Laparoscopic Anterior Resection

Elaine Hui Been Ng, Yeen Chin Leow,
and William Tzu-Liang Chen

Introduction

The first radical rectal surgery was first performed by Sir William Ernest Miles with a permanent stoma in 1907 while restorative rectal resection was introduced in 1948 by Claude F Dixon. The evolution of using surgical staplers in 1972 by Mark Mitchell Ravitch, doubling stapling technique by Knight and Griffen in 1980 as well as the development of coloanal anastomosis, intersphincteric dissection, and colonic-pouch anal anastomosis by Parks, Larzothes, and Parc respectively between 1980 and 1986 allows more opportunities for restorative resections for low rectal tumors. The concept of Total Mesorectal Excision (TME) with sharp dissection under direct vision and gentle continuous traction by RJ Heald [1] heralded the major milestone in modern rectal cancer surgery in significantly reducing local recurrence and improving patient outcomes. Although laparoscopic surgery began in the 1980s, the first laparoscopic colonic surgery was only performed in 1991. Laparoscopic rectal resection according to the principles of TME has been performed increasingly since with a few randomized controlled clinical trials (CLASICC, COLOR II, ACOSOG Z6051, ALaCaRT) [2–7] demonstrating significantly better postoperative pain, shorter hospital stay, and improved quality of life with controversial but mostly comparable short- and intermediate-term oncological outcomes.

E. H. B. Ng
Colorectal Surgery Unit, Department of Surgery, Hospital Raja Permaisuri Bainum, Ipoh, Malaysia

Division of Colorectal Surgery, Department of Surgery, China Medical University Hospital, Taichung, Taiwan

Y. C. Leow
Division of Colorectal Surgery, Department of Surgery, China Medical University Hospital, Taichung, Taiwan

Colorectal Surgery Unit, Department of Surgery, Hospital Sultanah Bahiyah, Alor Star, Malaysia

W. T.-L. Chen (✉)
Division of Colorectal Surgery, Department of Surgery, China Medical University Hsinchu Hospital, Zhubei City, Hsinchu County, Taiwan
e-mail: wtchen@mail.cmuh.org.tw

Indications

The most common indication is for resection of sigmoid and rectal tumors as long as a negative distal resection margin and adequate postoperative anal sphincter integrity can be preserved. Other indications include large rectal polyps not amenable to other excisional techniques, severe pelvic inflammation or infection causing refractory rectal stricture, severe pelvic endometriosis, salvage prostectomy for benign causes (rectovaginal or rectourethral fistula) with failure of all other treatment modality, secondary tumor by direct invasion, presacral tumors, and rectal trauma.

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Contraindications

Absolute contraindications are inability to tolerate prolonged pneumoperitoneum in a Trendelenburg position especially for patients with cardiac failure or severe pulmonary disease, hemodynamic instability, or cases of compromised oncological safety (sphincter, pelvic floor, sacral, and/or pelvic side wall invasion). Relative contraindications would be dependent on the skills of the surgeon and patient characteristics that may prohibit a laparoscopic approach including bulky rectal tumors requiring en bloc multivisceral resection, morbid obesity, severe adhesions, pregnancy, and bowel obstruction.

Preoperative Assessment

Postoperative expectations of pelvic organ function including infertility and possibility of stoma must be discussed as anatomical restoration in low rectal resection may not be functionally acceptable for certain patients because of their lifestyle or occupation.

A routine anesthetic assessment is performed prior to surgery. Preexisting anal sphincter function and previous trauma including perianal surgery must be elicited. Digital rectal examination is mandatory to assess the preexisting anal tone, sphincter integrity, distal margin of rectal tumor focusing on proximity to the sphincters and pelvic floor muscles, and possibility of invasion to adjacent structures. A complete preoperative colonoscopy is mandatory to exclude synchronous proximal lesions and biopsy the tumor (tattoo if small). Complete TNM staging with appropriate locoregional imaging is necessary to guide the optimal treatment approach. Computed tomography (CT) is used for the assessment of distant metastases and magnetic resonance imaging (MRI) is the current gold standard for preoperative T- and N-stage evaluation for rectal tumors as well as assessment for invasion into sphincters and pelvic floor [8].

