Robotic Abdominoperineal Resection

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Introduction

Abdominoperineal resection (APR) has been considered the operation of choice for lower rectal and anal canal tumors. First described by W. Ernest Miles in 1908 as a combined perineal and abdominal approach [1], APR has experienced many changes with the availability of minimally invasive techniques, but it follows the same key oncological principles. In this chapter, we describe robotic APR with different perineal approaches (lithotomy and prone) (Video 27.1).

Indications for Abdominoperineal Resection

APR is a standard treatment for adenocarcinomas that are fixed and/or infiltrate or about the anorectal ring. APR is usually indicated when the likelihood of obtaining an oncologically safe circumferential margin is low, rather than as a distal negative-margin compromise. It is the procedure of choice for patients with persistent or recurrent anal squamous cell carcinoma after definitive chemoradiotherapy [2]. Rare cases of melanoma, sarcoma, or gastrointestinal stromal tumors may require APR. APR can also be necessary in cases of vulvar, vaginal, and/or prostate cancer. During the decision process, anal continence should be taken into consideration. APR can result in a better quality of life in patients after a low anterior resection (LAR) and poor previous anal sphincter function [3]. APR can be considered in some cases of benign disease such as familial adenomatous polyposis syndrome or inflammatory bowel disease, but it is not the standard of care.

Preoperative Planning

APR is associated with considerable morbidity, making a proper preoperative evaluation mandatory. A digital rectal exam is necessary to evaluate the tumor mobility and distance from the anorectal ring. MRI is an excellent modality for evaluating the relationship of the tumor to various pelvic structures and for determining the extent of the planned resection [4]. Endorectal ultrasound can also be helpful for evaluating anorectal ring infiltration when there is doubt [5].

All patients should have medical clearance prior to surgery, and a colostomy site should be

Electronic supplementary material The online version of this chapter (https://doi.org/10.1007/978-3-030-18740-8_27) contains supplementary material, which is available to authorized users.

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J. Kim, J. Garcia-Aguilar (eds.), *Minimally Invasive Surgical Techniques for Cancers of the Gastrointestinal Tract*, https://doi.org/10.1007/978-3-030-18740-8_27

marked by a stoma therapist. Patients must be informed of possible long-term outcomes, particularly sexual and urinary dysfunction [6]. An enhanced-recovery-after-surgery protocol should be considered as standard of care postoperatively for patients undergoing APR. [7]

Operative Technique

Anatomical Considerations

The key to a successful APR is complete knowledge of the pelvic structures and pelvic floor. The pelvic floor is formed by the levator ani and coccygeus muscles, with the levator ani comprising the puborectalis, pubococcygeus, and iliococcygeus muscles. The fibers of the levator ani muscle are excised in an APR, while the coccygeus muscle is often preserved.

The rectum is usually described as the last 15 cm of the large bowel, but no clear boundaries have been defined. Internally, the rectum contains three valves, known as Houston valves, which can be used as a reference for locating rectal tumors. A more accepted and widespread method is to measure the distance of the lesion from the anal verge using a rigid or flexible scope. The anorectal junction, which is palpable at the top of the anorectal ring, is another important surgical landmark, comprising mainly the puborectalis and external sphincter muscle.

The mesorectum (mesentery of the rectum) carries all the vessels, nerves, and lymphatic drainage. It gains more prominence in the extraperitoneal portion of the rectum, becoming thick and bilobar in the posterior aspect. In its most distal part, the mesorectum narrows until it disappears at the pelvic floor. The fascia propria of the rectum varies in thickness. Anteriorly, the presence of a thin layer known as Denonvilliers' fascia separates the rectum from the urogenital structures. In the posterior aspect, a dense layer of fibrous tissue known as Waldeyer's fascia extends from the sacral vertebrae to the anorectal ring. It is very important to understand the anatomy of the posterior aspect of the rectum because dissection should begin there and requires accurately identifying the loose connective tissue that separates the mesorectum from Waldeyer's fascia. The lateral aspects of the extraperitoneal rectum are fused with the connective tissue and nerve plexus of the pelvic sidewall, forming lateral stalks. In some patients, the accessory middle rectal vessel is located at these structures.

