https://doi.org/10.48047/AFJBS.6.2.2024.4093-4103

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

An Overview about laparoscopic anterior resection of cancer rectum

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Article History

Volume 6, Issue 2, Apr-Aug 2024

Received: 5 August 2024

Accepted: 15 August 2024

Published: 15 August 2024

doi: 10.48047/AFJBS.6.2.2024.4093-4103

Abstract: Surgical proctectomy remains a cornerstone in the management of rectal cancer, aiming for complete tumor resection with adequate negative margins while preserving sphincter function whenever feasible. The optimal surgical approach is dictated by tumor location, stage, and patient-specific factors, encompassing a spectrum of techniques from transanal approaches for early-stage lesions to total mesorectal excision (TME) for more advanced disease. TME, a standardized surgical technique emphasizing meticulous dissection of the mesorectum, has significantly improved oncological outcomes by minimizing local recurrence. Advances in surgical technology, including laparoscopy, robotics, and transanal minimally invasive surgery (TAMIS), have refined TME, offering benefits such as reduced postoperative pain, shorter hospital stays, and improved cosmesis compared to open surgery. The choice between these approaches is guided by surgeon expertise, patient characteristics, and institutional resources. Preoperative staging, employing modalities like MRI, CT, and endoscopic ultrasound, is crucial for accurate assessment of tumor extent and lymph node involvement, aiding in surgical planning and neoadjuvant therapy selection. Neoadjuvant chemoradiotherapy (nCRT) has become standard practice for locally advanced rectal cancers, downstaging tumors, improving local control, and potentially enabling sphincter-preserving procedures. However, careful consideration is needed to balance the potential benefits of nCRT with the associated toxicity. Postoperative management focuses on optimizing bowel function, managing complications such as anastomotic leaks, infections, and sexual dysfunction, and ensuring adequate oncological follow-up. The development of permanent stomas remains a significant concern, impacting quality of life. Efforts are ongoing to minimize stoma creation through improved surgical techniques, meticulous patient selection, and advancements in anastomotic techniques. Furthermore, advancements in imaging, including advanced MRI and PET-CT, are improving the ability to detect recurrence and guide treatment strategies. Ongoing research focuses on personalized approaches based on molecular tumor characteristics, refined surgical techniques, and improved adjuvant therapies to further enhance oncological outcomes and improve the quality of life for patients undergoing proctectomy for rectal cancer. The ultimate goal remains to achieve optimal oncological control with minimal morbidity, tailoring treatment to individual patient needs.

Keywords: *laparoscopic anterior resection, cancer rectum*

Introduction.

Abdominoperineal resection (APR), commonly known as surgical proctectomy, is a major surgical procedure used to remove a cancerous rectum. It involves the complete excision of the rectum, along with the anus and surrounding tissues. This is typically indicated for rectal cancers that are located low in the rectum, are very

large, or have already spread to nearby lymph nodes. Due to its extensive nature, APR results in a permanent colostomy, meaning a surgically created opening in the abdomen (stoma) through which stool is diverted into a collection bag. The decision to proceed with APR is made after careful consideration of the tumor's characteristics, the patient's overall health, and the availability of alternative treatments. [1].

The surgical technique itself involves a multi-stage process. The surgeon begins with an abdominal incision to access the rectum. The rectum is then carefully separated from surrounding organs and blood vessels. Lymph nodes in the area are also removed and sent for pathological examination to determine the extent of cancer spread. Next, the surgeon performs a perineal dissection, making an incision in the perineum (the area between the scrotum and anus in men, or between the vulva and anus in women) to complete the removal of the rectum and anus. The colon is then brought through the abdominal wall to create the colostomy. [1].

Post-operative care is crucial for a successful recovery. Patients typically require a prolonged hospital stay, often involving pain management, intravenous fluids, and bowel rest. The colostomy requires meticulous care to prevent complications like infection or skin breakdown. A specialized nurse will provide education on colostomy management, including emptying and changing the collection bag, and maintaining stoma hygiene. Dietary changes may also be necessary to regulate bowel function and prevent complications. Physical therapy may be implemented to improve mobility and strength. [1].

