Chapter 26
Laparoscopic Low Anterior Resection

Katerina Wells

26.1 Introduction

Preoperative Planning: Multidisciplinary Evaluation and National Accreditation Program for Rectal Cancer (NAPRC).

Outcomes of the rectal cancer patient are highly dependent on the specialization, training and volume of the physicians and centers providing the care. [1, 2] In an effort to reduce variability in care and optimize patient outcomes, the National Accreditation Program for Rectal Cancer (NAPRC) was developed with the purpose of employing a multidisciplinary, evidence-based approach to guide the processes of rectal cancer care. The standards set forth by the NAPRC provide performance measures to be met along the critical steps of patient care processes and guidelines for a program structure that supports performance improvement as a way to standardize a high level of quality via real-time auditing. Ultimately the NAPRC will foster designation of rectal cancer surgery to specialized centers with experienced surgeons to ensure that surgical standards are consistently achieved [3].

26.2 Pre-operative Evaluation: Tumor Localization and Total Colon Clearance

Tumor localization prior to planned rectal resection is necessary for multiple reasons. The distance from the anal verge provides the surgeon with prognostic information about tumor behavior, option for sphincter preservation and functional expectations after resection. Localization of a rectal cancer by convention is

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described by its relationship to the anal verge. It is necessary to perform this assessment prior to initiation of neoadjuvant therapy as identification of the primary lesion after therapy is compromised in the case of significant clinical response. In anticipation of this possibility, India ink tattooing aids in localization with a low risk of associated morbidity [4]. Although different techniques can be used for tattooing, it is important to be consistent in the pattern of marking and document the method in the colonoscopy report. The authors recommend that tattooing be performed in 3 separate areas around the circumference of the lumen distal to the lesion. Intraoperative proctosigmoidoscopy can be employed when intraoperative localization measures fail.

Evaluation of the entire colon is also necessary as patients with primary colorectal cancer carry a 1–7% risk of having synchronous lesions [5]. Colonoscopy is 85% sensitive and 95% specific for the detection of malignancy and is the gold standard for evaluation of the colon [6]. In the case of obstructing tumors that prevent colonoscopic colon clearance, CT colonography (CTC) is an accurate and well tolerated method of noninvasive assessment with a sensitivity of 100% in detecting proximal synchronous cancers, specificity of 87.5% for cancers >15 mm and a negative predictive value of almost 100% [7].

26.3 Preoperative Evaluation: Local Staging with Rectal Cancer Protocol MRI

Rectal cancer protocol MRI has replaced endorectal ultrasound (ERUS) for local staging of rectal cancer. Rectal cancer protocol MRI is superior to ERUS as it allows for surgically relevant information beyond T and N stage including involvement of the circumferential resection margin (CRM) and surrounding pelvic structures that determine resectability. MRI also allows for identification of emerging oncologically prognostic features including extramural vascular invasion (EMVI) status, the presence of mucin, and tumor regression grade [8]. These radiologic findings play an important role in guiding risk stratification and perioperative therapy.

26.3.1 Technique

The principles of LAR for rectal cancer outlined by National Comprehensive Cancer Network guidelines include total mesorectal excision (TME) to address draining lymphatics and obtain adequate circumferential and distal resection margins. The surgeon must therefore be experienced in TME [9].

Minimally invasive LAR can be performed through a straight laparoscopic, hand-assisted laparoscopic, or robotic-assisted approach as there is no difference in long-term oncologic outcomes [10–17].

26.3.1.1 Technique: 1. Patient Positioning and Port Placement

The patient is placed in dorsal lithotomy to allow access to the perineum for anastomosis and assessment. Attention is placed on offloading the lateral knees and calves in stirrups to prevent decubitus injury and deep vein thrombosis. Fixation devices to prevent shifting of the body during steep Trendelenburg should be employed and tested prior to draping. A rectal preparation of betadine is performed to reduce bacterial burden at the time of rectal transection.

