



CONSENSUS ON LAPAROSCOPIC LOW ANTERIOR RESECTION STEPS FROM LEADING SURGEONS IN INDIA

Dr. Shailesh Puntambekar*	Medical Director, Galaxy CARE Laparoscopy Institute, 25-A, Ayurvedic Rasashala Premises, Karve Road, Opposite Garware College, Pune, Maharashtra. *Corresponding Author
Dr. Jagadishwar Goud	Head of Surgical Oncology and Clinical Director Robotic Surgery, Yashoda Hospitals, Alexander Road, Kummari Guda, Shivaji Nagar, Secunderabad, Telangana.
Dr. Pradeep Jain	Director of Gastrointestinal Surgery, Fortis Hospital, A Block, Shalimar Bagh, New Delhi, Delhi.
Dr. Rajesh Bhojwani	Head of Surgery, MS (Surgery), MCh (Surgical Gastroenterology), Santokba Durlabhji Memorial Hospital & Medical Research Institute, Bhawani Singh Marg, Bapu Nagar, Jaipur.
Dr. S. Ayyappan	Director, Madras Cancer Care Foundation, Consultant Surgical Oncologist, Apollo Cancer Speciality and Kumaran Hospital, Padma Complex, 320, Anna Salai, Rathna Nagar, Alwarpet, Chennai, Tamil Nadu.
Dr. Anil Heroor	Head of Surgical Oncology, Fortis Hospital, Mulund-West, Mumbai, Maharashtra.
Dr. Saumitra Rawat	Honorary Senior Consultant, Shri Ganga Ram Hospital, Rajinder Nagar, New Delhi.

ABSTRACT The incidence of colorectal cancer in India is lower when compared with statistics globally. Rectal cancer is more prevalent in rural India than colon cancer. Though low anterior resection (LAR) provides better survival rate and improved quality of life in patients with rectal cancer, however, laparoscopic colorectal surgery remains a challenge. Therefore, inexperienced surgeons face a lot of challenges during this procedure, such as difficulty in releasing the splenic flexure, releasing adhesions, releasing retroperitoneal fibrosis, and identifying inferior mesenteric artery (IMA) in the thick mesocolon. The objective of this paper is to provide a unanimous guide for aspirant laparoscopic surgeons in understanding steps for LAR technique based on several clinical evidence and expert opinions from leading surgeons in India. The paper describes in details the surgical aspects of LAR technique such as anatomic considerations, pre-operative care, patient positioning, access, repair, and closure.

KEYWORDS : Colorectal, rectum, LAR, IMA.

Introduction

In a country like India, the major burden of the low rectal cancers is most often of a locally advanced category. Surgery for low rectal cancer has gradually evolved towards sphincter-preserving operations, driven on by innovations like improved surgical techniques, better suture materials, and most importantly the use of the circular stapler. Improved quality of life and comparable recurrence and survival rates have been observed following low anterior resection (LAR). The learning curve for laparoscopic colorectal surgeries is ill-defined and subject to many influences. Body mass index and pelvic dissection (rectum), especially in male patients, independently increased the risk of complication and conversion. According to surgeons, the most common challenge for beginners was the difficulty in releasing the splenic flexure, and others that include releasing adhesions, the release of retroperitoneal fibrosis, and the identification of the inferior mesenteric artery (IMA) in the thick mesocolon. Left colon (inclusive of rectal surgeries) has a higher learning curve than right colectomy. Laparoscopic sphincter-preserving LAR for rectal cancer is a surgery demanding great skill. Immense efforts have been devoted to identifying factors that can predict operative difficulty, but the results are inconsistent. Mesorectal excision is the gold standard operation for rectal cancer. Here, the tumor and rectum with its mesorectal package are resected, and the colon is mobilized and anastomosed to the rectal stump. The anastomosis lies below the peritoneal reflection.

The unpredictability and increased learning curve realized the need for a unanimous guide for LAR surgical technique for aspirant laparoscopic surgeons to help them understand and fine-tune the sphincter-sparing technique based primarily on the experience of eminent key opinion leaders (KOLS) in India and available clinical evidence. The objective of this white paper is to serve as a go to document for understanding procedure steps for LAR technique.

This white paper endorses the definition of "evidence-based medicine" which is the integration of best research evidence with clinical

expertise and patient values to optimize clinical outcomes and quality of life. The paper gives us insight on following surgical aspects of LAR technique such as anatomic considerations, pre-operative care, patient positioning, access, repair, and closure(1).