The arterial supply from the upper rectum comes from the superior rectal artery, which is a terminal branch of the inferior mesenteric artery (IMA). The lower rectum receives blood from the inferior rectal artery, a branch of the pudendal artery providing blood to the anal canal and anal sphincter. Venous drainage comes from the superior rectal vein, which runs with its homonymous artery and joins the left colic vein to drain into the inferior mesenteric vein (IMV). The inferior rectal vein drains directly into the internal iliac veins. The middle rectal vessels are inconsistent branches that form part of the iliac vessels.

Important factors regarding the regional nerve anatomy must be considered in planning rectal cancer surgery, because correct identification of the nerve plexus is essential for better functional outcomes. The hypogastric plexus, located at the lower aorta, contains sympathetic fibers that arise from the lumbar sympathetic trunk. At the level of the aorta bifurcation, two well-defined hypogastric nerves run over the internal iliac vessels to the pelvic sidewall [8]. At the sidewall, they merge with fibers of the parasympathetic plexus from S3 to S4, which innervates most of the pelvic urogenital structures. Pudendal nerves originate from the sacral plexus, comprising somatosensory and parasympathetic fibers that innervate the perineal region and anal sphincter.

Operating Room Configuration and Patient Positioning

One of the most important aspects to consider is operating room configuration and patient positioning. For the robotic approach, this task is

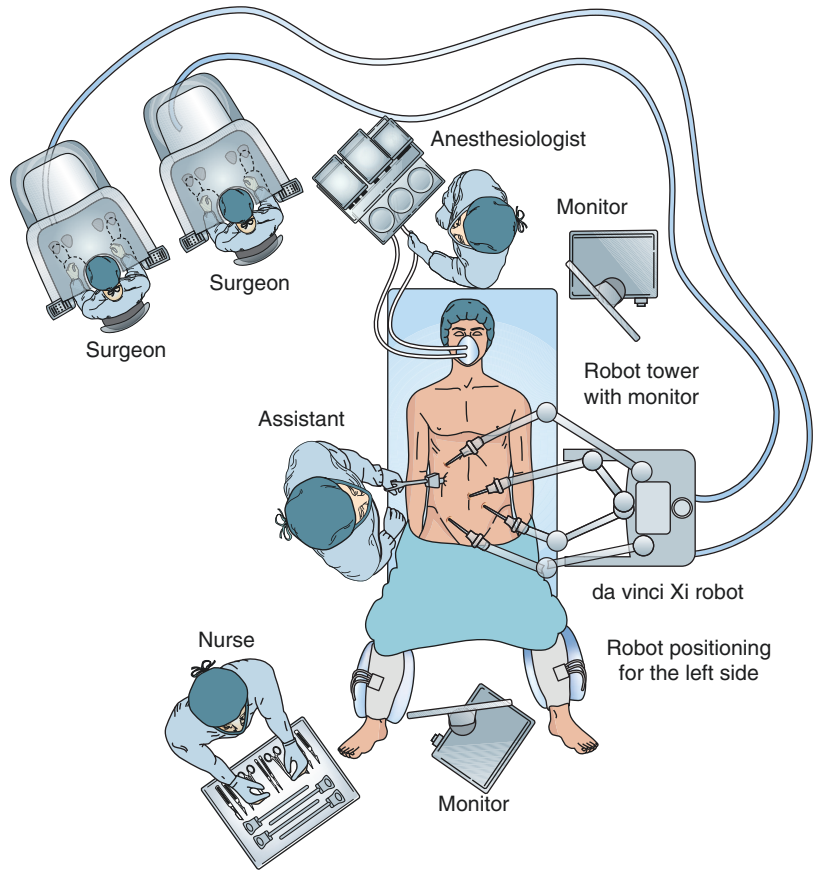

Fig. 27.1 Typical operating room setup for the abdominal portion of robotic APR at our institution

essential. The robot cart should be positioned to the left of the patient, allowing the surgeon to have direct access to the pelvis, keeping in mind that the cart should be removed before proceeding with the perineal part of the procedure (Fig. 27.1).

