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Single-incision laparoscopic colorectal surgery: a report of 33 cases in Saudi Arabia

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BACKGROUND: Single-incision laparoscopic surgery (SILS) has gained worldwide acceptance as a minimally invasive technique in colorectal procedures since its introduction in 2008. However, case series on its feasibility and safety in Saudi Arabia are lacking.

OBJECTIVE: Evaluate the operative results and clinical outcome of single-port laparoscopic procedures in colorectal surgeries.

DESIGN: Retrospective.

SETTING: This study was conducted at King Khalid University Hospital, Riyadh, Saudi Arabia.

PATIENTS AND METHODS: Demographic and clinical data, including pathology, and intraoperative and postoperative outcomes, were prospectively collected in patients undergoing SILS. This study was conducted during the period from January 2010 and October 2014.

MAIN OUTCOME MEASURES: Demographic and postoperative outcomes in patients undergoing SILS colectomies.

RESULTS: Thirty-three (33) patients underwent SILS. The mean (SD) age was 51 years (18.2 years), and the average body mass index was 26.6 (6.9) kg/m^2. Patients were primarily diagnosed with cancer (n=20/33, 61%), inflammatory bowel disease (n=12/33, 36%) and diverticulitis (n=1/33, 3%). Procedures included anterior resection (n=9/33, 27%), ileocecal resection (n=8/33 24%), hemicolectomy (n=7/33, 21%), extended right hemicolectomy (n=5/33, 15%) and total colectomy (n=4/33, 12%). The mean SD operative time was 212 minutes (76.4 minutes). The mean SD size of the extraction incision was 4.2 (1.7) cm. Six percent of the cases were converted to open (n=2/33), and 9% required placement of an extra port (n=3/33). Four (12%) patients had intraoperative complications, and 30% experienced postoperative complications. The average length of hospital stay was 6.4 (4.3) days.

CONCLUSIONS: SILS is technically feasible and safe for patients undergoing colorectal surgery with no unusual complications. However, comparative studies are necessary to validate the potential benefits of SILS over conventional colorectal laparoscopic surgery.

LIMITATIONS: The study lacked a comparison to conventional open procedures. Additionally, some evaluation criteria were not considered, including cosmesis, pain control, patient satisfaction and cost effectiveness.

Widespread innovative surgical techniques have captured the interest of surgeons throughout the world. However, the novelty of these concepts requires surgeons to carefully select patients and master the skills of the procedure. Single-incision laparoscopic surgery (SILS) is a new technique in minimally invasive colorectal surgery initially described by Remzi et al.[1] SILS enables colorectal surgeons to perform operations entirely through the patient's umbilicus or ostomy site, as an almost scarless procedure. Keller et al[2] specified that SILS is a minimally invasive platform with precise benefits over traditional multiport laparoscopic surgery. In addition, this technique may reduce trauma and postoperative pain while improving cosmesis and recovery without additional cost. Skepticism over single-port colorectal surgery has been addressed

in international case reports identifying the benefits of single-port laparoscopy, including safety, feasibility, improved cosmesis, decreased pain, and shorter length of stay.[2-5] This procedure has similar benefits in patients who have had previous abdominal surgery.[6] A meta-analysis comparing SILS with multi-port laparoscopic colectomies revealed similar safety profiles and efficacy, although the authors suggested further prospective, randomized-controlled trials.[7] However, to the best of our knowledge, no evidence-based studies have documented its technical feasibility and safety in Arab countries. This paper evaluates the operative results and the clinical outcome of single-port laparoscopic procedures in colorectal surgeries performed in a university hospital in Saudi Arabia.

METHODS

Colectomies by single-port laparoscopic surgery were performed on 33 consecutive patients between January 2010 and October 2014. Study approval was obtained from the Institutional Review Board of King Khalid University Hospital. Prospectively collected demographic and clinical data included age, gender, body mass index (BMI), diagnosis, type of surgery, estimated blood loss, operative time, and conversion to open or an additional extra port, extraction site length, and number of lymph nodes harvested. Finally, postoperative surgical outcomes, including duration of postoperative hospital stay, readmission and complications, were measured. All patients consented to a single-port incision laparoscopic approach with appropriate counseling on the potential need for additional ports as well as the possibility of conversion to an open operation.