Anatomic considerations

The anatomic features of the rectum pose particular challenges to complete excision of tumors; the lack of familiarity with this anatomy is probably a bigger contributing factor to low rectal cancer surgical failures. Thus understanding some elusive but critical features of anorectal anatomy lay the foundation for understanding some of the key rectal cancer surgical management challenges (Figure 1).

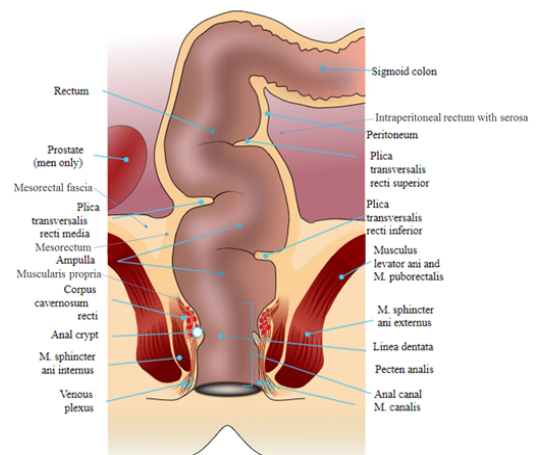


Figure 1. Anatomy of anal canal and rectum. The image has been adapted from Wikimedia.org licensed under the Creative Commons Attribution 3.0 Unported license.

- **Anal canal:** The anal sphincter muscular tube defines the functional (or "surgical") anal canal, with the levator ani muscles as the cranial boundary and the anal verge as the caudal limit. The embryological anal canal begins cranially at the dentate line, which is the fusion point of the endodermal and ectodermal contributions to the hindgut and ends caudally at the anal verge (Figure 1).
- **Rectal mucosa:** Lines the functional anal canal above the dentate line and transition zone and explains how rectal adenocarcinoma can arise within the functional anal canal and make sphincter-preserving surgery technically challenging (Figure 1).
- **Mesorectum:** The risk of local recurrence (LR) has improved with recognition and preservation of the integrity of the mesorectum (rectal mesentery) and the pelvic fascial plane that surrounds it (mesorectal fascia [MRF]) Most of the rectum is extraperitoneal. Below the peritoneal reflection, the mesorectum is a circumferential, fatty sheath that contains the perirectal lymph nodes (LNs) and surrounds the muscularis propria. It is sometimes several centimeters thick but it tapers at the lowest level, exposing the distal rectum as a muscular tube in continuity with the internal anal sphincter (Figure 1).
- **Sigmoid colon:** Another anatomic consideration is the geometric constraint of the bony pelvis, which impedes surgical access to the distal rectum and visualization of correct dissection planes. This can be particularly problematic when there is a bulky rectal tumor. A distance of more than 12 cm from the anal verge was adopted to distinguish the rectum from the sigmoid colon in the National Cancer Institute Guidelines 2000 for colon and rectal cancer. The intersphincteric groove is palpable and reproducibly demarcates the anal verge (Figure 1).

Pre-operative Care

The aim of the pre-operative care is to maximize the success rate of surgery. The following conditions should be followed for the maximum success rate of a surgery.

- **Antibiotic prophylaxis:** A single dose of cephalosporin (second generation or higher) is given on the day of surgery and at the time of induction of anesthesia. Metronidazole is added to the prophylaxis. The dose is repeated after 4 hr in case of prolonged surgeries.
- **Mechanical Bowel Preparation (MBP):** For the preparation of mechanical bowel, 1 to 2 sachets of polyethylene glycol (PEGLEC)/liquid diet is given to the patient early morning, prior surgery. MBP is a standard procedure before elective colorectal surgery which is practiced for centuries to reduce intraluminal fecal mass and bacterial load in the bowel. There is a controversy, how decrease in fecal content and reduction in bacterial load decreases the rate of infection, postoperatively, such as anastomotic dehiscence. However, based on several clinical evidence and expert opinions, use of PEGLEC has been recommended for standard bowel preparation.
- **Goal-directed fluid management:** According to the enhanced recovery after surgery (ERAS) guidelines, postoperative outcomes depends upon one of the factor know as fluid management that is debated. However, balanced IV fluids for adequate hydration are recommended.
- **Deep venous thrombosis (DVT) prophylaxis:** Low molecular weight (LMW) heparin plus Flowtron pump should be given to reduce the risk of thrombophlebitis or DVT, before surgery
- **Anesthesia:** General with epidural anesthesia

Patient Positioning

Correct patient positioning can greatly enhance the performance of any laparoscopic procedure. The following patient position was discussed and agreed upon for laparoscopic LAR surgery (Fig. 2).