For the abdominal part of the surgery, the patient should be placed in the lithotomy position, with legs flexed and arms tucked in, but always ensuring easy access for the anesthesiologist. The patient should be secured to the bed with straps around the chest and legs and shoulder pads to prevent the patient from sliding when the bed is tilted. Care must be taken to protect points of pressure in order to prevent iatrogenic lesions. At Memorial Hospital, a rectal washout and closure of the anus with a silk suture are done before sterile drapes are positioned.

Trocar Positioning

Trocars should be positioned after pneumoperitoneum is established because abdominal wall distension can alter the original positioning. Once the patient is correctly positioned and anesthetized, pneumoperitoneum can be established through an open approach with a Hasson port site after a 1.5-cm midline incision or with a Veress needle in the left upper quadrant directly under the costal border. Arm 1 should be positioned in the upper right quadrant during the dissection of the IMA and superior rectal vessels. Arms 2 and 4 are used for the pelvic part of the dissection and are located as shown in Fig. 27.2. During pelvic dissection, arm 1 can be positioned in the left lower quadrant for retraction of the vagina or prostate. Trocar 3 is generally used for the camera (Fig. 27.2 C(R3)).

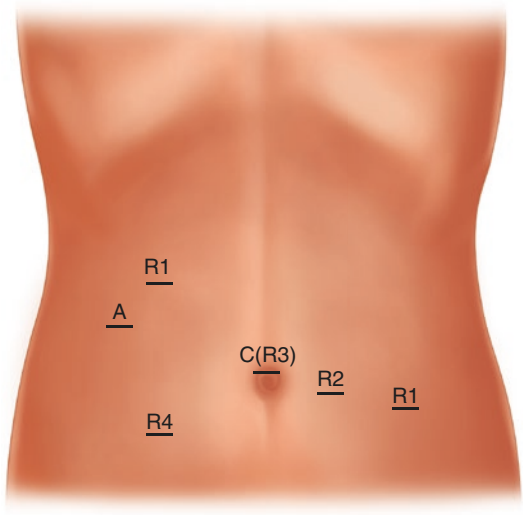

Fig. 27.2 Trocar positioning for the abdominal portion of robotic APR. Trocars are numbered according to the numbering of the robotic arms. A: assist port

Surgical Field

Once the ports are placed, a general examination is recommended to evaluate the possibility of metastatic disease in the peritoneum, liver, or any other abdominal organs. This should be done before docking the robot. Once the robot is docked and the patient positioned right side and head down, the next step is to expose the IMA, which can be found after identifying the right iliac artery and following it caudally. Proper mobilization of the small bowel from the surgical field is essential to avoid inadvertent injury/enterotomy and to facilitate IMA dissection. This occasionally requires sharp dissection and mobilization of embryologic adhesions to better expose the sacral promontory and to better visualize the target anatomy.

Inferior Mesenteric Artery Dissection

After IMA identification, one of the robotic arms should maintain tension to obtain correct exposure. A parallel incision to the right iliac artery should be done nearly perpendicular to the IMA following the insertion into the aorta. The pneumoperitoneum will help identify the plane in which the dissection will be performed. All the periaortic and peri-mesenteric artery tissue should be removed carefully to ensure a proper oncological resection. The dissection can be done with a 0 ° camera, but a 30 ° camera can also be used. Once the plane is identified, the superior rectal artery can be elevated with an arm, and medial-to-lateral dissection can be carried out with proper identification of the ureter and gonadal vessels. This dissection can be performed with robotic scissors or with a vessel sealer although these authors prefer use of the scissors for more precise dissection. The psoas muscle should not be exposed because the ureter and gonadal structures run over this plane, and dissection here increases the risk of injury, although in very thin patients with scarce intra-abdominal fat tissue, it can be difficult to find the correct plane.