The long-term outlook following APR depends on several factors including the stage of the cancer at the time of surgery, the extent of lymph node involvement, and the patient's response to post-surgical treatment, such as chemotherapy or radiation therapy. Regular follow-up appointments with the surgical and oncology teams are essential for early detection of recurrence and management of any potential complications. The adjustment to life with a permanent colostomy can be challenging, but support groups and specialized ostomy nurses can provide invaluable assistance. [1].

While APR is a significant and life-altering procedure, it offers a chance at cure for many patients with advanced rectal cancer. The procedure itself has evolved over time, with advancements in surgical techniques and minimally invasive approaches aiming to reduce complications and improve patient outcomes. Choosing the best treatment strategy is a collaborative effort between the patient, surgeon, and oncologist, taking into account individual circumstances and preferences. It’s vital that patients have realistic expectations regarding the procedure, its potential side effects, and the ongoing commitment required for long-term management and follow-up care [1].

Studies on the laparoscopic anatomy of colonic resection have focused on the left colon and rectum[1]. Locating the root of the inferior mesenteric artery (IMA) and protecting the autonomic nerve and ureter are of importance in total mesorectal excision (TME) [1]. There is an important surgical plane defined as Toldt’s space. Toldt’s space appeared and remained consistently between the lateral left mesocolon and prerenal fascia, as well as between the medial left mesocolon and pre-aortic fascia. The space also appeared between the mesorectum and parietal layer of the pelvic fascia[1].

Dissecting in the Toldt’s space might protect autonomic nerves and the ureter because they are all located beneath the pre-renal fascia [1]. The IMA ran along the surface of the cephalic abdominal aorta, down to the pelvic cavity and pre-sacral space. On the lateral side, an obvious yellow-white borderline was visible. The yellow portion is a part of the sigmoid mesocolon, and the white is a lateral abdominal wall. Dissecting from the medial and lateral space frees the colorectal mesentery completely. The surgical planes are between the colorectal mesenteries and the continuous pre-renal fascia. The superior hypogastric plexus closely associates with the back of the IMA. No obvious branches of autonomic nerves were found in the loose space between the visceral layer fascia (mesorectum) and the wall layer fascia (parietal pelvic fascia) at the back of the rectum [1]. Just inferior to the splenic flexure, the ligament of Treitz and the main vessels of the left colon are seen. Ligament of Treitz (LT), inferior mesenteric vein (IMV) and inferior mesenteric artery (IMA) (Fig.1)[2].

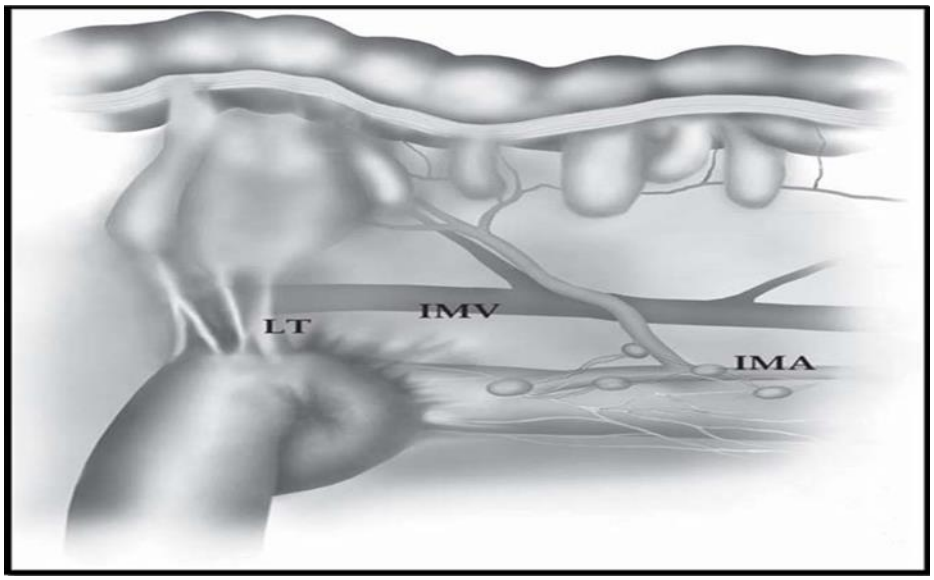

Fig. (2): Ligament of Treitz (LT), inferior mesenteric vein (IMV) and inferior mesenteric artery (IMA) [2].