- Most of the LAR surgeries follow maximal Trendelenburg and right lateral decubitus positioning.
- For lower dissection, modified Lloyd-Davis position should be followed in patients with no flexion at the hip joint, hands by the side, and a bolster behind the sacrum are advised, as the anal canal is required to be open to fire staples.
- For mobilization of the splenic flexure reverse Trendelenburg is suggested i.e. patient position with head up at 30° to 45° degrees to the left with a lateral tilt.
- Surgeon positioning between legs of patients may help to maneuver difficult flexures.
- Strapping of a patient is another very important detail to be taken care of.

- The positioning of the laparoscopic cart is to pay attention to have unhindered or usually, one monitor is placed between the legs and surgeon stands on the right side of the table.

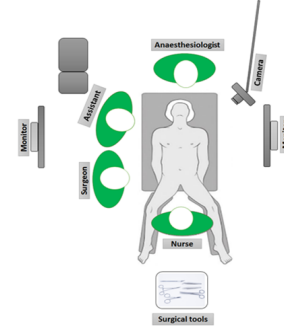


Figure 2. Position of the surgeon, surgeon's assistant, anesthetist, nurse, and patient in operation theatre. The patient is laid on the supine position. The surgeon stands on the right-side of the operation table, the assistant surgeon stand on the left-side of the operation table or on the left-hand side of the surgeon, the nurse stand on the right-hand side of the surgeon and close to the surgical tools, so as to provide surgical tools to the surgeon. The anesthetist stands at the top of the table and monitors anesthetic activities in the patient on a monitor. A camera is placed on the left side of the table for guiding/recording surgical procedure. The image in the figure is a modified image adapted from original source available at <https://www.intechopen.com/books/rectal-cancer-a-multidisciplinary-approach-to-management/single-incision-laparoscopic-surgery-for-rectal-cancer>.

Note: Placing the sacrum on a gel foam pad or slightly tilting the rectum forward can elevate the rectum. Taping the shoulders of the patient without restricting pulmonary function is a method of stabilizing the patient for the air-planning positional changes and steep Trendelenburg positioning that may be needed for sigmoid and rectal resections; however, beanbags are also effective. To avoid brachial plexus injury, shoulder stubs or pads should not be used as the only means of preventing slippage. All exposed nerves especially those around the elbows and knees should be protected. The arms of the patient should be kept close to his body to allow maximum tilt and mobility of the surgical team, since classical position of the patient may cause hindrance to move around the operation table.

Access

Entry, dissection, and mobilization present an obvious challenge during this complex procedure. Access can be briefly outlined in following five major steps

1. Access abdominal cavity

Trocar placement plays a pivotal role to access the abdominal cavity. These trocars are inserted in ports, which are placed at a specific distance in the abdomen. Following steps should be considered for trocar placement.

- Camera port: A laceration is made in the abdomen at a supra-umbilical port for insertion of 10 mm camera.
- Operating port: One 5 mm operating port is placed at McBurney's point (ipsilateral), 1-2 cm above and medial to anterior superior iliac spine (ASIS) to a midclavicular line lateral to the camera port.
- Operating port: Second 5 mm operating port is placed para-rectally and midclavicularly and 4 fingers away from the camera port.
- Accessory port: An accessory port, a mirror image of the right-side 5 mm port, is placed at the suprapubic region.

Additional port: For splenic flexure mobilization, 1 additional, 5 mm port is placed at right hypochondrium.

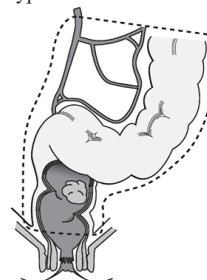


Figure 3. Resection of low anterior rectal cancer, resected material, inferior mesenteric artery (IMA). This image is sourced from http://www.surgwiki.com/wiki/Colorectal_cancer_and_adenoma.

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Note: It is always good to remember that in difficult situations additional ports and position may be used as per the need and surgeons convenience especially for high risk/special patients like obese patients, those with narrow pelvis, with hernias, uterus obstructing visualization, and high splenic flexure.