Preoperative oral bowel preparation for rectal surgery has been controversial but the current ASCRS recommendation for elective surgery is for preoperative oral antibiotics in combination with mechanical bowel preparation [9].

OT Setup and Techniques

The patient is placed in the modified lithotomy position with both legs on adjustable stirrups. Both arms are tucked in. A Trendelenburg position is utilized to gravitationally move the omentum and bowels cephalad for unobstructed access to the pelvis. Tilting the patient to the right allows unhindered access to the regions of the inferior mesenteric artery and vein, left mesocolon, left retroperitoneum, splenic flexure, and left colon (Fig. 1).

The surgeon (S) stands on the right side of the patient with the camera assistant (C) beside the surgeon. The first assistant (F) stands on the left side of the patient (Fig. 2). The monitor screens (M) are placed on the left side of the patient with flexible mobility between the cranial and caudal end as required.

(a) **Placement of Trocars**

We use an open technique to insert the 12 mm trocar for the telescope at the umbilical region, favoring the supraumbilical position. Additional varying number of working trocars are placed under direct visualization. We use the 5-trocar technique—Fig. 3. A high anterior resection may not require the fifth port. The second port at RLQ (two

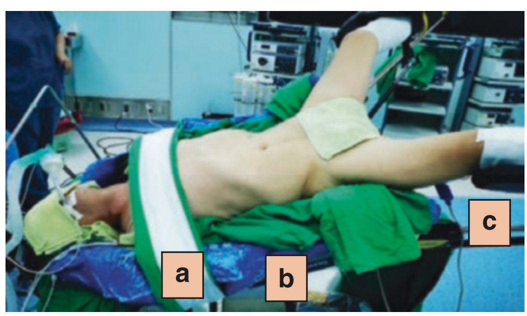

Fig. 1 Patient is strapped to the table with a chest strap (**a**) and mouldable bean bag (**b**), both legs in adjustable stirrups (**c**) to prevent truncal sliding in the Trendelenburg position with right table tilt