For a laparoscopic technique, ports are placed in a manner that allows for triangulation of the target anatomy with lateral ports placed medially enough to allow for unimpeded access of instruments over the sacral promontory. For a robotic-assisted technique, ports will vary based on the platform but should keep in mind access to the left upper quadrant for mobilization of the splenic flexure in addition to the pelvis.

A hand port or extraction port can be placed in the suprapubic, periumbilical or right lower quadrant depending on operator preference. The suprapubic position in either a midline or Pfannenstiel orientation is a versatile location as this allows access to the pelvis for dissection and anastomosisin addition to extraction of the specimen.

26.3.1.2 Technique: 2. Exploration of the Peritoneal Cavity

Upon entry into the abdomen inspection of peritoneal surface and surfaces of intraperitoneal organs is performed for identification of metastatic disease. A systematic approach by quadrants is recommended making note of the surfaces of the liver, bilateral diaphragms, the anterior peritoneal surface and the pelvis. In women, the adnexa of the uterus are inspected. It is not necessary to perform extensive dissection outside of the primary resection site for the purpose of exploration. Clinically suspicious lesions beyond the field of resection should be biopsied and/or removed, if possible; however extensive resection of M1 lymph nodes is not indicated [9].

26.3.1.3 Technique: 3. Medial to Lateral Approach

Minimally invasive LAR typically employs a medial to lateral approach and begins with identification and elevation of the superior rectal artery at the level of the sacral promontory (Fig. 26.1).

The peritoneum is incised from the sacral promontory to the origin of the IMA. Pneumoperitoneum aids in separation of the mesocolon from the retroperitoneum and this plane is further propagated byreflecting the retroperitoneum posteriorly and widening this window.

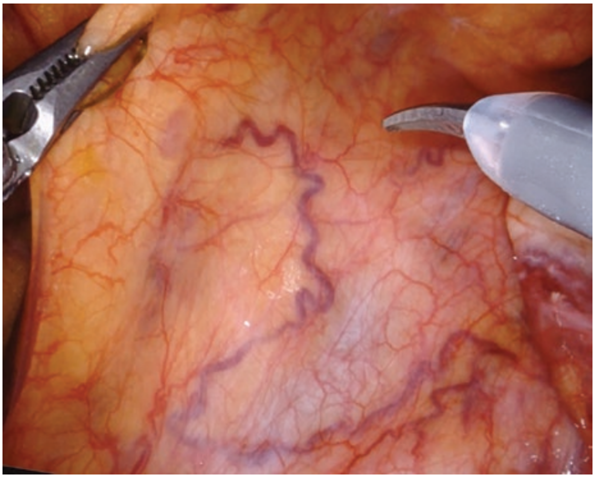

Fig. 26.1 Medial to lateral approach: elevation of the IMA

Troubleshooting: Identification of the Left Ureter

Identification of the ureter is facilitated using a three-step approach. The first step is identification in the retroperitoneum via the mesenteric window between the sacral promontory and the inferior mesenteric artery. If the ureter is not identified in this window, a mesenteric window between the IMV and IMA is created. At this level, the proximal ureter and this retroperitoneal plane is extended caudadto meet the original plane of dissection at the level of the sacral promontory. If this maneuver does not expose the ureter, a lateral to medial approach is applied. Failure to identify the ureter with this stepwise approach should prompt conversion to an open approach or placement of ureteral stents for the purpose of palpation via a hand-assisted technique at the discretion of the surgeon.

Though ureteral injury is rare, reported at 0.5–4.5% [18], placement of ureteral stents has gained popularity with the concern over loss of tactile feedback with minimally invasive techniques. Ureteral stents have been shown to aid in intraoperative identification of ureteral injuries through there is no evidence that ureteral stents reduce or prevent ureteral injury [19]. Placement of ureteral stentsare associated with slight to modest increases in total operative time. They are generally safe with no significant differences seen in postoperative urinary complications on a recent review [20]. Illuminated stents and ICG illumination are also described for intraoperative ureteral identification (Fig. 26.2).