The main surgical concern during this step is to ensure safe laparoscopic entry without injury to viscera or other internal structures. Care should be taken to prevent bleeding during or after the cannula site. Optical trocars provide the benefit of safe abdominal entry, especially in patients with previous abdominal surgeries (adhesion). The optical trocar allows visualization of the layers of the abdominal wall on the monitor and these are cut under vision by the advancement of the edge of the cannula which is surgically sharp or conical. This allows the surgeon to advance through the layers to the peritoneum in a clear area where there is no bowel. Following this procedure, Jirecek et al. reviewed 1500 patients without any major complications in the Optiview insertion group as compared to the group undergoing blind insertion(2).

The advantages of this surgical procedure are

- Enhance visualization by using an appropriate trocar
- Attention to methods of retraction
- Identify key landmarks such as vascular pedicle and ureter

1. Take down any adhesions; mobilize the medial and lateral aspects of the colon

Gain access to tissue low in the pelvis by taking down adhesions (Figure 3). In the presence of adhesions and for mobilizing the colon, the tools used are critical in managing heat when working near vital structures such as the ureters or spleen. Blunt dissection, scissors, monopolar energy, bipolar energy, ultrasonic energy may be used to deal with adhesions however care should be taken to control bleeding as it impairs operative field and minimizes thermal damage to the bowel. This step helps in developing the operative field. Ultrasonic energy creates less smoke, delivers less collateral thermal damage and acts as a sealing agent to prevent bleeding(3). The Harmonic scalpel is an important instrument for laparoscopic surgery, and it can be used for dissection and hemostasis. During the procedure of laparoscopic surgery for a colorectal tumor, surgeons can use Harmonic scalpel to identify the surgical plane around the mesorectum and mesocolon. Chi P et. al 2016 in his paper summarizes technical points based on their own 15-year experiences of harmonic scalpel use in laparoscopic surgery for colorectal surgery and extracts them into five words, which are 'shave, poke, cut, peel and push' (4).

2. Gain access to and mobilize the descending and sigmoid colon by ligating the IMA near its origin after identifying the left ureter

Despite the level of the tumor in the rectum, any sphincter-preserving rectal cancer resection will start with complete mobilization of the left colon to gain length for anastomosis in the depths of the pelvis. To carry out the procedure,

- Put omentum and transverse colon in the region and push the entire small bowel into right hypochondrium and right iliac fossa and above sacral promontory and should start dissecting.
- The assistant should hold the left upper port grasper to hold sigmoid colon cranially left shoulder upwards. He should ensure to always hold the mesenteric.

Note: Before dissecting and retracting the sigmoid colon there is a risk of ureteral injury which is related to procedure complexity (i.e., the presence of rectal cancer or advanced cancer, adhesions).

- Now identify and ligate major vessels in order like IMA, inferior mesenteric vein (IMV) using tools like clips, stapler and/or advanced energy. Advanced energy is found to be as safe as clips or ligatures at the same time providing ease of use.
- The approach for dissection is medial to lateral.
- To retract IMA, identify the left ureter by dissecting underneath the arch of IMA.
- The plane of dissection should be anterior to left gonadal vessels.
- To ligate IMA (irrespective of disease stage) clear fibro-fatty tissue along IMA and leave the adequate stump of IMA to avoid damage to the aorta.
- Similarly, to ligate IMV, ligation should proceed at the level of DJ flexure or proximally at the level of IMA.

Tips to identify IMA

- Make a peritoneal cut at the level of the sacral promontory and extend it caudally parallel to the rectum of about 5 cm and cranially up to the duodenojejunal junction.
- Further, extend peritoneal cut and identify structure crossing sacral promontory.
- Look for pulsations towards the sigmoid colon and fibrous structure.
- Angle where meso-sigmoid changes and take a turn to left, right ureter as the reference; (remain medial to the right ureter). Dissect under the IMA medial to lateral.

Tips to identify hypogastric nerves,

- Dissect snugly at the posterior part of IMA and push hypogastric nerve down.
- Nerves appear ivory white.