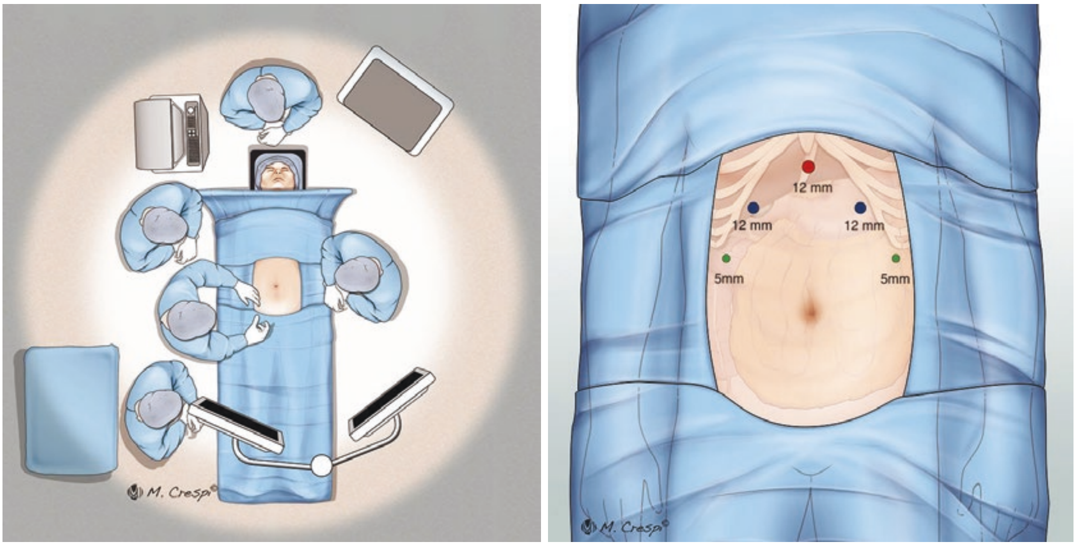

Fig. 2 OT setup and port placement

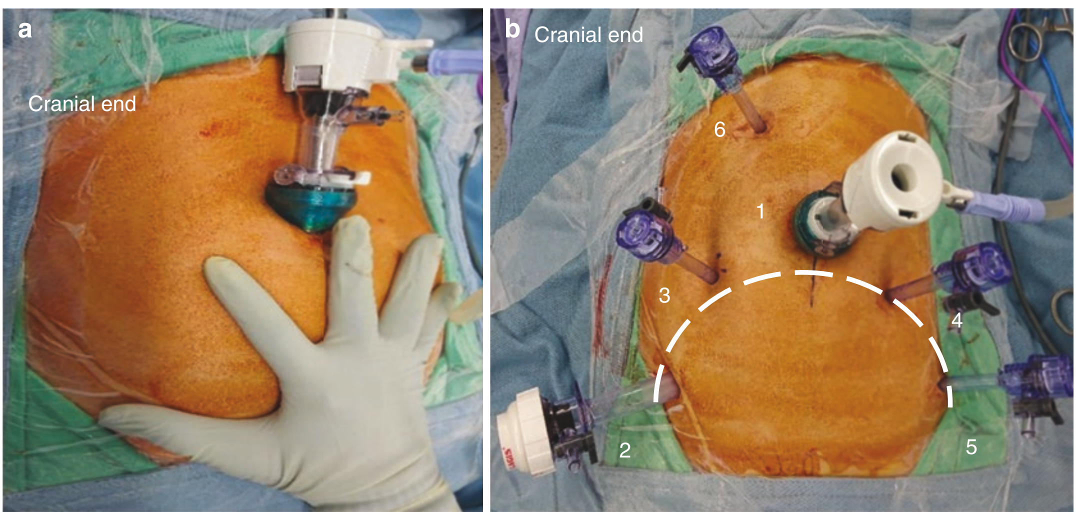

Fig. 3 Placing the palm with the wrist on the symphysis pubis and fingers spread open on an insufflated abdomen (**a**) can guide the positions of the trocars (**b**) placed on a semi-circular line with the left trocars as mirror trocars of the right

fingerbreadths anterior to the ASIS) is a 12 mm access port for the endoscopic stapler. The left-sided trocars are mirror trocars of the right. An additional sixth trocar at the RUQ is used to access the lesser sac and aid splenic flexure mobilization.

(b) **Medial-to-lateral mesocolic dissection, IMA division**

Pneumoperitoneum is created at 10–15 mm Hg and abdominal cavity is inspected for metastases. The sigmoid colon is retracted anteriorly out of the pelvis. Dissection begins at the level of sacral promontory and continued cephalad towards the ligament of Treitz, anterior to the aorta. An avascular plane is created beneath the SRA arch to separate the left mesocolon from the posterior retroperitoneal fascia in a medial-to-lateral fashion all the way to the left lateral peritoneal reflection (Fig. 4). An alternative

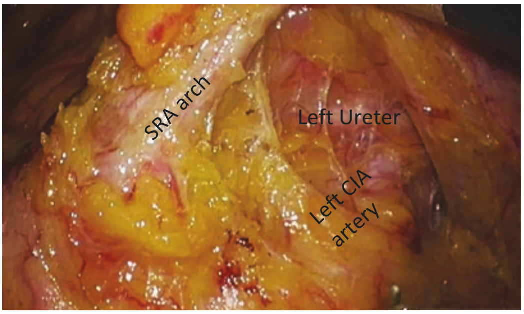

Fig. 4 Medial-to-lateral dissection (arrow) with the SRA arch being retracted anteriorly and the retroperitoneal fascia and structures being swept posteriorly

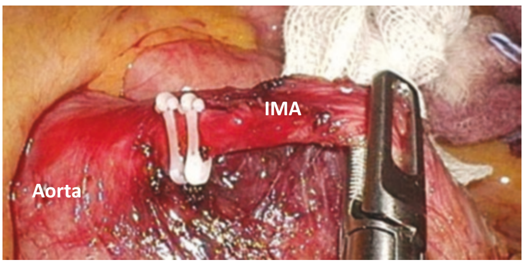

Fig. 5 IMA ligation—clips placed proximally at the root, 2 cm distal to the aorta, after adequate skeletonization

lateral-to-medial approach is used if this approach becomes difficult, especially in obese patients.