By retracting the small bowel to the right side of the abdomen, the attachments of the sigmoid colon and the main vessels of the left colon may be seen (Fig. 2)[2].

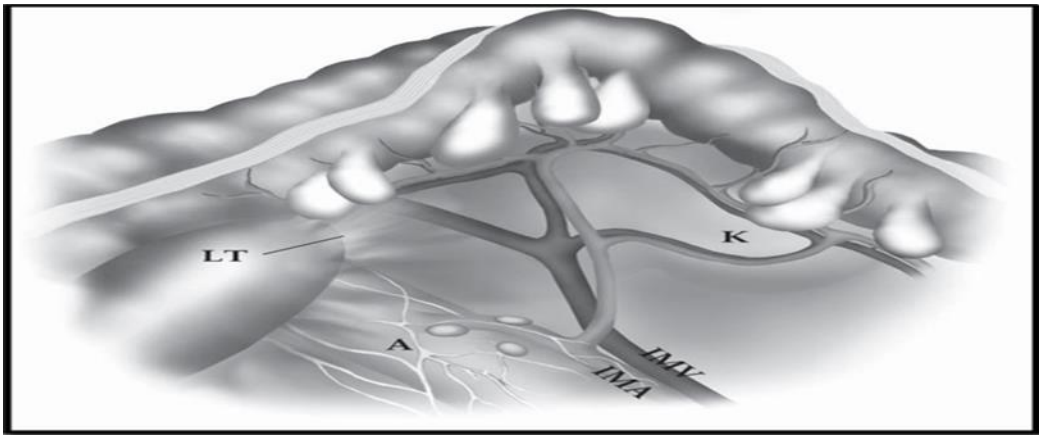

Fig. (2): Vascular supply of left colon: inferior mesenteric artery and vein (IMA&IMV), Aorta (A), ligament of Treitz (LT) and kidney [2].

During the surgical mobilization of the sigmoid colon, the relationships of the gonadal vessels and the ureter are appreciated. Sigmoid colon (SC), gonadal vessels (GV) and ureter (U) (Fig.3)[2].

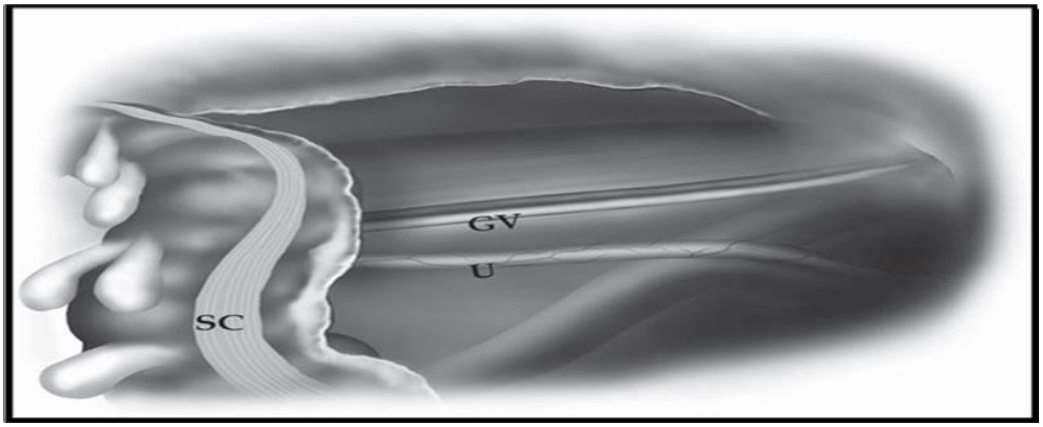

Fig. (3): Sigmoid colon (SC), gonadal vessels (GV) and ureter (U) [2].

During a surgical dissection of the origin of the inferior mesenteric artery, the relationships of the hypogastric nerves and the aorta are appreciated. Note how the two branches (left and right) are straddling the aorta. Inferior mesenteric artery (IMA), aorta (A) and left branch of the hypogastric nerve plexus (HN) (Fig. 4)[2].