26.3.1.4 Technique: 4. High Ligation of the IMA and IMV

Once the ureter is identified, the IMA is isolated and ligated at its origin. Care is taken to avoid division of branches of the hypogastric plexusin order to preserve sexual function. The IMV is then similarly isolated and ligated. High ligation of the primary feeding vessel ensures removal of all potential mesenteric nodal disease and maximizes lymph node harvest for pathologic assessment. There is no

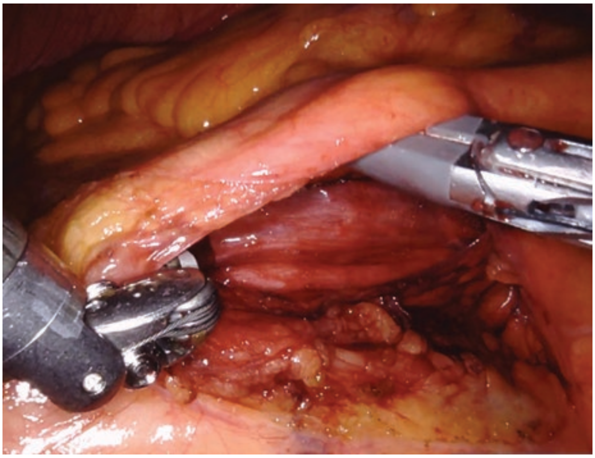

Fig. 26.2 Medial to lateral approach: identification of the Ureter

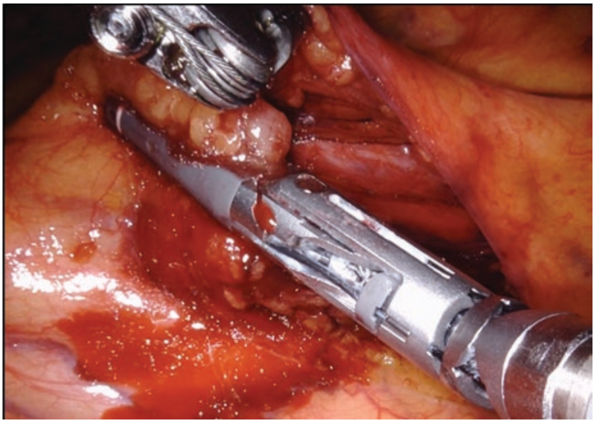

Fig. 26.3 High ligation of the IMA

difference in morbidity associated with high ligation, with the benefit of increased disease-free survival with this technique [21–23]. High ligation is also recommended to ensure optimal reach of the distal descending colon to the pelvis to allow for colorectal anastomosis. For example, division of the superior hemorrhoidal vessel will cause the descending colon mesentery to remain tethered at the left colic artery or origin of IMA. Similarly low division of the IMV will result in tethering of the proximal descending colon by splenic flexure venous branches.

Troubleshooting: Vessel Ligation

Care should be taken to avoid traction on the IMA or IMV at the time of ligation. Excessive traction can result in incomplete vessel sealing and retraction of the bleeding vessel (Fig. 26.3).

26.3.1.5 Technique: 5. Mobilization of the Splenic Flexure

Retromesocolic dissection proceeds along the inferior border of the pancreas, laterally to the white line of Toldt, and extends beyond the splenic flexure to allow for ease of mobilization of the remaining lateral attachments of the colon. Dissection of the remaining lateral attachments proceeds caudally to cranially from the pelvic inlet to the splenic flexure.

Troubleshooting: Splenic Flexure Mobilization

Splenic flexure mobilization is aided through entry into the lesser sac via the avascular attachments of the greater omentum to the mid-transverse colon. The remaining attachments along the inferior border of the pancreas are then divided completing splenic flexure mobilization. These attachments can be divided to the midline effectively freeing the transverse colon mesentery to the level of the middle colic artery.

26.3.1.6 Technique: 6. Total Mesorectal Excision (TME)

TME begins by sharply incising the areolar tissue behind the mesorectal envelope at the level of the sacral promontory. This avascular plane of loose areolar tissue is the guiding plane of dissection investing the mesorectum from the pelvic brim to the pelvic floor. Posterior dissection extends just beyond the level of intended distal margin in the case of tumor specific TME and to the level of the pelvic floor in the case of complete TME. Dissection extends into the upper anal canal if ultralow resection is needed (Fig. 26.4).