High ligation of the IMA requires exposure of the root of the IMA and ligating it at 1–2 cm from the aorta. The IMA can be divided between clips or with a linear vascular stapler/vessel-sealing device—Fig. 5.

(c) **Inferior Mesenteric Vein (IMV) Division and Access to Lesser Sac, Splenic Flexure, and Lateral Colonic Mobilization**

The dissection continues superiorly along this avascular plane all the way to the inferior border of the pancreas and ligament of Treitz with a high IMV ligation at this position (Fig. 6). Transverse colon is then retracted anteriorly adjacent to the ligament of Treitz to divide the root of the transverse mesocolon anterior to the pancreas to enter the lesser sac (Fig. 7a). Pancreaticocolic ligaments are divided, taking care to avoid

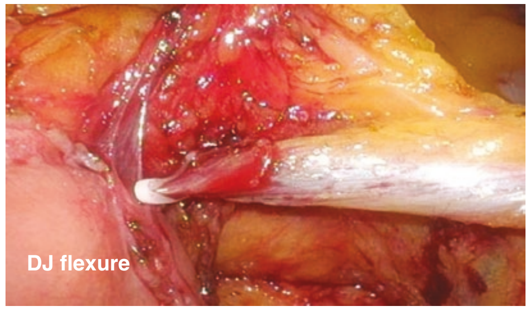

Fig. 6 IMV ligation, lateral to the ligament of Treitz, below the inferior border of the pancreas

the marginal artery. Transverse colon is retracted caudally to divide the gastrocolic ligament (Fig. 7b) to meet the dissection plane in the lesser sac. Left colonic and splenic flexure mobilization is completed with the division of the remaining lateral peritoneal attachments and splenocolic ligaments (Fig. 7c, d).

Alternatively, a reversed lateral-to-medial splenic flexure mobilization can be used to enter the lesser sac but it is technically more difficult and has a higher chance of pancreatic injury.

(d) **Pelvic Dissection:Total Mesorectal Excision (TME) and Bowel Transection**

Sigmoid colon is retracted cephalad and anteriorly to identify the retrorectal space. The posterior rectal mobilization is carried out with sharp dissection preferably with monopolar electrocautery along the avascular areolar plane between the visceral and parietal endopelvic fascia while simultaneously maintaining gentle continued traction of the rectum anteriorly all the way to the pelvic floor (Fig. 8a, b). A tape can be used to aid rectal retraction during the TME (Fig. 8c). The dissection continues in the same plane bilaterally (Fig. 8d, e) and anteriorly along the Denonvillier's fascia (Fig. 8f) down to the pelvic floor. Be wary not to injure the parasympathetic nervi erigentes (S2 to S4) from overzealous lateral dissection beyond the mesorectal fascia. Coordinated planar tractions and counter tractions are needed for

