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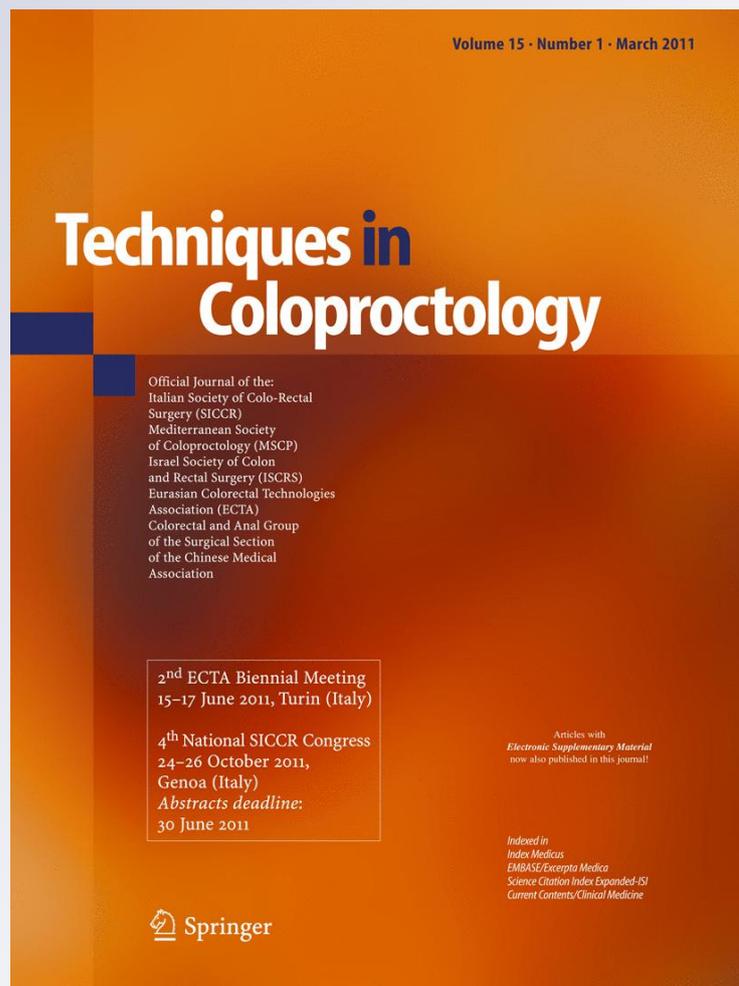
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Single-incision laparoscopic colectomy: a novel approach through a Pfannenstiel incision

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Abstract

Background Single-incision laparoscopic colectomy is evolving as a safe and feasible approach for the management of various diseases of the colon and rectum. The modality affords completion of “scarless” surgery through a transumbilical incision; however, this approach is associated with several limitations when performing colorectal procedures involving the pelvis. Collinear alignment of the camera and instruments through a single umbilical incision results in restricted visualization, inadequate dissection and mobilization, and the potential for inadvertent injury. We have developed an innovative approach utilizing a Pfannenstiel incision for single-incision access to the pelvis.

Methods Single-incision laparoscopic colon resection was performed using a single-access device placed through a mini-Pfannenstiel incision.

Results Three consecutive patients underwent single-incision laparoscopic anterior rectosigmoid resection for recurrent diverticulitis through a 4-cm Pfannenstiel incision. The procedures were performed at 150, 180, and 195 min with an estimated blood loss of 50, 150, and 75 mL, respectively. The resected specimen lengths were 10.5, 20.2, and 15.0 cm, respectively. There were no conversions to multi-port laparoscopic or open surgery. The

length of hospital stay was 4 days for patients 1 and 2, and 3 days for patient 3. There were no major complications or readmissions during postoperative follow-up.

Conclusion Single-incision laparoscopic anterior rectosigmoid resection for diverticulitis can be performed successfully through a Pfannenstiel incision. This approach facilitates direct visualization and access for rectal and pelvic dissection while maintaining adequate exposure to the left colon and splenic flexure during the procedure.