The lateral ligaments containing the middle hemorrhoidal vessels and splanchnic nerve branches are then divided. The rectum is retracted medially to aid in correct

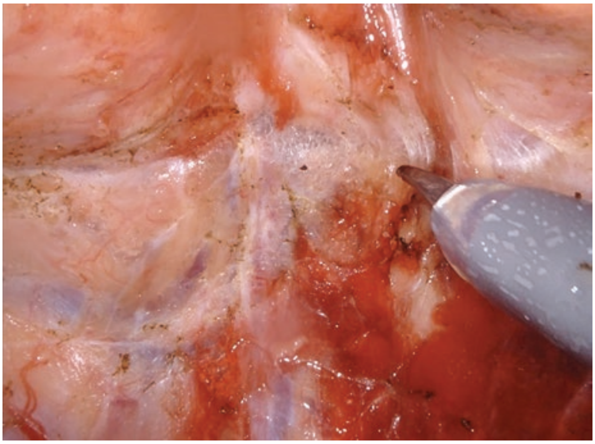

Fig. 26.4 Total Mesorectal Excision (TME): posterior dissection

identification of the plane of division and prevent dissection of pelvic plexus nerves and ureters within the lateral pelvic sidewall. Sharp or electrocautery instruments along with the magnified view of the laparoscope allows for this precise dissection (Fig. 26.5).

The anterior dissection plane is determined by the location of the tumor. For posterior tumors, Denonvillier's fascia is preserved. For anterior tumors, Denonvillier's fascia should be included in the TME to ensure a negative margin at the expense of thecavernous nerves and pelvic plexus nerves travelling to the bladder, prostate and sexual organs (Fig. 26.6).

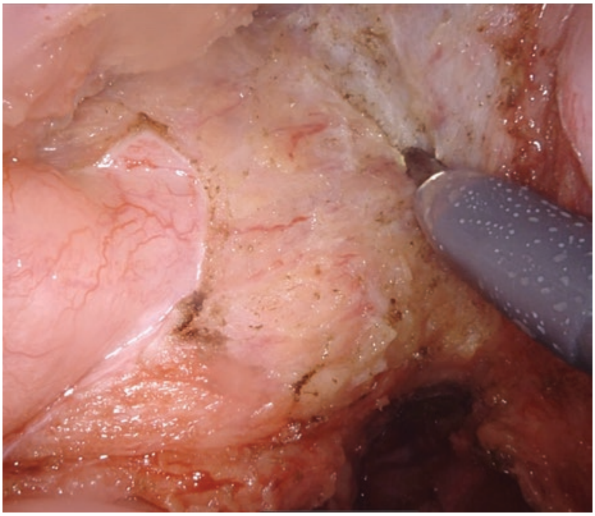

Fig. 26.5 Total Mesorectal Excision (TME): lateral dissection

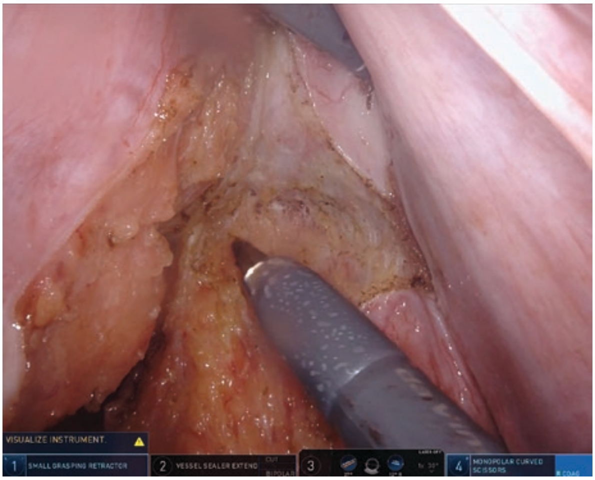

Fig. 26.6 Total Mesorectal Excision (TME): anterior dissection and preservation of Denonvillier's fascia