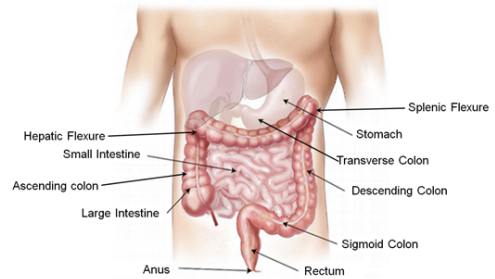


Figure 4. Colon and rectum. This image is sourced from <https://pixabay.com/images/search/rectum/> which is available under Pixabay License. This image is modified by the addition of the names of segment.

Note: Challenging situations like calcified vessel are to be dealt with care with the tools used for dissection/mobilization.

1. Gain access to and mobilize the splenic flexure by ligating the inferior mesenteric vein

- At first, the assistant leaves the sigmoid colon and picks up the distal cut stump of vessels and retracts it upwards and anteriorly.
- Next, pick up mesocolon and dissect sigmoid mesocolon cranially towards the splenic flexure remaining anterior to Gerota's fascia and the body and the tail of the pancreas.
- Further, make an incision in the lateral peritoneal to mobilize the descending colon and splenic flexure can be taken at this stage or later, after when pelvic dissection is complete with mobilization of the rectum (Figure 4).

2. Gain access to the rectum by continued mobilization of the colon; transect the mesentery

- Start dissecting presacral by keeping continuous traction on the rectum. The plane of dissection is superficial to the presacral fascia (Waldeyer's fascia) which can be identified by veins underlying.
- Dissection continues caudally in the "holy plane". The distal limit of this dissection is endopelvic fascia covering levator ani muscle.
- Since the description of the "Holy Plane" by (Figure 5), the surgery for the low rectal cancers has evolved dramatically (5). The concept of total mesorectal excision' leads to improved outcomes, in terms of the quality of resections and local disease control (6).
- The left hand of the surgeon should continue to give traction to rectum upwards.
- Lateral limit of dissection is hypogastric nerves on either side.

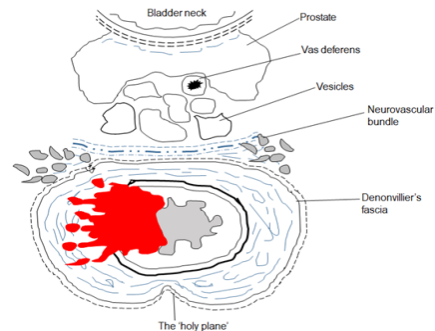


Figure 5. Illustration of a cross-section of the lower rectum showing

the plane of dissection for rectal excision, as per Heald, 1988. Note, fascia propria in the antero-lateral aspect of the mesorectum is not shown in the cross-section. The cross-section in this figure is a modified version of an illustration figure available at <https://research.space.auckland.ac.nz/handle/2292/5500> (Page. 23). For original cross-section, please refer to Heald, 1988, (Figure 5, Page. No. 506)(5).

1. Right lateral and pouch of Douglas dissection

- The assistant should retract the rectum cranially and to the left side.
- The left hand of the surgeon should take a medial cut at the end of the peritoneum and continue dissection medially to right hypogastric nerves into the rectovesical or recto-uterine pouch.
- Extend the cut from right to left in the pouch of Douglas (POD) avoiding injury to parasympathetic nerves which would be visualized at this stage.
- Keep the plane of dissection anterior in between seminal vesicle and rectum in males, and posterior for vaginal wall and rectum in females.
- The fascia covering the posterior vaginal wall and seminal vesicle should not be breached at this stage. The distal limit of anterior dissection is the base of the prostate at this stage and in females upper 1/3rd of the vagina.
- The surgeon then retracts rectum towards the left side and cut right lateral ligaments medial to hypogastric nerves.
- Distal limit of this dissection is endopelvic fascia covering the levator ani.
- The assistant then retracts rectum towards right and incision is taken along peritoneal reflection, care should be taken not to damage left ureter and left gonadal vessels.
- This exposes left hypogastric nerves and continue the dissection downwards to cut the left lateral ligament and join the peritoneal cut coming from right side anteriorly.
- This exposes the left-sided levator ani with its covering endopelvic fascia.
- Further mobilization of rectum anteriorly or posteriorly should be done at this stage till levator ani is seen covering the rectum.

• Repair

1. Transection of Rectum

- A digital examination should be carried out to decide the level of transection by the surgeon.
- The level of the transection should be marked by the assistant or surgeon's left hand.
- Introduce a stapler through the right working port and green cartridges (2 or 3) are used for transecting the rectum.
- Alternately suprapubic port should be used to introduce the stapler.
- The stapler should be only green reload. This is because the related tissue is very thick & transection is difficult if heavy reload (green) stapler is not used. In post radiated patients use of power stapler is recommended.