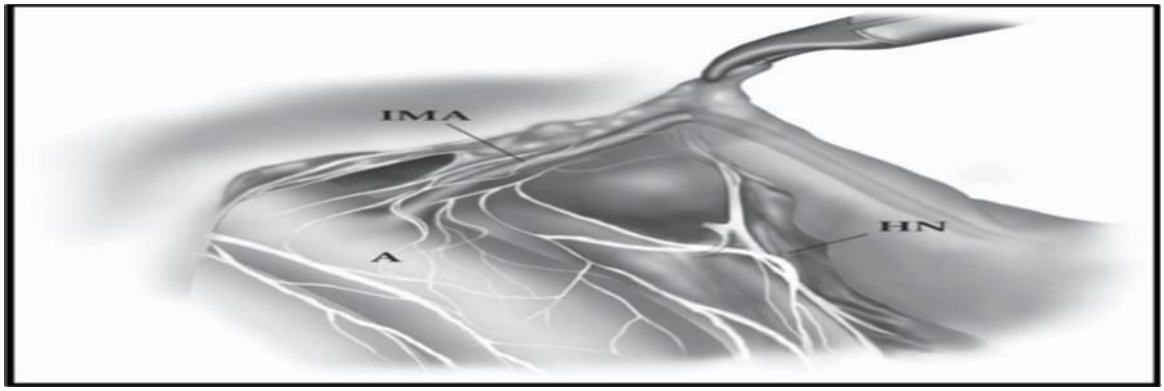

Fig. (4): Inferior mesenteric artery (IMA), aorta (A) and left branch of the hypogastric nerve plexus (HN) [2].

After complete mobilization of the rectum, the laparoscopic view affords excellent appreciation of some of the deep pelvic structures. Rectum (R), anal sphincter (AS), pelvic floor (PF), anococcygeal ligament (ACL) and coccyx (C) [2].

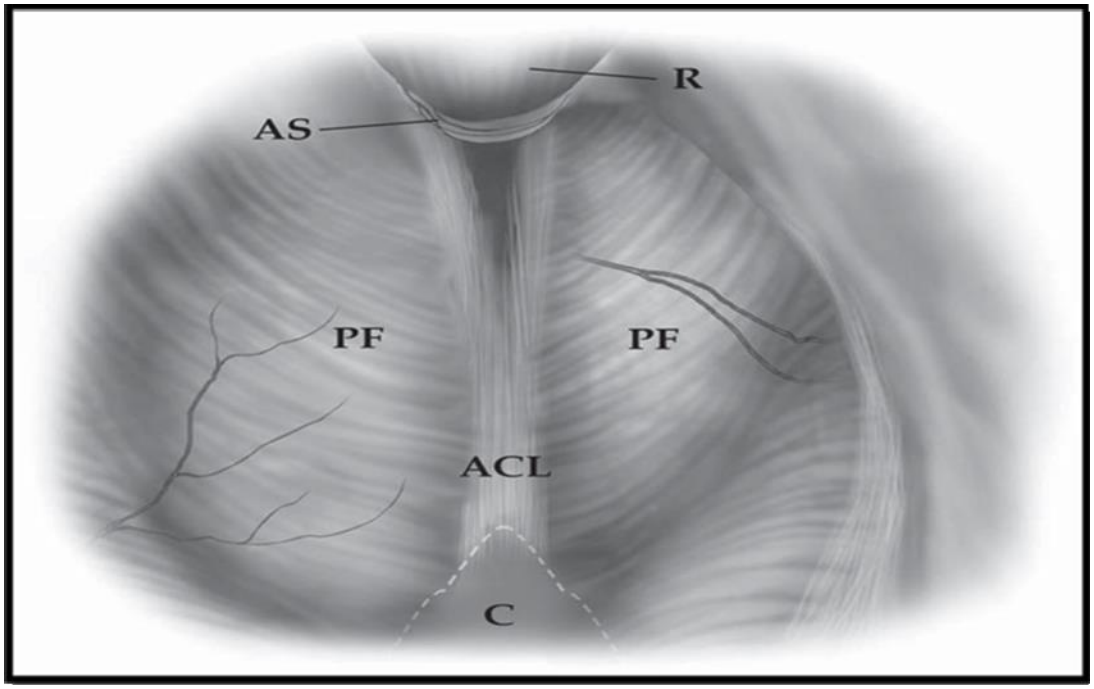

Fig. (5): Rectum (R), anal sphincter (AS), pelvic floor (PF), anococcygeal ligament (ACL) and coccyx (C) [2].

