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Suprapubic Single-Incision Laparoscopic Right Hemicolectomy With Intracorporeal Anastomosis

Giovanni Dapri, MD, FACS, FASMBS, HonFPALES, HonSPCMIN, HonBSS[1], Sergio Carandina, MD[1], Perrine Mathonet, MD[1], Jacques Himpens, MD[1], and Guy-Bernard Cadière, MD, PhD[1]

Abstract

Background. Single-incision laparoscopy (SIL) has gained significance recently. The umbilicus has been the preferred access site for SIL. Suprapubic access site (SAS) can be an alternative, especially for a right hemicolectomy (RH). *Methods.* Between November 2011 and July 2012, 7 consecutive patients underwent suprapubic SIL RH (SSILRH). The median age was 53 years, and the median body mass index was 23.9 kg/m^2. Indications for surgery included appendicular tumor (1) and adenocarcinoma of the right colon (6). Three reusable trocars were used, and the resection was performed through the SAS. An intracorporeal linear stapled anastomosis was performed, the mesenteric defect was closed, and the access site was used for specimen extraction. *Results.* No patient required additional trocars or conversion to an open surgery. The median laparoscopic time was 222 minutes, and the median final incision length was 50 mm. The median Visual Analogue Scale score (0-10) at 6, 18, 30, 42, 54, 66, and 78 postoperative hours was 6, 6, 2, 2, 2, 2, and 2, respectively. The median hospital stay was 4 days. *Conclusions.* SSILRH is useful because the SAS can be enlarged for extraction of the specimen without compromising the cosmetic outcome. The mesocolic and mesenteric dissections are on the same axis as the access site. The intracorporeal anastomosis can be performed without traction. Finally, positioning of the operative table improves exposure of the operative field and allows the surgeon to maneuver the colon and small bowel intracorporeally.

Keywords

single-incision, single-port, single-access, single-site, laparoscopy, right hemicolectomy, intracorporeal anastomosis

Introduction

Right hemicolectomy (RH) was first performed by laparoscopy in 1990.[1,2] The advantages of this approach include a decrease in the invasiveness of surgery, a reduction in postoperative pain, a shorter hospital stay, a lower wound complication rate, a decrease in blood transfusions, and an improvement in the quality of life.[3] Both benign and malignant diseases can be safely addressed with oncological outcomes that are similar to open surgery.[4] During laparoscopic RH, it is up to the surgeon to perform the anastomosis intracorporeally or extracorporeally.

Single-incision laparoscopy (SIL), first described in 1992,[5] remained unpopular for many years. Because of advent of Natural Orifices Translumenal Endoscopic Surgery (NOTES), SIL has recently been reconsidered as an approach and has garnered significant interest. The main advantage to SIL is the improved cosmetic outcome. However, SIL may also reduce postoperative pain, reduce abdominal trauma and adhesions, and decrease hospital stay. These potential benefits are currently under investigation. Moreover, well-informed patients are demanding a good cosmetic outcome.[6] Each incision and port site may worsen pain, may worsen the cosmetic appearance, is a potential cause of bleeding, and can lead to interfascial hematoma formation,

[1]Saint-Pierre University Hospital, Brussels, Belgium

Corresponding Author:
Giovanni Dapri, Department of Gastrointestinal Surgery, European School of Laparoscopic Surgery, Saint-Pierre University Hospital, 322, Rue Haute, 1000 Brussels, Belgium.
Email: giovanni@dapri.net

Table 1. Patient Characteristics and Demographics.

Patients	Age (years)	Sex	BMI (kg/m^2)	Indication
1	34	M	21	Appendicular mucineous tumor
2	77	F	30.4	Hepatic flexure adenocarcinoma
3	55	M	30	Ascending adenocarcinoma
4	50	M	22	Ascending adenocarcinoma
5	69	M	29.9	Ascending adenocarcinoma
6	53	M	23.9	Ileocecal valve adenocarcinoma
7	42	F	20	Ileocecal valve adenocarcinoma
Median	53	—	23.9	—

visceral injury, local nerve irritation, and incisional herniation. SIL may decrease the incidence of these complications and improve cosmetic outcomes.