Troubleshooting: Presacral Bleeding

Injury to the presacral venous plexus can result in large volume hemorrhage due to the lack of valves and high hydrostatic pressure present in this system. Presacral bleeding is initially managed with direct pressure at the point of bleeding. At this time, communication to the anaesthesia provider and surgical team should be performed to prepare for potential hemorrhage. Packing of the pelvis in combination with topical hemostatic agents is usually successful in controlling small-vessel venous bleeding. Direct ligation of the bleeding vessel can be attempted for larger vessels. If this measure fails use of metallic thumbtacks have been described. Rectal muscle flap fragment welding can also be performed.

26.3.1.7 Technique: 7. Determination of the Proximal Margin

A variety of approaches are used for proximal and distal transection. This can be performed in an open-approach through the hand-port. Alternatively the distal rectum can be divided intracorporeally and the proximal colon transected upon extraction of the specimen. Alternatively resection and anastomosis can be performed entirelyintracorporeally. Ultimately the proximal point of transection should be one that that is well perfused, reaches the pelvis without tension, and satisfies a 5 cm margin from the tumor. This margin length is based on the concept that colon cancers do not typically extend longitudinally along the mucosa but grow circumferentially and extend radially along the bowel wall. Moreover, resection length is a corollary for adequate lymphadenectomy. A retrospective study by Rorvig et al. describes a 37% rate of node positivity for tumors with a < 5 cm margin vs a 51% rate of node positivity with a > 5 cm margin [24].

Troubleshooting: Assessment of Perfusion

Assessment of adequate perfusion of the proximal point of transection is typically a gross assessment of bowel wall perfusion. Perfusion can be assessed by checking for back-bleeding from the marginal artery of Drummond prior to ligation or by the presence of arterial bleeding after sharp dissection of an epiploic appendage. Indocyanine green (ICG)-induced fluorescence angiography (FA) using near infrared (NIR) light can also aid in assessment of microperfusion of the bowel wall prior to transection and after anastomosis. FA is a safe and feasible adjunct togross assessment of perfusion for left sided anastomosis [25] and is readily available on most minimally invasive platforms (Fig. 26.7a, b).

26.3.1.8 Technique: 8. Determination of the Distal Margin

The distal resection margin (DRM) is more variable as it is tailored to the specific conditions of the patient. NCCN guidelines recommend that the DRM extend