Keywords Colectomy · Colorectal surgery · Laparoscopic surgery · Single-incision laparoscopic surgery · Minimally invasive surgical procedures · Colonic diverticulosis

Introduction

Single-incision laparoscopic surgery (SILS) is emerging as a safe and feasible approach for the surgical treatment of benign and malignant diseases of the colon and rectum. The technique facilitates completion of a laparoscopic procedure through a single “hidden” transumbilical (TU) incision, resulting in better cosmetic results [1]. Following our initial experience with SILS right hemicolectomy (RH) [2], we have expanded the application of this technique to more complex colorectal procedures, such as sigmoid colectomy (SC), anterior rectosigmoid resection (AR), and total colectomy (TC). Although these advanced procedures have been successfully completed with the TU-SILS approach [3–10], we encountered several limitations in those portions of the procedures involving the rectum and rectosigmoid. To overcome these limitations and gain optimal access and exposure for pelvic dissection, we implemented a novel approach to perform the

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single-incision procedure through a modified Pfannenstiel incision. We report our initial experience and outcomes with this approach.

Materials and methods

This study was approved by the Institutional Review Board. Three consecutive patients presented following repeated episodes of recurrent or complicated diverticulitis requiring hospitalization over the last 3 years. Colonoscopy and computed tomography (CT) scanning confirmed the diagnosis. Each patient provided written consent and was scheduled for a single-incision laparoscopic resection for recurrent diverticulitis. The procedures followed in this study were in accordance with the Helsinki Declaration of 1975. The procedures were performed by a board-certified colon and rectal surgeon (E.M.H.) using the GelPOINT™ Advanced Access Platform (Applied Medical, Rancho Santa Margarita, CA, USA), a 30° 5-mm laparoscopic camera with a right-angle light cord adaptor (KARL STORZ Endoscopy, El Segundo, CA, USA), and non-articulating standard and bariatric length laparoscopic instruments.

Operative technique

The patient was placed in a modified lithotomy position with 10° of hip flexion. A 4-cm transverse skin incision was made in the midline 2 cm above the pubic symphysis. The underlying fascia was divided in a transverse fashion exposing the rectus abdominis muscle. Anterior and posterior flaps were developed in the avascular plane, separating the fascia from the underlying muscle. The peritoneum was entered through the midline and an Alexis® wound retractor (Applied Medical, Rancho Santa Margarita, CA, USA) was inserted. Three 5-mm trocars were placed in a triangular fashion on the GelSeal® cap (Applied Medical, Rancho Santa Margarita, CA, USA) of the GelPOINT™, and the cap was connected to the Alexis® wound retractor.

Pneumoperitoneum was established, and laparoscopic exploration was performed. The patient was placed in a steep Trendelenburg position with their left side elevated for the pelvic portion of the procedure. The surgeon and assistant were positioned on the right side of the patient with the GelPOINT™ device orientated accordingly (Fig. 1). The small bowel was gently swept out of the pelvis, and the rectosigmoid colon was retracted for countertraction. The avascular presacral plane was entered and established in a medial-to-lateral fashion. The pelvic splanchnic nerves, left ureter, and left gonadal vessels were identified and preserved. The superior rectal artery was then identified and divided just beyond its origin from the inferior mesenteric artery.

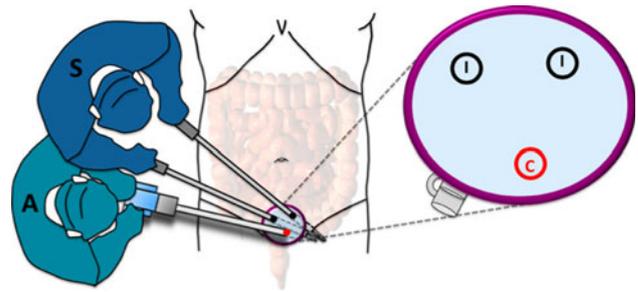


Fig. 1 Orientation of GelPOINT™ device for rectal or rectosigmoid dissection; (A) refers to the assistant, (C) refers to the camera port, (I) refers to the instrument ports, and (S) refers to the surgeon

The device was subsequently rotated 180° to facilitate optimal placement of the instruments and camera, and the surgeon and assistant exchanged positions (Fig. 2). The divided pedicle was elevated, and the avascular retroperitoneal plane was established medially to the level of the ligament of Treitz, superiorly to the inferior border of the pancreas, and laterally to the peritoneal reflection. The lateral peritoneal reflection was divided in a lateral-to-medial fashion up to the level of the splenic flexure. In the second and third cases, splenic flexure takedown was performed with entry into the lesser sac in a lateral-to-medial fashion. In both of these cases, the inferior mesenteric vein was divided adjacent to the ligament of Treitz. The patient was placed in a reverse Trendelenburg position as needed to assist with small-bowel retraction.