Colorectal SIL was first performed in 2008.[7,8] The umbilicus has historically been the main access site for most SIL procedures because it represents the embryonic natural orifice that allows intra-abdominal access for most surgical operations. Most RHs have been performed through the umbilicus.[7-44] However, removal of the specimen requires an incision of at least 2 to 3 cm. Therefore, the suprapubic access site (SAS) can be used for access and specimen removal.[32,35,45] The SAS allows for removal of the specimen, independent of the diameter, and achieves a satisfactory cosmetic outcome because the scar is located below the bikini line. Moreover, because it is positioned in the lower quadrant of the abdomen, it remains in the same axis as the laparoscopic mesenteric and mesocolic transection. The risk of incisional hernia, which is associated with transumbilical SIL,[39] is most likely avoided during suprapubic SIL because of easier access to the fascial edges, predominance of muscle-splitting incisions, and closure of the fascia multiple layers.[46,47]

The authors report their technique and their initial experience with suprapubic SIL RH (SSILRH) using an intracorporeal anastomosis for malignant diseases of the right colon.

Methods

Between November 2011 and July 2012, 7 consecutive patients underwent SSILRH. Informed consent was obtained from all the patients. The patients understood the risks and benefits of the procedure and were informed about the possibility of adding additional ports or converting to an open surgery. Patient characteristics and demographics are shown in Table 1. Preoperative workup included hematological and biochemical laboratory evaluations, tumor markers, and thoracoabdominal CT scan.

No patient received preoperative colon preparation. Intraoperatively, 2 g of cefazoline and 500 mg of metronidazole were administered intravenously; 1 g of paracetamol was added at the end of the procedure. Postoperatively, 1 g of paracetamol was administered to patients who reported a WHO Visual Analogue Scale (VAS) pain score between 1 and 3. Patients with a VAS score between 4 and 8 received 100 mg of tramadol, and those with a VAS score between 9 and 10 received 1 mg of piritamide. Deep-vein thrombosis prophylaxis was given to all patients.

Surgical Procedure

Team, trocars, instruments, and positioning. The patient was placed under general anesthesia in a supine position and with the legs apart. An urinary catheter and nasogastric tube were inserted. The surgeon stood between the patient's legs and the camera assistant stood to the patient's left. A 3.5-cm midline transverse skin incision was made 1 cm above the pubic symphysis. The underlying fascia was divided in a transverse fashion, which exposed the rectus abdominis muscle. Anterior and posterior flaps were developed in the avascular plane separating the fascia from the underlying muscle. A purse-string suture using 1 polydiaxone (PDS) was placed in the fascia. The peritoneum was entered through the midline with a 1-cm incision, and a new purse-string suture using 1 Polyglactin (Vicryl) was placed. A reusable 11-mm trocar was inserted into both purse-string sutures to accomodate a 10-mm, 30° standard-length scope (Karl Storz - Endoskope, Tuttlingen, Germany). A 6-mm reusable flexible trocar (Karl Storz - Endoskope, Tuttlingen, Germany) was inserted at the 9 o'clock position outside the purse-string sutures (Figure 1) for the surgeon's non-dominant-hand instrument, which was the curved grasping forceps I (Figure 2A). Another 6-mm reusable flexible trocar was inserted at the 3 o'clock position outside the purse-string sutures for the surgeon's dominant-hand instruments, such as the curved grasping forceps IV (Figure 2B), curved coagulating hook (Figure 2C), curved RoBi bipolar forceps and scissors (Figures 2D-2E), curved dissecting forceps (Figure 2F), curved scissors (Figure 2G), curved needle holder I (Figure 2H), and curved suction and irrigation cannula, all from Karl Storz - Endoskope (Tuttlingen, Germany) and a straight 5-mm clip applier (Weck Hem-o-lock, Teleflex Medical, Belgium).

RH and intracorporeal anastomosis. The abdominal cavity was explored to rule out peritoneal metastases, superficial hepatic lesions, and free peritoneal fluid. The operative table was initially placed in a moderate Trendelenburg position with left-sided tilt. The transverse colon was exposed by reflecting the greater omentum, and the small bowel was gently swept out of the right