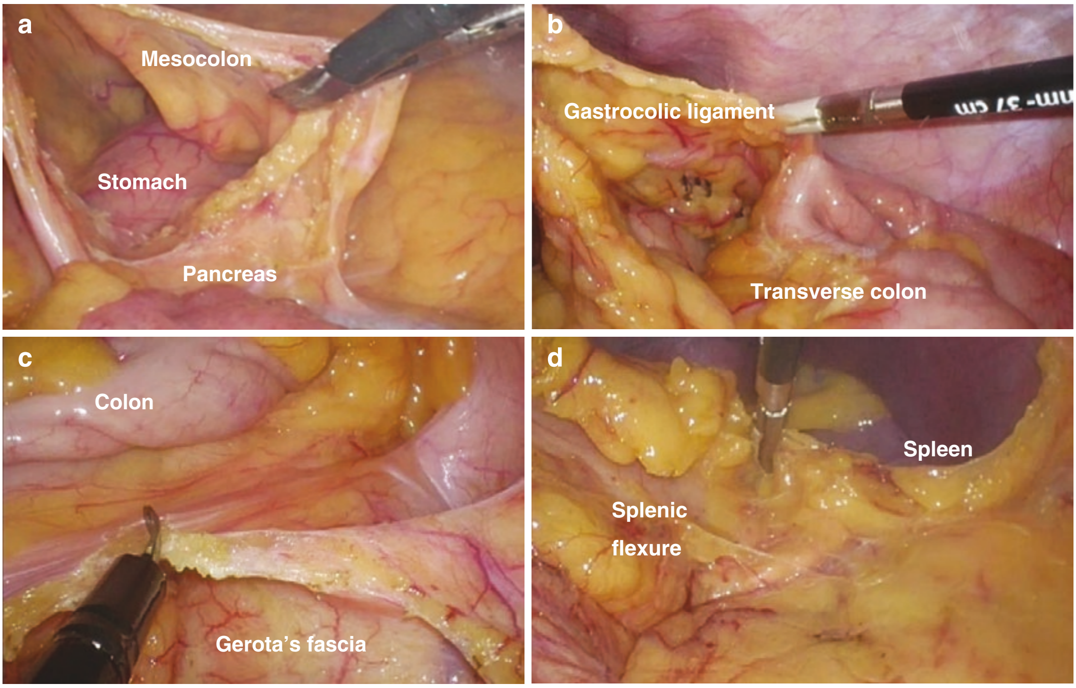

Fig. 7 (**a**) Entering lesser sac. (**b**) Division of gastrocolic ligament. (**c**) Dividing lateral peritoneal attachment. (**d**) Dividing splenocolic ligament

accurate TME dissection. The level of rectal transection is then confirmed by digital rectal and/or endoscopic examination after a complete circumferential TME. The rectum is irrigated, stapled, and divided with an endoscopic stapler (Fig. 9).

The mesocolon is divided intracorporeally. A grasper holding the proximal bowel presents the specimen at the extraction site for exteriorization (Fig. 10a). Anvil of the circular stapler (at least 28 mm) is anchored in the conduit with a purse-string suture after transection (Fig. 10b). The colon is returned to the abdomen and the extraction site is temporarily closed for re-pneumoperitoneum in preparation for intracorporeal anastomosis.

(e) **Anastomosis**

The rectal stump is transfixed with the tip of the head of the circular stapler while the posterior vaginal wall/prostate is retracted anteriorly to avoid inclusion into the stapler line. The colonic mesentery is checked for twisting before firing the stapler. The integrity of the anastomosis is assessed by visually verifying the completeness of the proximal and distal donuts, performing an air insufflation test and endoscopic evaluation of the anastomotic stapling line. Several intracorporeal stapled anastomotic techniques other than end-to-end anastomosis (ETE) can be used to reduce the incidence of low anterior resection syndrome (LARS) by creating a neorectal reservoir (Fig. 11). We do not routinely insert a drain in the pelvis. A temporary diverting stoma is constructed mainly in low anastomosis of immunosuppressed individuals and/or irradiated pelvis.