For the final steps of the procedure, the GelPOINT™ was rotated 180° to provide access to the rectum (Fig. 1).

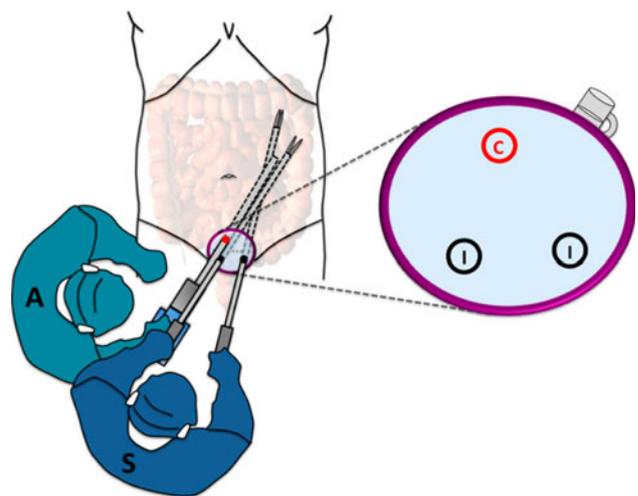


Fig. 2 Orientation of GelPOINT™ device for mobilization of the left colon and splenic flexure (when needed); (A) refers to the assistant, (C) refers to the camera port, (I) refers to the instrument ports, and (S) refers to the surgeon

The intraperitoneal portion of the rectum was mobilized posteriorly in the avascular presacral plane along the fascia propria of the rectum and laterally down to the level of the anterior peritoneal reflection. The mesorectum was divided using an ENSEAL[®] tissue sealing device (Ethicon Endo-Surgery, Cincinnati, OH, USA) at the level of the sacral promontory, followed by division of the rectum just beyond the confluence of the tenia coli using an Echelon[™] Flex 60 Endopath[®] stapler (Ethicon Endo-Surgery, Cincinnati, OH, USA).

The bowel was extracorporealized through the Alexis[®] wound retractor and divided proximal to the diseased segment, and a purse-string suture was placed to secure the anvil of an ECS29 circular stapling device (Proximate[®] ILS, Ethicon Endo-Surgery, Cincinnati, OH, USA). The bowel was returned to the abdomen, pneumoperitoneum was re-established, and a primary end-to-end circular stapled colorectal anastomosis was fashioned. Two intact donuts and a negative air insufflation test confirmed the integrity of the anastomosis. The port was removed, pneumoperitoneum was released, and the incision was closed in a layered fashion.

Results

Three consecutive patients successfully underwent single-incision laparoscopic anterior rectosigmoid resection for recurrent diverticulitis utilizing a single-access port placed through a modified 4-cm Pfannenstiel incision. The patients were 64, 50, and 66 years old with body mass indices (BMI) of 23.1, 35.3, and 24.2 kg/m², respectively. No intraoperative complications were encountered. The procedures were completed in 150, 180, and 195 min with an estimated blood loss of 50, 150, and 75 mL, respectively. The resected specimen lengths were 10.5, 20.2, and 15.0 cm, respectively. There were no conversions to multiport laparoscopic or open surgery. Patient 2 required a diverting loop ileostomy due to the presence of a peridiverticular abscess cavity.

Each patient had an uncomplicated postoperative course. Return of bowel function, as evidenced by passage of flatus, occurred on postoperative day 2 in all patients. The length of hospital stay was 4 days for patients 1 and 2, and 3 days for patient 3. At two-week postoperative follow-up, no patients reported complications. There were no surgical site infections or anastomotic leaks. On examination, a small hematoma was noted at the surgical incision of patient 1. The hematoma was drained in the office without complication. None of the patients required reintervention or readmission. Patient 2 underwent laparoscopic ileostomy takedown without complications 2 months after the initial procedure.

Discussion

Sustained interest in improving surgical techniques and patient outcomes has been essential in fueling innovation in minimally invasive surgery. Recent improvement in the access devices and the instrumentation available for SILS has fostered increased exposure to and application of the single-incision approach. Several published series have demonstrated the safe and feasible application of the transumbilical SILS technique in colorectal surgery, including RH [2–10], SC [11–16], and AR [17]. In some of these reports and in our own experience, performance of SILS through TU access has several limitations, most pronounced during the pelvic portions of the procedure.