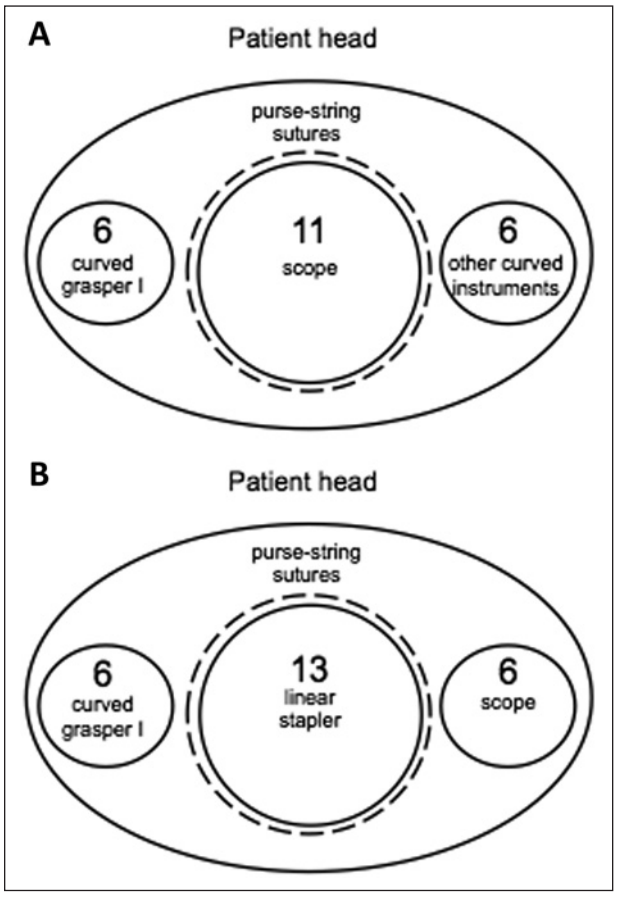

Figure 1. Placement of an 11-mm metallic trocar and two 6-mm flexible trocars through the SAS (A); interchange of the 11-mm trocar with a 13-mm metallic trocar for the stapler introduction, and use of a 5-mm scope for the anastomosis step (B).
Abbreviation: SAS, suprapubic access site.

quadrants of the abdomen, until the last bowel loop was identified. This loop was grasped with the curved grasper I, and the mesentery was separated from the peritoneal sheet using the curved coagulating hook. The ileocecal valve was freed from the parietal peritoneal sheet, and the right mesocolon was dissected using a lateral-to-medial approach. The dissection was carried superiorly, respecting Gerota's fascia, until the second and the third portions of the duodenum were identified (Figure 3A). For the mesocolic dissection, the operative table was positioned without any Trendelenburg and tilt. By grasping the mesentery (Figure 3B) and the right mesocolon (Figure 3C) with the curved grasper I, sufficient tension was applied for section, using the curved coagulating hook, RoBi bipolar forceps and scissors, respecting the limit of the superior mesenteric vein. The surgeon was able to create optimal triangulation, which allowed space to work without crossing hands or clashing instruments (Figure 3D). The ileocecal vessels, the right colic vessels, and the right branch of the middle colic vessels were exposed at their root and dissected using curved dissecting forceps. These vessels were individually clipped at their root, using a 5-mm straight clip applier and divided with curved scissors. For mobilization of the hepatic flexure, the operative table was placed in a reversed Trendelenburg position with left-sided tilt. The hepatic flexure attachments were dissected using a lateral-to-medial approach. The portion of the omentum attached to the proximal transverse colon was also dissected. For the anastomosis, the operative table was positioned in a Trendelenburg position with right-sided tilt. The 11-mm trocar was replaced with a reusable 13-mm trocar to accomodate a roticulating linear stapler (Johnson & Johnson, Ethicon Endosurgery, Cincinnati, OH). A 5-mm, 30° longer scope was inserted into the 6-mm flexible trocar at the 3 o'clock position (Figure 4A). The small bowel was divided with a linear stapler white load, and the proximal transverse colon was divided with blue loads. An intracorporeal linear, mechanical, side-to-side ileocolic anastomosis was performed. The remnant transverse colon and small bowel were placed next to each other, and a 1-cm opening was made in each lumen using the curved coagulating hook. A linear stapler blue load was inserted and fired (Figures 4B and 4C). The enterocolotomy was closed by 2 converting 2/0 PDS running sutures using the curved grasper I and the curved needle holder I (Figures 4D and 4E). The mesenteric window (between the right mesocolon and the small-bowel mesentery) was closed by a 2/0 PDS running suture.

End of the procedure. The operative table was placed without any Trendelenburg and tilt. The abdominal cavity close to the anastomosis was washed by physiological solution, and the specimen was removed through the suprapubic incision. Hence, both purse-string sutures were retrieved together with the 3 trocars. The trocar openings on the rectus abdominis muscle fascia were joined together, and a plastic ring (Vi-Drape, Medical Concepts Development, MN) was inserted into the peritoneal cavity to protect the SAS, just prior to removal of the specimen. The peritoneal sheet and rectus abdominis muscle fascia were meticulously closed with absorbable sutures, and the dermis was closed with intradermal sutures. No drains were left in the abdominal cavity. The urinary catheter and nasogastric tube were removed at the end of the procedure.