Total Mesorectal Excision (TME):

Total mesorectal excision (TME) technique was described by Heald in 1982 [3]. It consists of resection of the rectum within the mesorectal envelope, allowing for the removal of the mesorectum en bloc along with the fascia recti propria [3]. The local recurrence rate in rectal cancer patients exceeded 25% before implementation of the TME technique, whereas the local recurrence rate was reduced to 4% to 5% with the implementation of TME [4]. A complete TME has been defined as a "complete removal of the lymph node bearing mesorectum along with its intact enveloping fascia." The complete TME has components including: (1) high ligation of the inferior mesenteric artery (IMA), (2) complete mobilization of the splenic flexure, (3) division of the colon at the descending sigmoid junction, (4) sharp dissection in the avascular plane into the pelvis anterior the presacral fascia and outside the fascia propria or enveloping visceral fascia, (5) division of lymphatic and

middle hemorrhoidal vessels anterolaterally, and (6) inclusion of all pelvic fat and lymphatic material at least 2 cm below the level of the distal margin. All of these criteria have been validated by multiple studies and are the framework for current practice guidelines [5].

The technique of TME performed in concert with APR or low anterior resection (LAR) allows for precise dissection and removal of the entire rectal mesentery, including that distal to the tumor as an intact unit. Conventional blunt dissection techniques resulted in unacceptable inadequate surgical clearance and likely explained high local failure rates. Because TME is performed sharply under direct visualization with a focus on autonomic nerve preservation and avoidance of mesorectal envelope violation, all tumor satellites should be contained, improving the likelihood of local control. In most series, local recurrence rates are less than 7% in patients undergoing TME even when no adjuvant therapy is given [6]. TME is the gold standard for the surgical treatment of rectal cancer involving the middle and lower third of the rectum. For the upper third of the rectum, TME is not considered obligatory (removal of the mesorectum to the level of the levator muscles) [4].

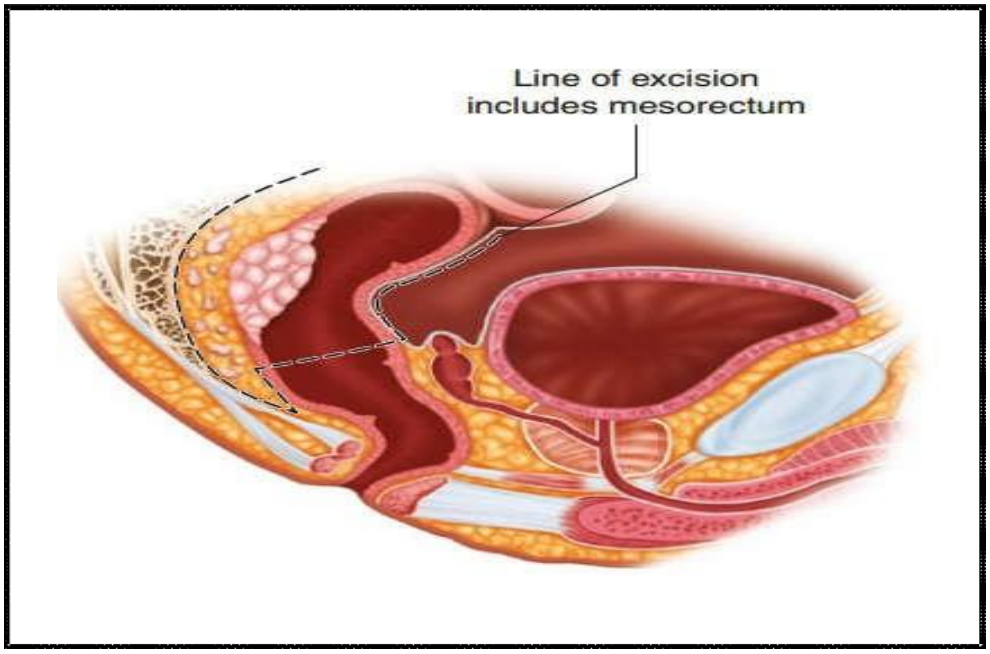

Figure (6): Plane of excision in total mesorectal excision [7].