During single-incision laparoscopic rectal and rectosigmoid procedures, collinear alignment of the camera and instruments through a single umbilical incision results in restricted visualization, especially beyond the level of the sacral promontory where the sacrum curves downwards and backwards. Collinear alignment also restricts the surgeon's ability to divide the rectum and mesorectum in a tangential fashion. With this configuration, there is a tendency to create oblique angles of dissection and division. Furthermore, inadequate reach, angulation, and clashing of instruments may result in inadvertent tearing of the mesentery and traction injury of the bowel. Thus, the portions of the procedure involving the rectum and pelvic structures tend to be the most challenging when performed through the transumbilical approach.

The utilization of a Pfannenstiel incision as our point of access helped overcome many of these limitations, affording direct visualization beyond the sacral promontory and optimizing reach and angulation of the instruments during rectal dissection. We were able to approach the rectal portion of the procedure with much more ease than when using the TU approach. However, close proximity of the Pfannenstiel incision to the sacral promontory resulted in a limited field of view when operating directly beneath the single-port device. In this field of view, the visualization was maximized by using a 30° camera angled in a nearly perpendicular fashion to the axis of the patient. When operating in the pelvis, along the left colon, or near the splenic flexure, the camera was maneuvered in a tangential manner to provide a much wider field of view. The Pfannenstiel incision may also confer several benefits to the patient, including reduced morbidity [18, 19], diminished perioperative pain [20], and a lower rate of incisional herniation [21]. In addition, some patients prefer the cosmetic results of this incision as it is made below the waistline.

Flexible or articulating instruments were not required for the completion of any of these procedures, and this was

consistent with our previous experience with transumbilical single-incision technique [2]. A right-angle light cord adaptor was utilized in each procedure, as well as a long-shaft laparoscope, to limit potential clashing between instruments during camera movements. Two of the cases required splenic flexure takedown for adequate tension-free anastomosis. We found it necessary to use bariatric length instrumentation (supplementing length by 10–12 cm) to adequately reach the region of the splenic flexure. Gaining access to the splenic flexure also necessitated repositioning of the patient in the reverse Trendelenburg position with their left side elevated. With these modifications, take down of the splenic flexure was completed without any additional degree of difficulty and within a reasonable time frame of 35–45 min (in patients with a BMI of 24.2 and 35.3 kg/m²).

Three consecutive patients underwent single-incision laparoscopic resection for recurrent (or complicated) diverticulitis through a mini-Pfannenstiel incision. A second incision was necessary for a diverting loop ileostomy in the second case due to the presence of a peri-diverticular abscess cavity. In cases where it is known that an ileostomy will be required, placement of a second port through the predetermined ostomy site may be considered as it could be utilized for additional instrumentation without worsening the final cosmetic result. However, in our case, the decision to create an ileostomy was not made until the end stages of the procedure, and addition of a supplementary port was not required.

This procedure was attempted only in patients presenting with benign disease in order to specifically evaluate its safety, feasibility, and limitations during our initial experience. Although ours was a small series, the technique afforded optimal access to multiple quadrants, resulting in quality early outcomes without added morbidity. We believe that principles of oncologic resection, such as high ligation of the vascular pedicle and wide mesenteric resection, may be maintained with this technique. However, this approach in patients with a significant inflammatory response such as that associated with colovesical fistula or phlegmon, bulky tumors, and malignant disease of the middle or lower rectum will present additional challenges. Further evaluation through increased experience and comparative studies is warranted to elucidate additional advantages and limitations of the Pfannenstiel approach in a wider range of disease processes.

Conclusion

Single-incision laparoscopic anterior rectosigmoid resection can be achieved through a Pfannenstiel incision. The incision facilitates direct visualization of and access to the

rectal portion of the dissection while still providing an optimal approach to the left colon. When required, mobilization of the splenic flexure may be achieved through use of bariatric length instrumentation. Our early experience with this novel approach has resulted in quality patient outcomes. Additional advantages and limitations will be discovered as we expand the use of this technique.

Conflict of interest The authors of this manuscript have no financial relationships to disclose. The authors have full control of all primary data and agree to allow the journal to review their data if requested.

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