Results

Operative and postoperative outcomes are shown in Table 2. No patient required additional trocars or conversion to an open surgery. The median total operative time (between skin incision and closure of the fascia) was 256 minutes (range = 155-346 minutes), and the median laparoscopic time (from the beginning of pneumoperitoneum to the removal of instruments and trocars) was 222 minutes (range = 103-303 minutes). The median blood loss was 200 mL (range =

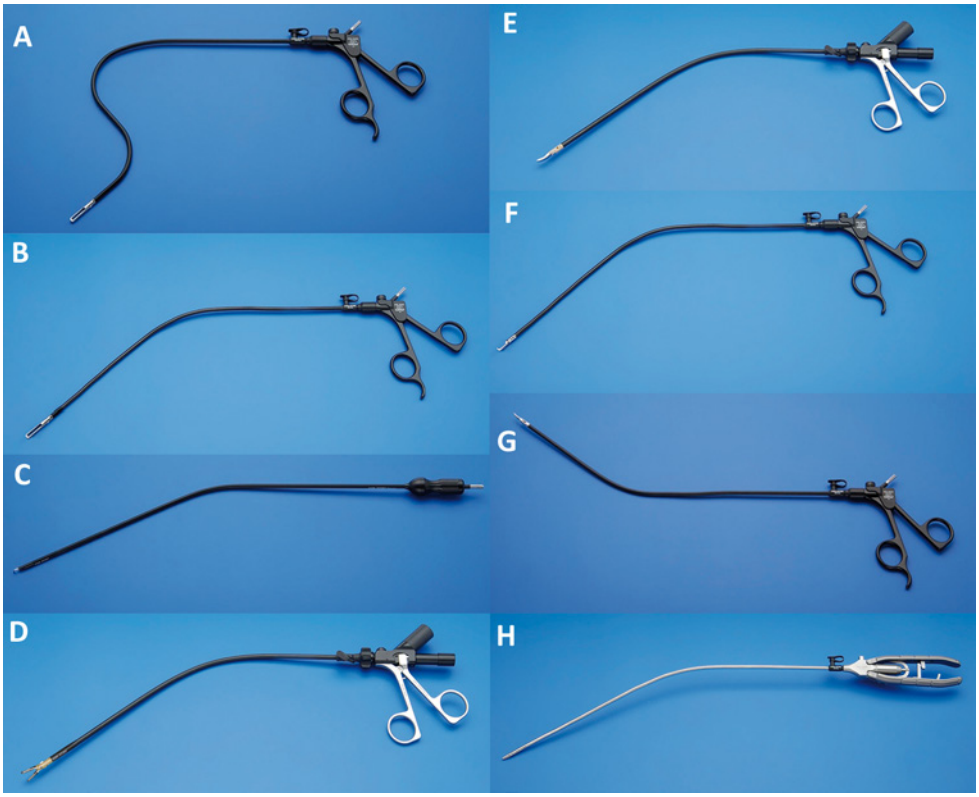

Figure 2. DAPRI curved reusable instruments (Source: Karl Storz - Endoskope, Tuttlingen, Germany). Grasping forceps I (A), grasping forceps IV (B), coagulating hook (C), RoBi bipolar forceps and scissors (D, E), dissecting forceps (F), scissors (G), needle holder I (H).

20-600 mL). The median final incision length was 50 mm (range = 35-70). During the postoperative course, 1 patient developed a leak from the ileocolic anastomosis, and 2 other patients developed a postoperative ileus. The anastomotic leak was treated conservatively and resolved with percutaneous CT scan–guided drainage and parenteral nutrition; the ileus was resolved with nasogastric tube drainage and supportive intravenous fluids. After the discharge, 1 patient developed a wound infection at the access site, which was medically treated and resolved after 2 weeks. The median VAS score (0-10) at 6, 18, 30, 42, 54, 66, and 78 postoperative hours was 6, 6, 2, 2, 2, 2, and 2 (range = 2-9), respectively. Patients were allowed oral fluid on postoperative day 1 and free light diet after passing flatus. The median length of stay was 4 days (range = 4-26 days). The median number of the lymph nodes retrieved was 22 (range = 15-47).