Surgical technique

Single-port laparoscopic surgery was performed with standard laparoscopic instruments. The operation was performed through an initial 2-cm incision, primarily at the umbilicus or right lower quadrant when proximal diversion was anticipated. If the umbilicus was the site of access, it was thoroughly disinfected following infiltration with 0.5% bupivacaine, everted, and opened longitudinally (**Figure 1**) with an initial 2-cm incision through the skin and fascia. The flexible Gelport (Applied Medical, Rancho Santa Margarita, CA, USA) port was used almost universally in this series. It consists of two essential parts: the GelSeal cap, which can accommodate up to four access ports and which can be used for 5- and 12-mm trocars, has separate insufflation and ventilation attachments. It offers unparalleled access for rapid dissection and mobilization of tissue, facilitating a wide range of procedures. The second part

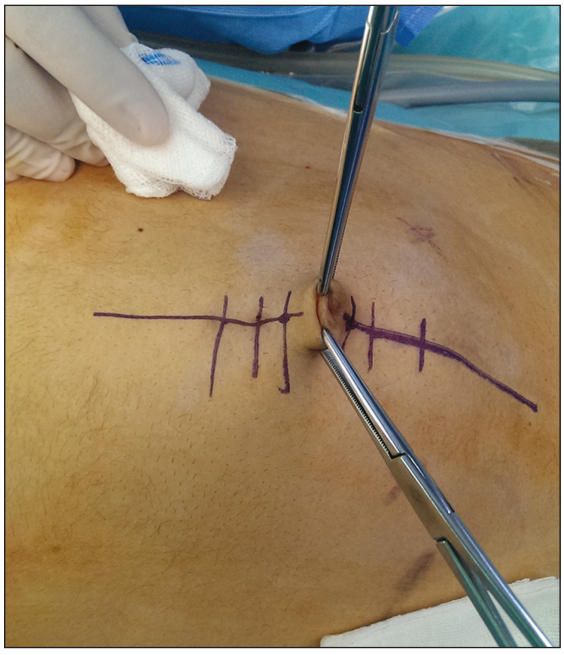

Figure 1. Pre incision markings over the umbilicus.

is the integral Alexis wound protector/retractor, which adjusts to varying abdominal wall thicknesses and incision sizes, protects the incision site and enables extracorporeal resection and specimen retrieval. After insertion of the trocars, a pneumoperitoneum was created. The Olympus 5-mm Endo-EYE 30° video laparoscope was used (Olympus Europa GmbH, Wendenstrasse, Hamburg, Germany). All mesenteric dissection, colon and small bowel mobilization, and vessel sealing was performed using straight 5-mm atraumatic graspers and the 5-mm LigaSure (Covidien, Mansfield, MA, USA). During dissection, the surgeon changed the ports used for the grasper and LigaSure device to ensure the best angles. No changes were made in the surgical technique between benign and malignant cases. The incision was enlarged for specimen removal when needed. Extracorporeal and end-to-end functional anastomoses were routinely performed for right-sided resections, whereas all left-sided anastomoses were intracorporeally performed utilizing a double-stapling technique.

For SILS right hemicolectomy, the patient was placed in a supine position and tilted to the left. The surgeon and the assistant stood on the left side with the assistant holding the camera at the head of the patient. The right colon is usually mobilized from lateral to medial by mobilizing the cecum and the terminal ileum. Dissection would continue through mobilizing the ascending, hepatic flexure, and the proximal third of the transverse colon through a sharp incision in the white line of Todd's. After this step, the patient was placed

Figure 2. Bowel specimen extracted from the umbilical port with skin protector in place.

in reverse Trendelenburg, and the terminal ileum was lifted. The dissection then occurred in a medial-to-lateral direction. The cecum was lifted, and the mesentery was divided up to the base of the ileocolic artery. The ileocolic vessels were divided using the LigaSure or an endostapler, based on the surgeon's discretion. The retroperitoneal plane was developed until the duodenum was identified. The lateral peritoneum was opened from the previous lateral dissection, which would allow for dividing the mesentery up to the middle colic artery. An opening was created in the mesentery, and the small bowel was divided using an endostapler (tri-stapling Covidien, Mansfield, MA, USA). After complete mobilization of the right colon, both ends of the bowel were grasped, and both the GelSeal cap and the specimen were removed while the skin protector remained to extract the specimen and to protect the skin from tumor contamination. If necessary, the incision was enlarged to a maximum of 4.5 cm for the externalization of the colon. A stapled end-to-end functional anastomosis was made using a 75-mm GIA stapler (Ethicon, Cincinnati, OH, USA).