An ideal specimen should have the following criteria:

- Circumferential margin 1mm.
- Distal resected margin 2cm (or 1 cm with clear frozen section in the low rectum).
- Good TME specimen as defined earlier [8].

Table (1): Quality of the mesorectum [8].

Quality of the Mesorectum	
Good	Intact Mesorectum with only minor irregularities of a smooth mesorectal surface. No defect is deeper than 5 mm. No coning on the specimen.Smooth CRM on slicing.

Moderate	Moderate bulk to the mesorectum, but irregularity of the mesorectal surface. Moderate coning of the specimen toward the distal margin. At no site is the muscularis propria visible, with the exception of the insertion of levator muscles. Moderate irregularity of CRM.
Poor	Little bulk to mesorectum with defects down to muscularis propria and/or very irregular circumferential resection margin.

B) Rectal surgery (Resection margins):

1. Proximal Margin: A single study performed in 1954 revealed that submucosal spread rarely exceeds 4 cm. Consequently, a proximal margin of 5 cm remains the recommended extent of proximal large bowel resection [9].
2. Distal Margin: The adequate length of the distal margin for a radical rectal cancer resection remains somewhat controversial. Although the primary area of extension for rectal cancer is upward along the lymphatics, tumors below the peritoneal reflection can spread distally through intramural or extramural lymphovascular routes. The use of APR for low rectal cancers has traditionally been based on the need for a 5-cm distal margin of normal tissue. However, subsequent retrospective studies have shown that margins as short as 1 cm are not associated with an increased risk for local recurrence. Distal intramural spread is usually limited to within 2 cm of the tumor unless the lesion is poorly differentiated or metastatic [6].
3. Radial or Circumferential Margin: The closest radial margin between the deepest penetration of the tumor and the edge of the resected soft tissue around the rectum is termed the circumferential resection margin (CRM). Low rectal tumors will be completely surrounded by a non-peritonealized margin CRM, whereas upper rectal tumors will have a non-peritonealized margin posterolaterally, and a peritonealized (serosal) surface anteriorly [10]. A circumferential margin of 1 mm is the current accepted recommendation, but one study shows that if the circumferential margin is above 2 mm, local recurrence rates decrease from 16% to 5.8% [11].

C) Lymphadenectomy: The current guidelines from the American Joint Committee on Cancer and the International Union against Cancer defined a minimum of 12 lymph nodes to be examined to reach an appropriate pN staging to avoid understaging. While neoadjuvant CRT and radiotherapy (RT) only has been shown to induce shrinkage of the tumor and improved local control, several studies demonstrated a decrease in the number of lymph nodes examined in these pretreated mesorectal specimens [12].

Surgical approaches for rectal cancer: Surgical approaches to the rectum include trans-abdominal procedures abdomino-perineal resection (APR), anterior resection (AR), low anterior resection (LAR) with colo-anal anastomosis or trans-anal approaches [13].

A) Transanal excision: Transanal excision is reserved for early-stage cancers in a select group of patients. Criteria for Transanal excision:

- Lesion less than 3 cm in size.
- Lesion occupying less than 1/3 of the circumference of the rectum.
- Exophytic/polypoidal growth
- Low-grade tumors (well differentiated)
- Tumors located within 8 cm of the anal verge
- T1 lesions
- T2 in select groups.

The lesion is excised fully with a 1 cm margin of normal tissue and the defect is closed. Positive resected margin, lymphovascular invasion, lymph node metastasis in postoperative histopathological examination mandate further radical procedures [14].