Discussion

The SAS has gained popularity as the site for specimen retrieval during laparoscopic colorectal surgery because of technical ease and cosmetic outcome. In the philosophy of SIL, the specimen has to be removed through the same access, but if it is either too large or too thick, the access site has to be enlarged, which jeopardizes the cosmetic outcome. As a result, a suprapubic incision should be considered as the access site for SIL procedures because it allows for the retrieval of a specimen independently of the specimen's dimensions. Furthermore, for malignant colorectal diseases, the specimen has to be removed and maintained intact for the pathological examination. Therefore, the final scar will depend on the specimen's size. Other factors that determine the length of the scar include the thickness of the mesentery and omentum, and the death of the abdominal wall.

The SAS is located under the bikini line, similar to a caesarean section incision and produces satisfactory cosmetic results even if the incision needs to be extended. Ramos-Valadez et al[30] reported that 28.6% of patients required at least a 1-cm extension of their initial incision, and a 3.5-cm extension of their incision was necessary in 60% of patients with malignant diseases and in 16% of

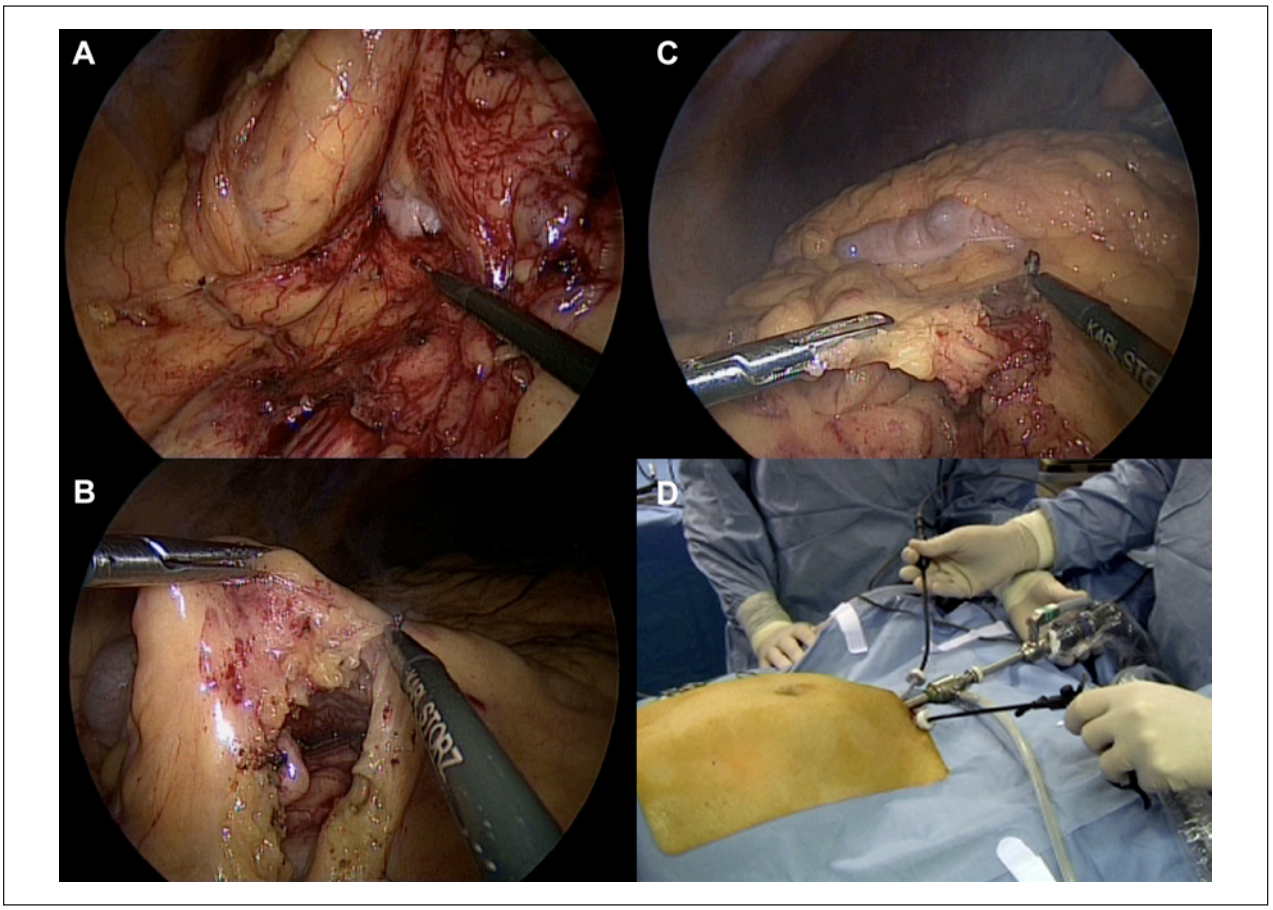

Figure 3. Because of the established intra-abdominal triangulation, the right mesocolon is freed from the Gerota's fascia and duodenum (A). The mesentery (B) and the right mesocolon (C) are dissected as well. Moreover, the surgeon works in ergonomic positions thanks to the curves of the instruments outside the access site (D).

