in obese patients with erosive reflux esophagitis and/or hiatal hernia. We regard pre-existing reflux disease as a contraindication to RPSG because posterior hiatoplasty is technically difficult. One patient in the series reported herein required revision LRYGB because of refractory GERD. Performance of the surgery through a small incision in the absence of traction makes the RPSG procedure difficult, and it may result in residual fundus. However, we found no significant neofundus formation during bypass surgery. Rather, intrathoracic sleeve migration, which was probably not due to technical issues associated with RPSG, was observed. Because GERD can occur for various reasons after sleeve gastrectomy, careful, long-term follow-up is necessary.

For RPSG, we use a transumbilical approach with an extra 5-mm trocar. Thus, we are not performing "pure" SISG. However, the instrument triangulation is improved, and the advantages of the single incision approach, such as good cosmesis, are not lost. In addition, the technique is easy and thus, reproducible by trained laparoscopic bariatric surgeons. However, if critical complications occur during RPSG, surgeons should not hesitate to place additional trocars or convert to CLSG.

Limitations of this study include its retrospective design, relatively small patient groups, and inclusion of only female patients without large amounts of visceral fat. Another limitation is that the cosmetic outcomes of

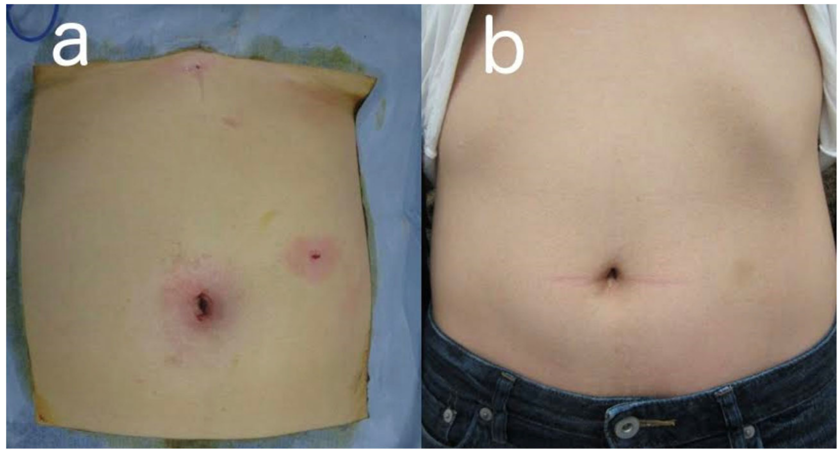


Fig. 4 RPSG scar. **a** Postoperative wound, **b** 4 years after the operation

RPSG were rated simply on the basis of scar size. We plan, for the future, to obtain patients' perception of cosmetic outcomes by incorporating "cosmetic result" into a validated postoperative questionnaire so that we include cosmesis scores in future analyses. Our study was of midterm (up to 2 years) outcomes of RPSG. We plan to continue the evaluation into the long term, especially with regard to EWL and postoperative complications such as incisional hernia and GERD.

Conclusion

RPSG is a technically safe and feasible procedure for properly selected, morbidly obese patients. Although the operation time appears to be slightly increased in comparison to that of CLSG, weight loss and remission of comorbidities are comparable. When introducing RPSG, particular care should be taken to avoid surgical complications, especially during the early learning period. RPSG should be regarded as a valid approach to patients who are concerned about the cosmetic results of LSG.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in our study involving human participants were in accordance with the ethical standards of the institutional and/or Japanese national research committees and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent Consent to use their anonymized data for research purposes has been obtained from all included in the study.

References

1. Sjöström L, Narbro K, Sjöström CD, et al. Effects of bariatric surgery on mortality in Swedish obese subjects. N Engl J Med. 2007;357:741–52.
2. Angrisani L, Santonicola A, Iovino P, et al. Bariatric surgery and endoluminal procedures: IFSO worldwide survey 2014. Obes Surg. 2017;27:2279–89.
3. Ohta M, Seki Y, Wong SK, Wang C, Huang CK, Aly A, et al. Bariatric/metabolic surgery in the Asia-Pacific region: APMBSS 2018 survey. Obes Surg. Springer; 2018;1–8.
4. Lee WS, Choi ST, Lee JN, et al. Single-port laparoscopic appendectomy versus conventional laparoscopic appendectomy: a prospective randomized controlled study. Ann Surg. 2013;257:214–8.
5. Curcillo PG, Wu AS, Podolsky ER, et al. Single-port-access (SPA TM) cholecystectomy: a multi-institutional report of the first 297 cases. Surg Endosc. 2010;24:1854–60.
6. Champagne BJ, Papaconstantinou HT, Parmar SS, et al. Single-incision versus standard multiport laparoscopic colectomy: a multicenter, case-controlled comparison. Ann Surg LWW. 2012;255: 66–9.
7. Raman JD, Bagrodia A, Cadeddu JA. Single-incision, umbilical laparoscopic versus conventional laparoscopic nephrectomy: a comparison of perioperative outcomes and short-term measures of convalescence. Eur Urol. 2009;55:1198–206.
8. Targarona EM, Balague C, Martinez C, et al. Single-port access: a feasible alternative to conventional laparoscopic splenectomy. Surg Innov. 2009;16:348–52.
9. Hamzaoglu I, Karahasanoglu T, Aytac E, et al. Transumbilical totally laparoscopic single-port Nissen fundoplication: a new method of liver retraction: the Istanbul technique. J Gastrointest Surg. 2010;14:1035–9.
10. Saber AA, El-Ghazaly TH, Dewoolkar AV, et al. Single-incision laparoscopic sleeve gastrectomy versus conventional multiport laparoscopic sleeve gastrectomy: technical considerations and strategic modifications. Surg Obes Relat Dis. 2010;6:658–64.
11. Lakdawala M, Agarwal A, Dhar S, et al. Single-incision sleeve gastrectomy versus laparoscopic sleeve gastrectomy. A 2-year comparative analysis of 600 patients. Obes Surg. 2015;25:607–14.
12. Delgado S, Ibarzabal A, Adelsdorfer C, et al. Transumbilical single-port sleeve gastrectomy: initial experience and comparative study. Surg Endosc. 2012;26:1247–53.
13. Sucher R, Resch T, Mohr E, et al. Single-incision laparoscopic sleeve gastrectomy versus multiport laparoscopic sleeve gastrectomy: analysis of 80 cases in a single center. J Laparoendosc Adv Surg Tech. 2014;24:83–8.