2. Transect the proximal end of the rectum

- Adequately, check the proximal colon mobilization to reach distal rectal stump.
- Further, mobilize the proximal colon, if required, by releasing the supra colic omentum.
- Ensure adequate margins to achieve hemostatic and leak-free staple lines.
- Ensure adequate blood supply to the anastomotic site, so as to take the specimen, safely.

Ensure adequate margins: Primarily, the importance of the mesorectum in local recurrence was recognized. Recurrence rates of < 5% have been reported with a distal margin of <2cm, provided the mesorectum could be completely excised (8). The more modern concept focuses on the deep margin more than the distal margin. Surgical techniques are available that can preserve the anus and sphincters, even for very low tumors. The surgeon counts on meticulous technique and the use of neoadjuvant chemo/radiation therapy to assure a negative deep margin. This should ensure a low rate of local recurrence.

Transecting the colon/rectum: Before transection, the stapler instrument is closed to clamp the rectal lumen just above the planned resection line. Care must be taken to make sure the division is perpendicular to the plane of the rectum. Any mesorectum present is divided with an electromechanical device or electrocautery. In cases

where it is difficult to get the stapler across the rectum, the rectum may be drawn to the left to open an angle to insert the stapler.

Tip: The assistant must be able to perform traction and counter-traction to facilitate the dissection within the correct plane by minimizing the risk for breakage of the mesorectal fascia.

Remove Extraction Site Selection

There are three typical options for extraction site, abdominal, midline, and transanal. Studies show that midline extraction sites have a higher chance of incisional hernia than non-midline (Pfannenstiel/muscle-splitting) sites (8). Stoma site or rectum have also been explored but insufficient evidence exists at this time. The exteriorization of the specimen should always be done through a wound protector to reduce the risk of implantation metastasis.

Tips: The opening must be wide enough to avoid squeezing, trauma, or perforation to the tumor-bearing intestine.

Closure

1. Create the anastomosis

- Insert circular stapler anvil proximal resection of the rectum.
- The anvil should be brought to the pelvis and secure.
- Firing and removal of the stapler leaves an anastomotic "doughnut".
- The tissue doughnuts should be inspected for the completeness before being sent for pathological examination.
- The integrity of the anastomosis may be verified by air insufflation of the rectum with the pelvis filled with saline.

There should be absolutely no tension on the anastomosis, whether it is constructed in the mid rectum after resection of an upper rectal cancer, or at the dentate line after an intersphincteric low anterior resection for a tumor at the upper aspect of the anal canal. For distal tumors, when reconstruction is performed with either a colonic J-pouch or a transverse colectomy pouch, complete mobilization is of particular importance.

Tips: A large circular stapler head or not careful enough insertion and advancement of the stapler gun through anus and rectal remnant might tear the sphincter muscles or perforate the rectal remnant.

2.1 Close the fascia

2.2 Close the subcuticular layer and skin

To minimize the risk of herniation, dehiscence, and infection, antibacterial coated suture should be used. These steps are discussed here to enable the aspirant laparoscopic surgeon to understand the complexities involved anatomically when learning and adapting LAR.

Summary

This paper provides a guide for aspirant laparoscopic surgeon for performing colorectal surgeries and explains the complexities involved anatomically when learning and adapting LAR. This paper explain the LAR procedure with details such as anatomic considerations, pre-operative care, patient positioning, access, repair, and closure. The knowledge of anatomic features of the rectum is vital to avoid rectal cancer surgical failures. Preoperative care maximizes success percentage of the surgery with the following conditions such as antibiotic prophylaxis, MBP, goal-directed fluid management, DVT prophylaxis, and anesthesia. Most of the LAR surgery follow maximal Trendelenburg and right lateral decubitus positioning to enhance performance of this surgery. Entry, dissection, and mobilization can present apparent challenges during this compound procedure. Repair, removal, and closure are last but not significant steps of laparoscopic surgical procedures. To circumvent the surgical failures associated with colorectal surgeries, all the steps in surgery should be performed with utmost care and keeping all the above anatomic recommendations in mind.

In India, LAR has substantially improved the survival rate and quality of life of the patients with rectal cancer.

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