B) Abdomino-perineal resection (APR): APR is performed in patients with lower-third rectal cancers. APR should be performed in patients in whom negative margin resection will result in loss of anal sphincter function. This includes patients with involvement of the sphincters, preexisting significant sphincter dysfunction, or pelvic fixation, and sometimes is a matter of patient preference [15]. A 2-team approach is often used, with the patient in a modified lithotomy position. The abdominal team mobilizes the colon and rectum, transects the colon proximally, and creates an end-sigmoid colostomy. The perineal team begins by closing the anus with a purse-string suture and making a generous elliptical incision. The incision is carried through the fat using electrocautery. The inferior rectal vessels are ligated and the anococcygeal ligament is divided. The dissection plane continues posteriorly, anterior to the coccyx to the level of the levator ani muscles [15]. In patients who have rectal cancer with adjacent organ invasion, en bloc resection should be performed in order to not compromise cure. This situation is encountered in 15% of rectal cancer patients. The urinary bladder is the organ most commonly involved in locally advanced rectal carcinoma. Extended, en bloc resection may involve partial or complete cystectomy. In women, rectal carcinoma also commonly invades the uterus, adnexa, and posterior vaginal wall [15].

Treatment of colorectal cancer with liver metastasis: Chemotherapeutic regimens for liver metastasis including systemic and intrahepatic administration have only had limited benefit. Systemic chemotherapy had 18-28% response rates. However, one meta-analysis found that carefully selected patients with metastatic colorectal cancer may benefit from preoperative chemotherapy with curative intent [16]. It is well accepted that liver resections in selected patients are beneficial. Overall, 5-year survival rates following surgical resection of liver metastasis vary from 20-40%. A study by Dhir et al. found that among patients undergoing hepatic resection for colorectal metastasis, a negative margin of 1 cm or more had a survival advantage [17].

C) Low anterior resection (LAR): LAR generally is performed for lesions in the middle and lower third of the rectum. Because this is a major operation, patients who undergo LAR should be in good health. They should not have any preexisting sphincter problems or evidence of extensive local disease in the pelvis. Patients will not have a permanent colostomy but should be informed that a temporary colostomy or ileostomy may be necessary. They also must be willing to accept the possibility of slightly less-than-perfect continence after surgery, although this is not usually a major problem. Other possible disturbances in function include transient urinary dysfunction secondary to weakening of the detrusor muscle. This occurs in 3-15% of patients. Sexual dysfunction is more prominent and includes retrograde ejaculation and impotence. In the past, this has occurred in 5-70% of men, but recent reports indicate that the current incidence is lower [18].

D) Ultra-low anterior resection: Very distal rectal cancers that are located just above the sphincter occasionally can be resected without the need for a permanent colostomy. The relationship of low-lying rectal tumors with respect to the anal sphincter complex is based upon the Rulliey Classification system for distal rectal tumors. There are four types classified as follows:

- Type 1: supra-anal, > 1cm from anorectal ring.
- Type 2: Juxta-anal, < 1cm from the anorectal ring.
- Type 3: Intra-anal with internal anal sphincter invasion.
- Type 4: Trans-anal with invasion of tumor into levator ani or external anal sphincter.

The suggested surgical options for these tumors are as follows:

- Type 1: Managed by ultra-low anterior resection
- Type 2: Managed by partial inter-sphincteric dissection with ultra-low anterior resection.
- Type 3: Managed by total inter-sphincteric dissection with ultra-low anterior resection.
- Type 4: Managed by abdominoperineal resection [19].

The functional results of this procedure have been poor in some patients, who experience increased frequency and urgency of bowel movements, as well as some incontinence to flatus and stool. An alternative to the straight-tube CAA is the creation of a colonic J pouch. The advantages of the J pouch include decreased

frequency and urgency of bowel movements because of the increased capacity of the pouch. A temporary diverting stoma is performed routinely with any coloanal anastomosis [20].

Fluorescence imaging with indocyanine green (ICG) has been increasingly considered a potential intraoperative tool that could be used in routine practice to ensure adequate perfusion at the time of anastomosis formation. It allows surgeons to visualize bowel microperfusion in real time, being fast and easy to perform. Recent literature shows the potential benefit of fluorescence imaging with ICG in lowering anastomotic leak (AL) rates by changing the surgical plan. Moreover, it has already been proven to be safe and feasible in colorectal surgery. However, further research is needed to validate its efficacy in reducing the AL rate [21].