patients with benign diseases. Chew et al[27] reported 1 case where the incision was extended to 10 cm because of tumor size. In a series reported by Baig et al,[29] 14% of patients required extension of their incision. Therefore, extending the incision allows the surgeon to maintain oncological principles of tension-free and atraumatic extraction of large and bulky colorectal specimens.[30]

During SSILRH, one of the rules of laparoscopy, which is maintaining the surgeon's head, the access site, the pathology, and the video screen on the same axis,[48] is respected. Another rule, which is to keep the optical system positioned as the bisector of the working triangulation between the 2 ancillary effectors,[49] is restored thanks to the curves of the instruments, which permitted an intra-abdominal triangulation and good external ergonomy. The only step where triangulation is not maintained is during the insertion of the linear stapler because the optic needs to be located laterally and so switched to a 5-mm scope. This strategy is based on the principle of not inserting another 11- or 12-mm trocar beside the only 11-mm trocar, placed in the center of the access. Obviously, if the 6-mm flexible trocar at the 3 o'clock position is switched to a 12-mm trocar, and the optic remains unchanged, the triangulation is completely respected also during this step. We preferred to use a 10-mm scope for the majority of the procedure because it magnifies the image and can be kept clean for a longer time than the 5-mm scope.

In the technique described above, we did not use any disposable trocars, port devices, or instruments, as is usually done during general SIL. This choice was based on the concept that SIL can be performed with reusable material, which keeps the cost of the procedure similar to the cost of multiport laparoscopy. Furthermore, the use of disposable port devices may lead to dislodgement of the port, leakage of pneumoperitoneum, or the inability to regain pneumoperitoneum after extending the incision for specimen extraction.[19,20] The available port devices frequently have to be rotated and are used with crossing or swapping operative hands.[38] We used two 6-mm reusable flexible trocars because they permitted easy insertion of curved reusable instruments into the abdomen. Unlike traditional SIL, these curved instruments allowed the surgeon to