For SILS sigmoid resection or low anterior resection, the patient was placed in a dorsal lithotomy position. The surgeon stood at the head end of the patient; alternatively, he stood on the right side of the camera operator when mobilizing the sigmoid and on the left side when dissecting the rectum. In the case of a long sigmoid loop, we used the fourth port to hold up and retract the redundant sigmoid loop out of the operative field by lifting it to the abdominal wall to maximize visualization. The sigmoid was mobilized from medial to lateral. The peritoneum of the mesentery was opened using the LigaSure, and the avascular plane was dissected, identifying the ureter and the gonadal vessels. The inferior mesenteric artery and vein were dissected at the origin and divided with the LigaSure. Next, the lateral peritoneum was opened along with the white line of Toldt. Depending on the distance of the tumor from the anal sphincter, the rectum was mobilized, starting with the opening of the peritoneal reflection. The mesocolon and mesorectum were divided using the LigaSure. After complete mobilization distal to the marked tumor, the bowel was transected using endostaplers. The endostapler was inserted directly through the SILS port through the 15-mm trocar. If needed, the descending colon was mobilized up to the splenic flexure to guarantee a tension-free anastomosis. The GelSeal cap was removed while the skin protector remained to extract the specimen and to protect the skin from tumor contamination (**Figure 2**). In some procedures, the incision was enlarged for retrieval of the specimen to a maximum of 5.5 cm depending on the size of the tumor or mesorectum. The anvil of the circular stapler was introduced in the proximal colon, and then the bowel was divided using staplers. The bowel was placed back into the abdominal cavity. The GelSeal cap was reintroduced. The pneumoperitoneum was reestablished, and an end-to-end anastomosis was stapled using a 31-mm circular stapler (DST series EEA stapler, Covidien, Mansfield, MA, USA). The umbilical fascia was closed using continuous looped PDS (polydioxanone) sutures (Ethicon, Cincinnati, OH, USA); the umbilicus was restored using Monocryl intracutaneous sutures (Ethicon, Cincinnati, USA).

RESULTS

Eighteen patients (54.5%) were female (**Table 1**). Ages ranged from 19-97 years old, with mean (SD) of 51 years (18.2 years). Patients had a BMI of 15-40 kg/m^2, with a mildly overweight mean (SD) BMI of 26.6 (6.9) kg/m^2, a factor identified in other SILS studies as increasing the difficulty of the procedure and lengthening the operating time.8 The majority of the patients (n=18/33,

54.5%) had an American Society of Anesthesiologists (ASA) classification of II, indicating mild systemic disease. Patients were primarily diagnosed with cancer (n=20/33, 60.6%), inflammatory bowel disease (n=12/33, 36.4%) and diverticulitis (1/33. 3.0%), which is a known risk factor for surgical complications due to post-inflammatory tissue changes.[9] The procedures performed included 9 anterior resections (27.3%), 8 ileocecal resections (24.3%), 7 hemicolectomies (21.2%), 5 extended right hemicolectomies (15.2%) and 4 total colectomies (12.2%). Procedures were performed by two surgeons well-trained in minimally invasive laparoscopic.

The mean (SD) operating time was 212 (76.4) minutes, with a duration of 115-514 minutes in all cases (**Table 2**). The average size of extraction was 4.2 cm (1.7 cm), ranging from 3-8 cm. The estimated blood loss was ranged from 0-2.3 liters, with a mean (SD) of 269 mL (400 mL). Six percent (n=2/33, 6.1%) of the procedures were converted to open, and 9.1% (n=3/33, 9.1%) required an additional port due to technical difficulties, including bleeding and adhesions. There were 6-36 lymph nodes harvested, with a mean (SD) of 17.4 (6.1). Four patients (n=4/33, 12.2%) exhibited intraoperative complications, including colonic perforation, bleeding, bowel obstruction and ureter injury.

The average length of hospital stay was 6.4 days (4.3 days) (**Table 3**). Ten patients (30%) were readmitted due to chemotherapy, 7 due to complications (21%) and 1 due to metastasis (3%). Moreover, 10 patients (30%) had post-operative complications, including 3 wound infections, 2 incisional hernias, 1 case of dehiscence, 1 anastomotic leak, 1 case of ileus, 1 case of hydronephrosis and 1 case of sepsis and acute respiratory distress syndrome (ARDS). Two of the patients died due to tumor recurrence after 10 months and 4 years of surgery, respectively. Another one patient, aged 72 years old, died due to sepsis and respiratory failure 1 month after the operation.

Table 1. Patient demographic and clinial characteristics (n=33).

Gender	
Male (n)	15 (45.5%
Female (n)	18 (55.5%)
Age (years)	51 (18.2) (range, 19-97)
BMI (kg/min^2)	26.6 (6.9) (range, 15-40)
ASA score	
I	6 (18.2)
II	18 (55.5)
III	9 (27.3)
Diagnosis	
Inflammatory bowel disease	12 (36.4)
Diverticulitis	1 (3.0)
Cancer	20 (60.6)
Type of surgery	
Ileocecal resection	8 (24.3)
Anterior resection	9 (27.3)
Extended right hemicolectomy	5 (15.2)
Hemicolectomy	7 (21.2)
Total colectomy	4 (12.2)

Data are presented as the number (%) or the mean (standard deviation).
ASA, American Society of Anesthesiologists; BMI, body mass index.

DISCUSSION

During the study period (between January 2010 to October 2014), SILS was offered to all patients undergoing colorectal operations. SILS is a significant milestone in the field of laparoscopy. It may have advantages over conventional laparoscopic surgery in terms of reduced pain, lower cost, faster recovery and cosmesis.[10] Although the disadvantages of colorectal SILS remain unclear, surgeons believe that the potential benefits outweigh the risk.