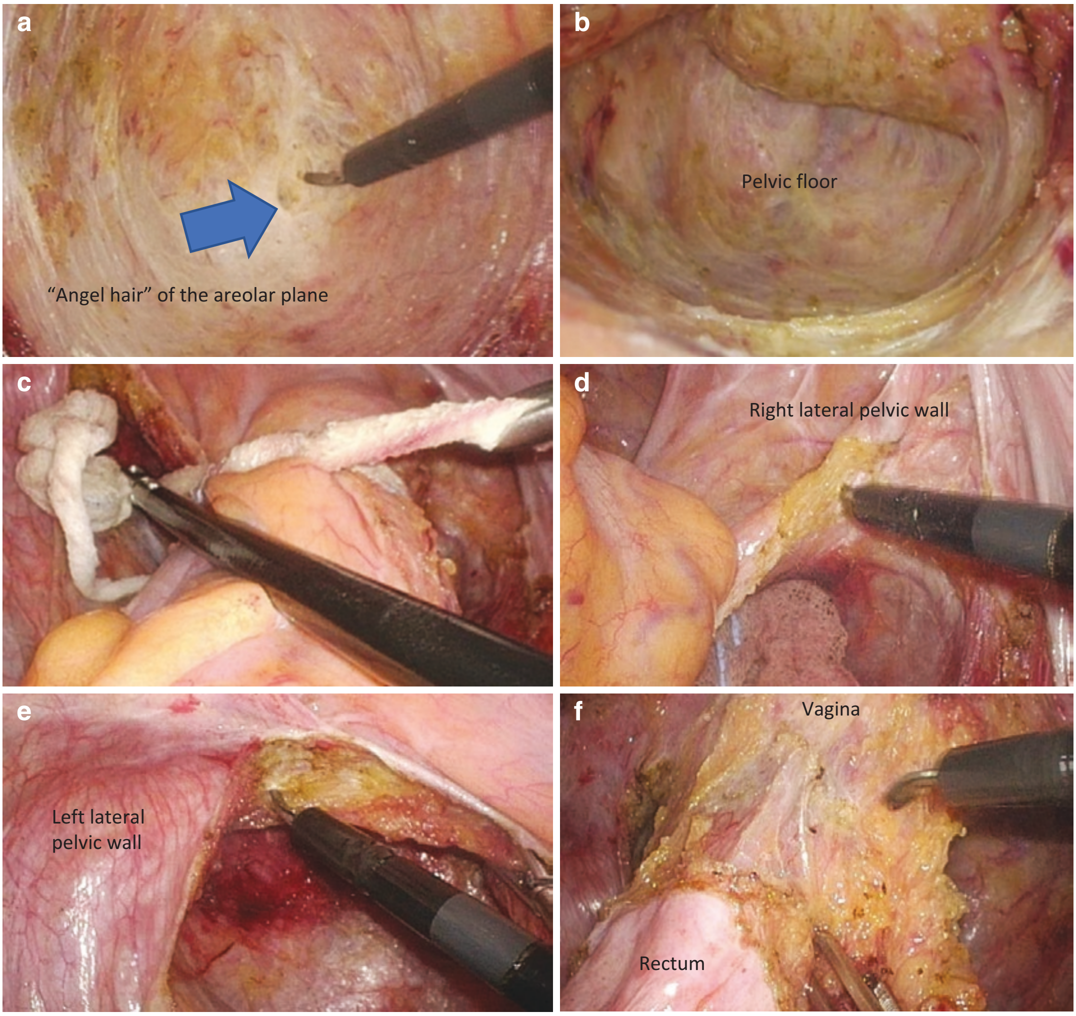

Fig. 8 (**a**) Posterior TME, sharp dissection at the avascular areolar plane; (**b**) complete posterior TME down to the pelvic floor; (**c**) cotton sling/tape to retract the rectum cephalad; (**d**) right lateral TME; (**e**) left lateral TME; (**f**) anterior TME

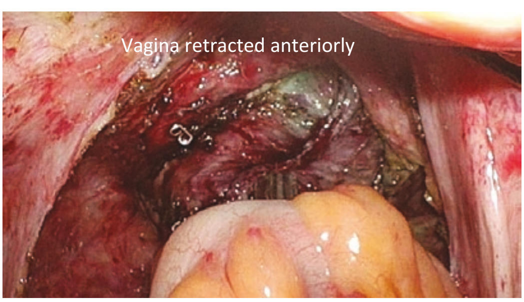

Fig. 9 Rectal transection with GIA, vagina retracted anteriorly by the first assistant