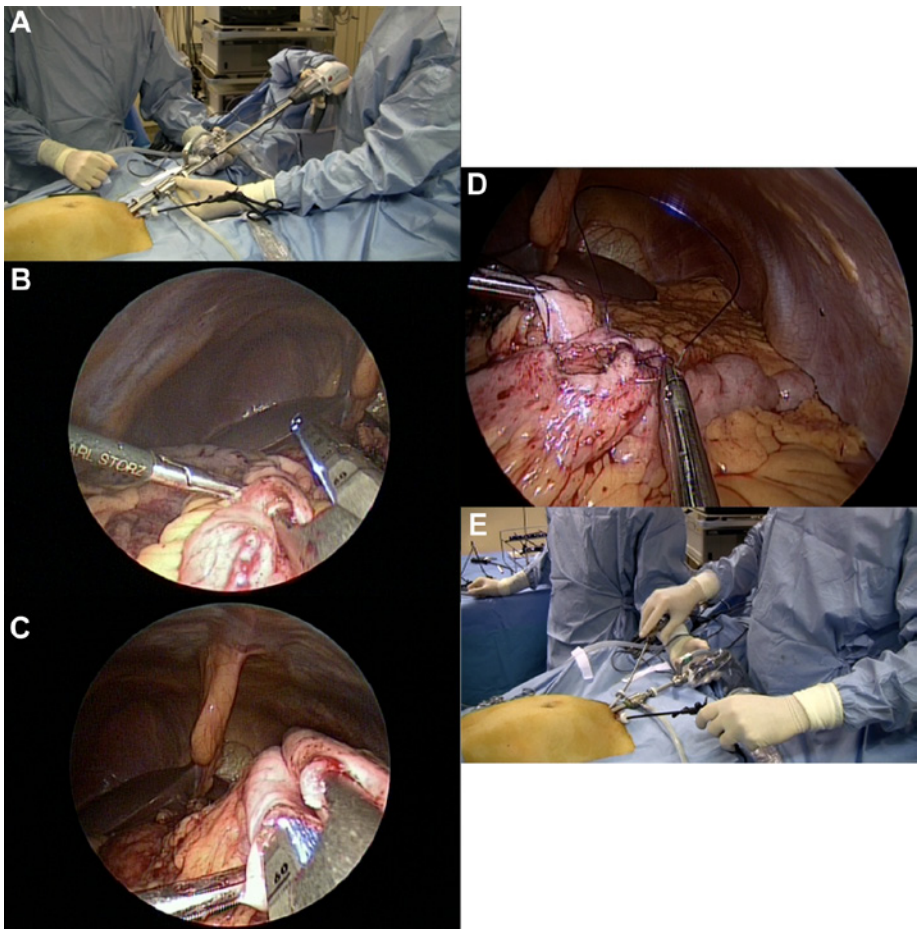

Figure 4. Intracorporeal linear mechanical side-to-side ileocolic anastomosis: the 11-mm reusable trocar is replaced with a 13-mm reusable trocar to accomodate the linear stapler, and a 5-mm, 30° longer scope is inserted through the 6-mm flexible trocar at the 3 o'clock position (A); the linear stapler is inserted into the bowel (B) and transverse colon (C) and fired; the enterocolotomy is closed with intracorporeal sutures (D) under optimal external ergonomy (E).

Table 2. Operative and Postoperative Outcomes.

Patients	Total Operative Time (minutes)	Laparoscopic Time (minutes)	Blood Loss (mL)	Final Scar Length (mm)	Length of Stay (days)	Pathology (TNM Stage)	Pathology (Number of Nodes)
1	256	222	20	35	4	pT1N0	16
2	236	207	300	70	26	pT3N0	18
3	346	303	280	50	4	pT1N0	37
4	278	240	200	45	4	pT1N0	22
5	295	266	600	65	12	pT4N1	15
6	199	163	100	55	4	pT2N0	38
7	155	133	30	50	9	pT3N0	47
Median	256	222	200	50	4	—	22

develop an intra-abdominal working triangulation without clashing instruments and crossing hands.[50] To increase mesenteric exposure, the surgeon can insert percutaneous sutures using a straight needle,[18] use extracorporeal magnetic retraction,[12] or introduce gauzes under the dissected mesocolon to prevent the bowel entering in the operative field.[12] We managed to skeletonize and clip the vessels at their origin without using linear staplers.[17,27]

The operative table can be used as a nurse-assistant by changing its position. In our technique, it was placed

in various positions during different steps of SSILRH, which helped the surgeon improve exposure. The lack of adequate exposure remains one of the main drawbacks of SIL. We found that mobilizing the hepatic flexure was the most challenging step of the procedure. However, changing the operative table position allowed us to take down the hepatic flexure successfully in all cases. The third patient in our study required an extra 50 minutes of laparoscopic time to mobilize the hepatic flexure. Other authors have confirmed that this step may require additional time for careful dissection.[33,35,40] Furthermore, this step may lead to conversion to multiport laparoscopy[35] if SIL is not performed safely.

The anastomotic technique during classic laparoscopic RH remains the surgeon's choice. For SIL, the anastomosis can be performed using an extracorporeal[7-16,19-45] or intracorporeal approach.[17,18] We preferred the intracorporeal approach because it is the technique we routinely use during multiport laparoscopic RH. In addition, it avoids traction on the mesentery at the site of specimen extraction, especially when using a SAS. We perfomed this anastomosis at the end of the procedure and before the removal of the specimen in order to avoid the risks of dislodgement trocar reinsertion and re-establishment of pneumoperitoneum.[19,27]

Unlike other authors,[13] we considered it mandatory to close the mesenteric defect in all patients to avoid the risk of internal herniation and occlusion. As described, in the multiport laparoscopic approach,[51] we did not place a drain at the end of the procedure. If a drain has to be placed,[18,42] a different abdominal scar should be used to avoid the risk of an incisional hernia.[40]