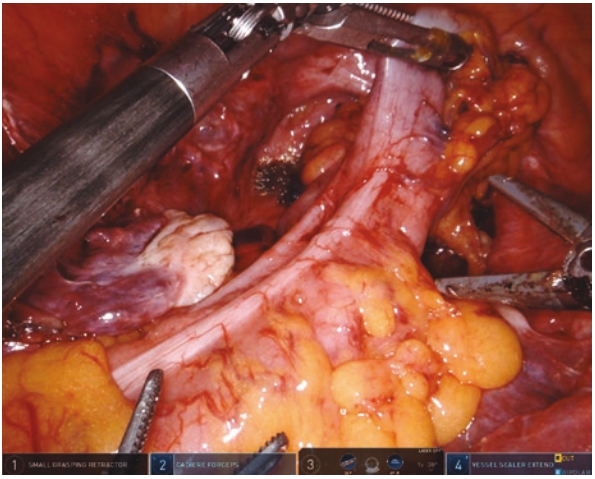

Fig. 26.7 (**a**) Determination of the proximal margin: gross assessment

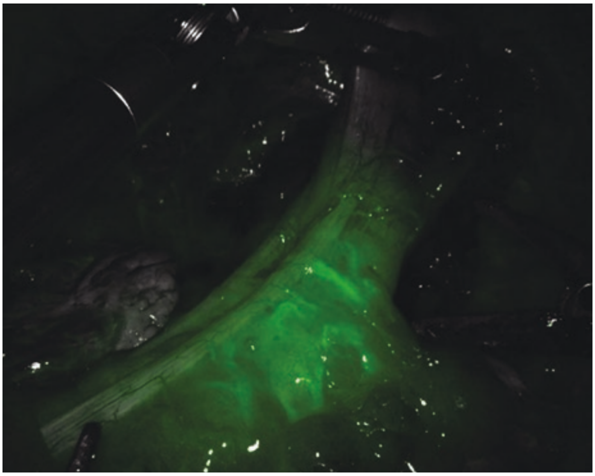

Fig. 26.7 (**b**) Determination of the proximal margin: fluorescent angiography

4–5 cm below the distal edge of the tumor for an adequate mesorectal excision. However in the case of low rectal tumors (<5 cm from the AV) several studies have demonstrated that distal tumor extension is confined within 2 cm of the primary lesion and that a DRM of 2 cm from the distal edge of the tumoris oncologically sufficient [26]. Among patients receiving preoperative chemoradiotherapy, a DRM of 1 cm andin some cases <1 cm is oncologically non-inferior and acceptable when balanced against a goal of sphincter preservation.

The mesorectum is transected perpendicular to the axis of the mesorectum without coning of the mesorectum in the vicinity of the tumor. The TME specimen is a circumferentially encased fascial envelope with a bilobed configuration of the posterior mesorectum. Complete and near complete grading of TME is considered acceptable.

26.3.1.9 Technique: 9. Colorectal Anastomosis

The double staple anastomosis technique in either an end-to-end or side-to-end coloproctostomy is most commonly performed. Creation of a colonic J pouch reservoir is also an acceptable option though more technically demanding. Each offer similar rates of postoperative morbidity and long term functional outcomes [27]. Once the proximal bowel is prepared, the EEA anvil is inserted and secured in a purse-string fashion. It is important to ensure that the mucosal edges are well everted against the anvil and no gaps occur between the bowel wall and shaft of the anvil. The EEA stapler is then inserted transanally to the level of distal transection. The spike of the EEA is deployed through the top of the distal point of transection and mated to the anvil. Attention should be directed to ensure that the proximal bowel is properly oriented and reaches without tension. The anastomosis should be inspected circumferentially to ensure that that no intervening tissue is entrapped in the staple line prior to firing.

Troubleshooting: Transanal Passage of the EEA Stapler

In the case of resistance with passage of the stapler, the rectum should be evaluated for stricture, adhesion or valves that may limit passage to the staple line. This can be performed with sequential sounding of the rectum with EEA sizers followed by proctoscopy if needed. If this is encountered, lysis of adhesion with rectal mobilization is performed to straighten the rectum and allow passage of the EEA to top of the rectal stump. In the case of stricture, the rectum should be divided below the stricture to prevent obstruction distal to the colorectal anastomosis and stasis that can occur in the redundant rectal stump (Fig. 26.8).

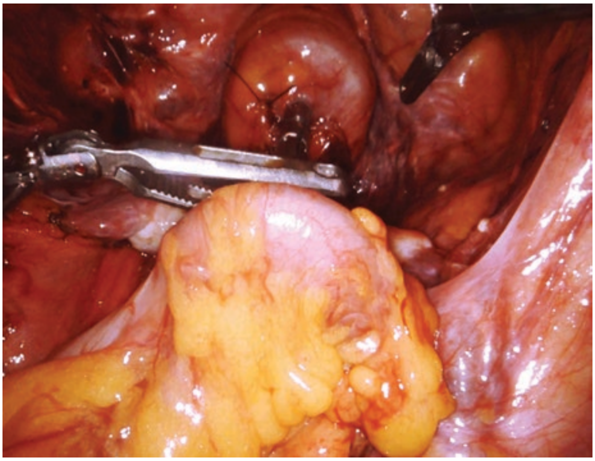

Fig. 26.8 Colorectal anastomosis: side to end intracorporeal anastomosis

26.3.1.10 Technique: 10. Anastomotic Assessment

Anastomotic assessment is performed with insufflation of the rectum under saline. Routine intraoperative sigmoidoscopy offers direct visualization of the anastomosis for bleeding and integrity. In a prospective review by Kamal et al., the finding of an endoscopic abnormality was highly correlated with a positive leak test and should prompt repair [28]. Intraluminal fluorescence angiography is also available to assess staple-line perfusion [25].