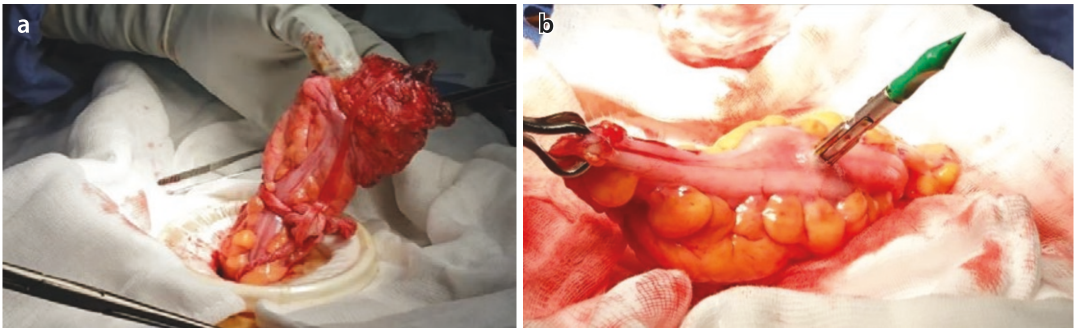

Fig. 10 (**a**) Specimen extraction. (**b**) Anvil inserted into the antimesenteric border of colonic conduit for side-to-end anastomosis

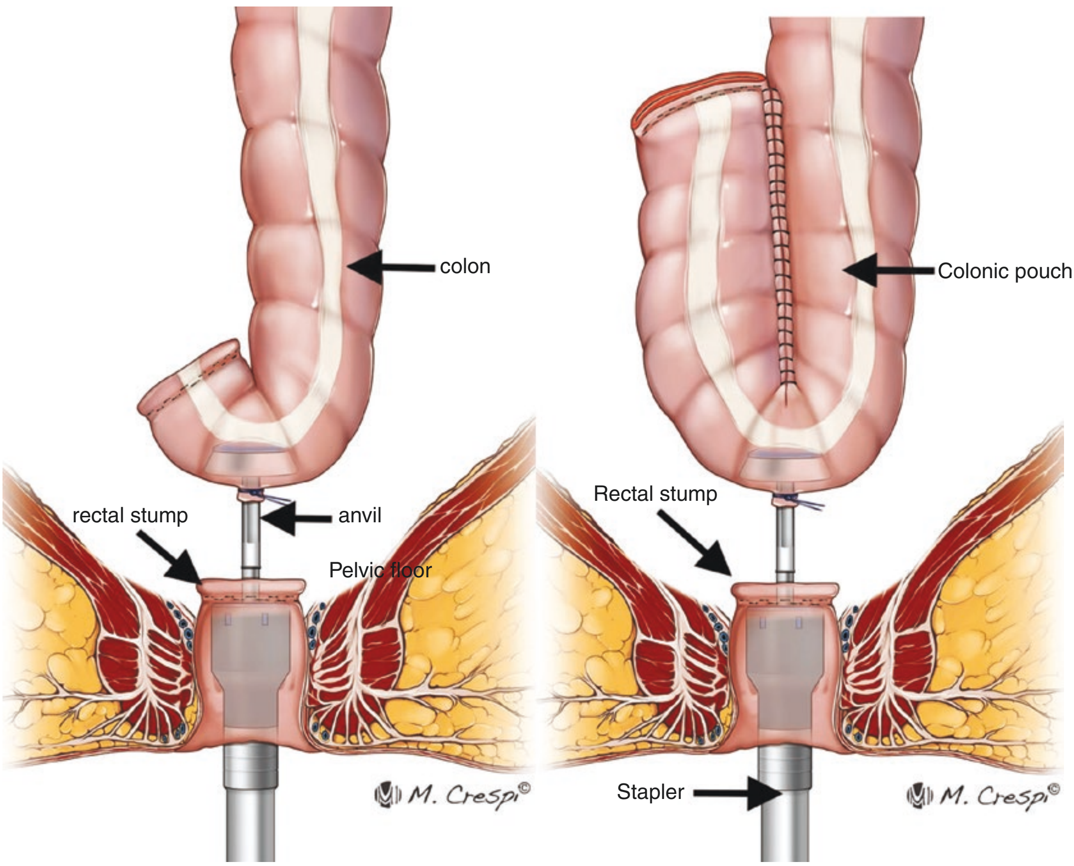

Fig. 11 Intracorporeal colorectal end-to-end (ETE) stapled anastomosis, side-to-end anastomosis, colonic J-pouch