The mean operating time of 212 minutes (76.4 minutes), ranging from 115-515 minutes for the 33 cases in this study appeared to be within the range reported by Diana et al,[10] which varied greatly from 90 to >250 minutes. This time was slightly increased compared with the operating time reported by Vestweber et al. 9 in their 224 colonic resection cases (mean [SD] OR time of 166 [74] min in the overall patient population). The result is reasonable as this report of 33 cases is in the early stage of experience. Keller et al[2] stated that clinical applications of SILS continue to grow with experience and technical adaptations developing as needed to deal with a difficult patient population.

The conversion rate to open surgery in this study (6.1%, n=2/33) was quite similar to the single port procedures reported by Vestweber et al[9] (6.3%, n=14/224) and the multi-institution experience with single-incision laparoscopic colectomy reported by Ross et al (5.1%, n=2/39).[12] Additionally, 9% of patients required an additional port (n=3/33) due to the technical chal-

Table 2. Intraoperative outcomes (n=33).

Operating time (minutes)	212 (76.4) (range, 155-514)
Size of extraction (centimeters)	4.2 (1.7) (range, 3-8)
Estimated blood loss (mL)	269 (400) (range, 0-2300)
Conversion to open	2 (6.1)
Extra port	3 (9.1)
Harvested lymph nodes	17.4 (6.1) (range, 6-36)
Intraoperative complications	**4 (12.1)**
Colonic perforation	1
Bleeding	1
Bowel obstruction	1
Ureter injury	1

Data are presented as the number (%) or the mean (standard deviation).

Table 3. Postoperative outcomes (n=33).

Length of stay (days)	**6.4 (4.3)**
Readmission	
Due to chemotherapy	10 (30.3)
Due to complications	7 (21.2)
Due to metastasis	1 (3.0)
Postoperative complications	**10 (30.3)**
Incisional hernia	2
Wound infection	3
Wound dehiscence	1
Anastomotic leak	1
Ileus	1
Hydronephrosis	1
Sepsis/ARDS	1

Data are presented as the number (%) or the mean (standard deviation).

lenges brought about by complicated patient cases. This intraoperative performance indicator is comparable with other studies,[9,12-13] where supplementary ports were used in difficult cases as needed for a safer operation.

The mean length of hospital stay among these patients was 6.4 (4.3) days. This finding is consistent with the reported mean hospital stay of 2 to 6 days in other studies.[6,7] However, the health care delivery system in Saudi Arabia is a national health service and is free of charge, so there is a tendency for patients to stay longer in the hospital.[14] Two of the patients developed an incisional hernia postoperatively. A longer incisional length in the port site was believed to increase the tendency toward wound herniation.[15] However, no study to date has reported the long-term results of late wound herniation.[16]

Geisler and Garrette[17] suggested that a minimally invasive approach to colorectal diseases like SILS could have oncologic consequences. However, a systematic review of the literature by Maggiori et al[16] demonstrated the technical feasibility of the procedure even in more complex surgeries, such as colorectal resection; they found that the procedure is suitable for colonic cancer surgery in carefully selected patients and with resection margins respecting oncological principles. The average number of harvested lymph nodes was 17.4 (6.1), closely similar to that reported by Al Sabah[18] and a little less than the 25.3 reported by Woo et al.[11] The result should remind all surgeons to keep in mind oncological principles during margin resection.

A meta-analysis suggested that when compared with multi-port laparoscopic surgery, SILS is associated with a similar postoperative morbidity.[15] This means that none of the reviewed studies reported an increased morbidity incidence with this method of surgery. In our study, 30.3% had postoperative complications, which is comparable to other studies[8,19] and suggests that SILS is a safe and feasible alternative to conventional laparoscopic surgery. The incidence of wound infection in three of the patients dictates the need to intensify preventive strategies for surgical site infection. Postoperative incisional hernia in two patients suggests the importance of safeguarding the abdominal wall and peritoneum during closure. Baig[5] stated that SILS provides a lower incidence of incisional and adhesional complications.

A limitation of this study is the lack of direct comparison with conventional open and traditional laparoscopic procedures. Additionally, some evaluation criteria were not considered, including cosmesis, pain control, patient satisfaction and cost effectiveness. According to Maggiori et al,[15] one of the pitfalls of SILS is an increase in the need for equipment and a consequent increase in cost. Metzger[20] agreed that this aspect is an important issue in the future with expected health care developments.

In conclusion, SILS is technically feasible and safe for patients undergoing colorectal surgery. There are no unusual surgical complications. In the future, com-

parative studies will be necessary to validate the potential benefits of SILS compared with conventional open and laparoscopic colorectal surgery.

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