Minimally invasive techniques: Minimally invasive approaches can be used to effectively treat a variety of colon and rectal conditions. Advanced technologies eliminate the need for large incisions. Laparoscopic surgery is a specific type of surgery, but the term is often used for all minimally invasive surgical procedures. The general consensus is that minimally invasive surgery is suitable for rectal cancer in the hands of well-trained surgeons following accepted cancer surgery principles [22].

Laparoscopic surgery: Laparoscopic rectal surgery eliminates large incisions and bowel exposure to room air as it excels in its plasticity with flexible placement and number of trocars as needed. A supportive hand port is optional and may be used to facilitate the dissection and serve as an extraction site for the specimen. The position of the operating table can be adapted to momentary needs to take full advantage of gravity, and the surgeon can move easily around the table [23].

Robotic surgery or robotic-assisted surgery: Similar to standard laparoscopic surgery, this newer technique allows a surgeon to control a robot that moves the surgical instruments [24]. The robotic approach with stabilized 3D vision and a higher degree of freedom for instrument motion and maneuverability was engineered to address some of the specific problems of laparoscopic surgery. The robotic TME has been standardized over time. The instruments are touted as having seven ranges of motion and behave more like a normal human wrist [24].

Advantages of minimally invasive techniques:

- Incisions are much smaller than those used in traditional surgery, so there is usually less post-surgery discomfort.
- Shorter hospital stays.
- Reduced prescription pain medications.
- Earlier return to normal activities.
- Less visible scarring.

It is important to note that long-term outcomes are similar between open and minimally invasive procedures. However, minimally invasive surgery offers potential benefits in the early post-surgery recovery period [25].

Functional outcome after rectal surgeries: Before the introduction of TME, the incidence of postoperative urinary and sexual dysfunction was high, with reported rates of 10-30% and 40-60% respectively [26]. Following rectal surgery, bowel and GI dysfunction range from 13-49% for diarrhea and 7 to 16% for other GIT symptoms, which may persist for years into survivorship [27]. Aside from early perioperative or postoperative complications, preoperative radiochemotherapy may result in late toxicity involving anorectal, sexual, and urinary function. Approximately one-third of cancer survivors suffer from chronic gastrointestinal symptoms. If initially the incidence of postoperative dysfunctions was high with reported rates up to 30–60%, the introduction of TME and preservation of the autonomic nerves reduced the incidence of postoperative complications to 10–35% [28]. Neoadjuvant treatment was also found to be an independent risk factor for low anterior rectal syndrome after long-term follow-up and the mean number of daily bowel movements to be increased at one year after preoperative radiochemotherapy [29]. Colonic J pouch and side-to-end coloanal anastomosis lead to a better functional outcome than straight coloanal anastomosis for the first year after

surgery. No superiority of stapled over handsewn techniques in colorectal anastomosis surgery, regardless of the level of anastomosis [30].

Low Anterior Resection Syndrome: Low anterior resection syndrome (LARS) is severe bowel dysfunction resulting in incontinence of flatus, feces, urgency, and frequency that occurs after low anterior resection; the reported incidence is 10-20% and apparently related to the location of the anastomosis in proximity to the anal verge [31]. LARS is thought to occur by one or more of several pathophysiologic mechanisms: rectal reservoir dysfunction, colonic dysmotility, or anal sphincter damage. Prevention is somewhat achieved by limiting the amount of radiation delivered to the sphincter when possible [32, 33].

Late Small Bowel Toxicity: Late small bowel toxicity develops usually 6-18 months following radiotherapy; frequent symptoms include bloody diarrhea, colicky abdominal pain, nausea, and vomiting; less common are severe side effects like small bowel obstruction, fistulas, bowel perforation, and massive bleeding [34, 35].

Sexual Dysfunction: Sexual dysfunction is a common problem among male RC survivors. Radiation treatment for RC may also cause damage to the nerves and blood vessels involved in erections; the buildup of fibrosis occurs at a gradual rate after radiation [36]. In men, the sympathetic nerves control ejaculation with injury resulting in ejaculatory dysfunction; symptoms can consist of absent ejaculation, retrograde ejaculation, and painful ejaculation; parasympathetic nerves control erectile function with injury resulting in impotence [37]. In women, there is limited data concerning female sexual function following mesorectal resection. Injury to these nerves can cause difficulty in achieving an orgasm and can cause vaginal dryness and dyspareunia [38].

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