Complications and Management

Ureteric and Bladder Injury

Adequate exposure in the correct dissection plane would avoid accidental injury. Inflammation, cancer infiltration, and adhesions can alter the regional anatomy and would require insertion of an intraoperative ureteric stent for identification. Repair is dependent on the location of injury and length of transected ureter. Bladder injury usually results from electrocoagulation tears during TME. Immediate suturing with postoperative bladder catheterization for 7–10 days is usually adequate.

Vascular Injury

Aggressive grasping or lifting of the vessels during mesenteric dissection can cause vessel tear. IMA and IMV must be adequately skeletonized with forceps in an alternating parallel and perpendicular direction to the vessel from its surrounding tissues at an appropriate exposure length before vascular clipping or sealing prior to division. Injury to the marginal artery and Arc of Riolan can occur during the medial dissection into the lesser sac and should be avoided to maintain collateral supply to the left colonic conduit. Bleeding from presacral venous plexus during TME may require second-look laparotomy after pelvic packing if conventional hemostatic methods fail. Iatrogenic splenic injury can occur from traction or capsular tear during splenic flexure mobilization.

Neurological Injury

Urinary and sexual dysfunction from damaged superior hypogastric plexus, the hypogastric nerves, the inferior hypogastric plexus, the pelvic splanchnic nerves, and the neurovascular bundle of Walsh from thermal injury, ischemia, tension, or inflammation during IMA dissection and TME can be avoided by careful sharp dissection with anatomical familiarization in these areas.

Anastomotic Leak

Any error during intracorporeal stapling anastomosis must be fixed immediately. A close-up visual inspection of the staple formation on the rectal stump should be undertaken after the firing of the endoscopic stapler and when the circular stapler is pushed up to the top of the rectal stump before anastomosis. Any incomplete donuts would require inspection of the anastomosis, leak test, and additional suturing of the defect. Recently, the use of indocyanine green (ICG) in the evaluation of perfusion for both proximal and distal stumps prior to anastomosis may reduce the risk of anastomotic leak from ischemia [10]. A tension-free anastomosis is essential. Proximal diverting stoma should always be considered in the presence of any doubt of the anastomotic integrity.

Low Anterior Resection Syndrome (LARS)

Alternative anastomotic techniques of STE, CJP, and TC create a neorectal reservoir to reduce the incidence of LARS, especially in young patients with irradiated pelvis. CJP has been demonstrated to provide better bowel function for up to 2 years compared to ETE but is technically limited by a narrow pelvis, insufficient colonic length, or colonic diverticulosis. STE seems to be functionally comparable to CJP in a limited literature review [11, 12].

Fistula

Although rare, rectovaginal fistula is caused more commonly by inadequate dissection and stapling error. One must carefully dissect between the rectal stump and posterior vaginal wall and introduce the circular stapler at a marked posterior angle in the rectal stump to avoid the inclusion of the vaginal wall in the tissue rings (donuts).

Incisional Hernia

Specimen extraction from the conventional left iliac fossa port or midline contributes to a higher incidence of incisional hernia. Moving the specimen extraction site to a Pfannenstiel incision reduces the incidence [13].

Postoperative Care

Nasogastric tube is removed at the end of surgery. Pelvic and peritoneal drains are not routinely inserted. Postoperative urinary drainage should be ideally ≤24 h for low-risk patients but those with extensive pelvic dissection may require catheterization up to 3 days after surgery. Early diet on the first day (liquids/low residue diet within 4 h) after surgery should be introduced. Early postoperative mobilization is encouraged as early as 2 h after surgery and 6 h thereafter.

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