14. Gomberawalla A, Salamat A, Lutfi R. Outcome analysis of single incision vs traditional multiport sleeve gastrectomy: a matched cohort study. Obes Surg Springer;. 2014;24:1870–4.
15. Porta A, Aiolfi A, Musolino C, et al. Prospective comparison and quality of life for single-incision and conventional laparoscopic sleeve gastrectomy in a series of morbidly obese patients. Obes Surg. Springer;. 2017;27:681–7.
16. Hosseini SV, Hosseini SA, Al-Hurry AMAH, et al. Comparison of early results and complications between multi-and single-port sleeve gastrectomy: a randomized clinical study. Iran J Med Sci. 2017;42:251.
17. Himpens J, Dobbeleir J, Peeters G. Long-term results of laparoscopic sleeve gastrectomy for obesity. Ann Surg. 2010;252:319–24.
18. Guidelines for Clinical Application of Laparoscopic Bariatric Surgery. Society of American Gastrointestinal and Endoscopic Surgeons (SAGES). http://www.sages.org/publications/guidelines/guidelines-for-clinical-application-of-laparoscopic-bariatric-surgery/. Accessed 26 Jan 2019.
19. Zachariah SK, Tai CM, Chang PC, et al. The "T-suspension tape" for liver and gallbladder retraction in bariatric surgery: feasibility, technique, and initial experience. J Laparoendosc Adv Surg Tech A. 2013;23:311–5.
20. Mittermair R, Pratschke J, Sucher R. Single-incision laparoscopic sleeve gastrectomy. Am Surg. 2013;79:393–7.
21. Fernández JI, Ovalle C, Farias C, et al. Transumbilical laparoscopic Roux-en-Y gastric bypass with hand-sewn gastrojejunal anastomosis. Obes Surg. 2013;23:140–4.
22. Palanivelu P, Patil KP, Parthasarathi R, et al. Review of various liver retraction techniques in single incision laparoscopic surgery for the exposure of hiatus. J Minim Access Surg. 2015;11:198–202.
23. Shi X, Karmali S, Sharma AM, et al. A review of laparoscopic sleeve gastrectomy for morbid obesity. Obes Surg. 2010;20:1171–7.
24. Gentileschi P, Camperchioli I, Benavoli D, et al. Laparoscopic single-port sleeve gastrectomy for morbid obesity: preliminary series. Surg Obes Relat Dis. 2010;6:665–9.
25. Uslu HY, Erkek AB, Cakmak A, et al. Trocar site hernia after laparoscopic cholecystectomy. J Laparoendosc Adv Surg Tech. 2007;17:600–3.
26. Marks JM, Phillips MS, Tacchino R, et al. Single-incision laparoscopic cholecystectomy is associated with improved cosmesis scoring at the cost of significantly higher hernia rates: 1-year results of a prospective randomized, multicenter, single-blinded trial of traditional multiport laparoscopic. J Am Coll Surg. 2013;216:1037–47.
27. Julliard O, Hauters P, Possoz J, et al. Incisional hernia after single-incision laparoscopic cholecystectomy: incidence and predictive factors. Surg Endosc. 2016;30:4539–43.
28. Buckley 3rd FP, Vassaur HE, Jupiter DC, et al. Influencing factors for port-site hernias after single-incision laparoscopy. Hernia. 2016;20:729–33.
29. Soricelli E, Iossa A, Casella G, et al. Sleeve gastrectomy and crural repair in obese patients with gastroesophageal reflux disease and/or hiatal hernia. Surg Obes Relat Dis. 2013;9:356–61.