We found a difference between the total and laparoscopic times in our study. This time interval can be accounted for by the time needed to gain access to the peritoneal cavity and the time required to meticulously close the SAS at the end of the procedure. Our laparoscopic time was similar to the time reported by Uematsu et al[12] and in the interval reported for other SILs.[7-11,13-23,25-28,30-38,40-43] The operative time may have been affected by other factors. These factors include the characteristics and demographics of the patients, the surgeon's experience with laparoscopic colorectal surgery, and the realization of the anastomosis externally. Ramos-Valadez et al[19] found that patients with a BMI greater than 25 kg/m^2 had longer operating times than patients with a BMI less than 25 kg/m^2. Our third patient had an anatomical anomaly of the sigmoid colon that was seen on the preoperative CT scan. This, added to the difficulty of mobilizing the hepatic flexure, prolonged the total operative time. Compared with hand-assisted laparoscopy, SIL achieved a smaller incision length and a shorter hospital stay. However, the operative time was longer for SIL than for the hand-assisted approach.[16]

No patient in our initial experience required insertion of a supplementary trocar. Others have reported the need for additional trocars when presented with a large tumor[16] or significant intra-abdominal adhesions.[14,32] This issue emphasizes the importance of patient selection for SIL. We considered the insertion of another trocar as strategic laparoscopy for improved cosmesis (SLIC), instead of conversion to multiport laparoscopy or failure of SIL. Insertion of additional instruments for technical problems such as difficult flexure mobilization,[35] inadequate countertension,[14,32,33] difficult retraction,[11] visceral obesity,[27,28] or gas leakage[40] should be interpreted as factors related to SLIC rather than factors related to conversion. Kawahara et al[52] reported the introduction of a stapler using an additional trocar in a different quadrant. This strategy can be considered a form of SLIC. Similarly, if an ileostomy is required, the insertion of a second trocar at the beginning of SIL is advised; this additional incision can then be used for stoma placement.[45] We agree with other authors that conversion to an open procedure is a real conversion.[16,28,32,33,44]

The final scar length depends on the size of the specimen. A final scar length between 2 and 9.8 cm has been reported after SIL RH.[7-23,25-35,39-44] In a comparison of SIL versus multiport or hand-assisted laparoscopy,[26] there was a significant and direct positive correlation between the incision length and BMI for patients undergoing SIL. Furthermore, the incision length was significantly smaller during SIL than multiport or hand-assisted laparoscopy. In another study,[35] SIL resulted in a statistically higher cosmetic score than multiport laparoscopy 3 months after surgery.

In this preliminary and limited series of patients, we achieved a length of stay between 4 and 26 days. Our data were superior to the length of stay of 46 hours to 9.2 days reported after SIL RH.[7,9,10-15,18-23,26-38,40-44] The length of stay in our study reflected the incidence of postoperative complications. One patient developed a postoperative anastomotic leak that prolonged the hospital stay. Anastomotic leak is known to prolong hospital stay.[24,26,27] We treated this complication conservatively with CT scan–guided percutaneous drainage. However, some patients who develop anastomotic leak may require a reoperation.[26] As in other studies,[14,15,21,28,29,32,35,38,40,41,44] two other patients presented with postoperative ileus, which resolved with nasogastric tube drainage and supportive intravenous fluids. After the discharge, another patient developed a wound infection, as reported after colorectal SIL.[14,20,24,28,30,33,34,38,40,44] This complication was probably related to a poor 13-mm trocar cleansing after the removal of the stapler. Papaconstantinou et al[26] found a difference in surgical site infection that was not significant between SIL and multiport or hand-assisted laparoscopy but a significant lower length of stay after SIL than multiport or hand-assisted laparoscopy.

We recorded a minimal amount of postoperative pain after SIL, which was similar to findings reported by other authors.[15,34,37] Papaconstantinou et al[26] showed a significantly lower VAS pain score on the first and second postoperative day after SIL than after multiport or hand-assisted laparoscopy. Lim et al[25] reported no significant pain after the second postoperative day, and Katsuno et al[34] reported no use of analgesics after the fourth postoperative day.

Finally, we agree with other authors[10,13,33,35] that colorectal SIL is a challenging procedure. Nevertheless, we believe that it is a reasonable surgical technique for appropriately skilled surgeons who perform minimally invasive colorectal resections and who are familiar with SIL procedures.

Conclusions

SSILRH is a useful technique because the SAS can be enlarged to permit the extraction of a specimen without cosmetic consequences. Furthermore, mesocolic and mesenteric dissections can be performed along the same axis as the access site. SSILRH allows the surgeon to perform an intracorporeal anastomosis without traction. Finally, positioning of the operative table improves exposure of the operative field and allows the surgeon to maneuver the colon and small bowel intracorporeally.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: Giovanni Dapri is consultant for Storz - Endoskope, Tuttlingen, Germany.

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