Anastomotic assessment by leak testing with or without endoscopic visualization is necessary due to the high risk of leak with coloproctostomy. In a retrospective review by Ricciardi et al. of 998 patients undergoing coloproctostomy, the overall leak rate was 4.8%. The rate of clinically evident leak rates following a positive air leak test was 7.7% compared to 3.8% following a negative air leak test. Suture repair was less effective at preventing clinically evident leaks compared to anastomotic revision or proximal diversion [29].

Troubleshooting: Positive Leak Test

If anastomotic assessment is positive for leak, an effort should be made to identify the focus of the leak. In the case of a well defined and small defect, the site of leak can be oversewn directly and should be similarly oversewnon either side of the defect. Anastomotic assessment is then repeated. If a leak persists, the anastomosis should be revised. In the case of a diffuse leak or a large defect, the anastomosis should be revised and assessment repeated. Diversion or resection with end colostomy is performed at the surgeon's discretion.

26.4 Post-operative Management: MIS LAR and ERAS

Enhanced Recovery after Surgery (ERAS) Programs work in conjunction with minimally invasive LAR to improve outcomes and is the standard of perioperative care forcolorectal surgery. Kehlet and colleagues first introduced ERAS as a "bundle" of interventions that cumulatively reduce postoperative stress, reduce recovery time, and decrease postoperative morbidity [30]. The main principles of ERAS include a minimally invasive approach, mechanical and oral antibiotic bowel preparation, low dose carbohydrate/balanced electrolyte preoperative hydration, multimodal analgesia including regional analgesia for reduction of narcotic use, and early mobilization and feeding.

26.5 Post-operative Management: Short-term Outcomes

The short-term benefits of minimally invasive LAR are clearly demonstrated including shorter hospital stay by 2 days (95% CI −3.22 to −1.10), shorter time to defecation by approximately one day (95% CI −1.17 to −0.54), fewer wound infections (OR 0.68; 95%CI 0.50 to 0.93), bleeding complications (OR 0.30; 95% CI 0.10 to 0.93) and similar 30 day morbidity (OR 0.94; 95% CI 0.8 to 1.1) compared to open resection at the expense of slightly increased operative times (MD = 37.23 minutes, 95% CI 28.88–45.57, $p < 0.0001$, 31,32). Minimally invasive resection also affords lower analgesic use, pain scores and significantly shorter incision length (MD −12.83; 95% CI −14.87 to −10.80) [31].

The cost of minimally invasive technologies, while higher in the operating room, has been shown to be lower overall, due to these reduced complications, length of stay and standardization of resource utilization [32, 33].

26.6 Long-term Outcomes

Multiple nonrandomized studies support the use of minimally invasive techniques for rectal cancer with acceptable oncologic outcomes including survival, recurrence, lymph node harvest and ability to resect locally advanced, emergently operated, obstructed tumors and in elderly and high risk patients [15, 31, 34–36]. In addition, level 1 evidence reported over the last 20 years has also solidified the oncologic efficacy of minimally invasive rectal cancer surgery with similar rates of OS, DFS and local recurrence compared to open resection with a generally low rate of conversion [10–17, 37].

26.7 Conclusion

Management of the rectal cancer patient is complex and requires expert multidisciplinary care under the guidance of the NAPRC. A standardized preoperative evaluation is key to optimize the patient for resection and offer the best possible oncologic and functional outcomes including sphincter preservation for distal lesions. In the same vein, minimally invasive LAR is a high-risk procedure best performed by an experienced surgeon. Regardless of minimally invasive technique, the goal of the operation is complete TME to reduce local recurrence. Minimally invasive surgery when paired with an Enhanced Recovery After Surgery Program improves postoperative outcomes with reduced morbidity, decreased length of stay and readmission.

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