The IMA can then be divided using a conventional linear endostapler through assistant port sites, a robotic linear stapler, a vessel sealing device, or the Hem-o-lok system. Using a stapler helps avoid extreme dissection of the artery, while using Hem-o-lok facilitates identification of the artery, although more time is required for the dissection. A selective dissection of the superior rectal artery and sigmoid branches can be performed (Fig. 27.3), but a proper lymphadenectomy should be done if there is suspicious preoperative lymphadenopathy to reduce the risk of recurrence [9].

Medial-to-Lateral Dissection

After the artery is divided, the stump should be gently lifted to complete the medial-to-lateral dissection. Correct dissection here is important in order to protect autonomic nerve function. When the wall of the colon is reached, the dissection should end. The third arm, which was used to lift the colon and then the stump of the artery, should now retract the colon from the abdominal wall to expose Toldt's fascia, which should be opened to

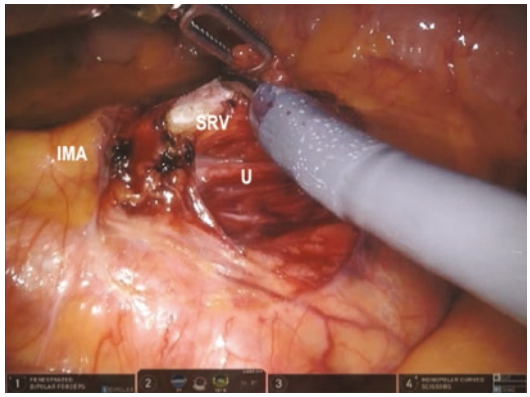

Fig. 27.3 A selective section of superior rectal vessels (SRV) can be performed, but a proper lymphadenectomy should be done if there is suspicious preoperative lymphadenopathy at the root of the inferior mesenteric artery (IMA). Clear visualization of the left ureter (U) before vascular section is essential

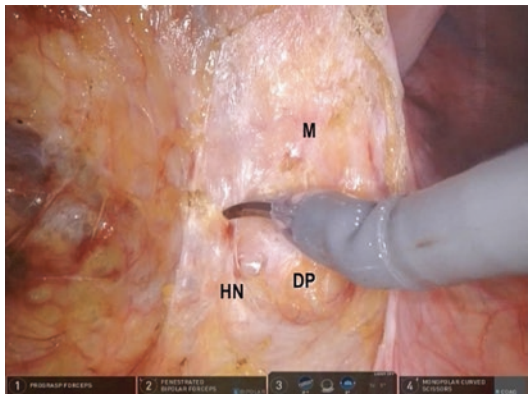

Fig. 27.4 Posterior dissection in the areolar space between the mesorectal fascia and presacral fascia. M, mesorectum; HN, hypogastric nerve; DP, dissection plane

meet the retromesocolic dissection plane. When the medial-to-lateral dissection is not done to completion, the risk to the ureter or gonadal vessels is further increased, and special attention to this step is necessary to avoid harm.

Pelvic Dissection

For dissection of the mesorectum, the importance of the third robotic arm is greater than in previous steps because this arm is used to retract the rectum and provide a correct view of the pelvis, first of the posterior mesorectal plane from the promontory to the pelvic floor and second of the lateral and anterior planes (Fig. 27.4). Pelvic peritoneum should be opened on both sides, and a sharp posterior dissection should be performed with robotic scissors. Care must be taken to avoid bleeding from the posterior venous sacral plexus and potential injury to the hypogastric nerves and lateral pelvic plexus. This plane should be dissected to the pelvic floor to avoid a cylindrical resection. Lateral mesorectal dissection can be particularly challenging, and special attention should be paid to avoid damage to neurovascular structures.

The anterior plane should be the last part of the mesorectal excision. The third arm can now be used to first lift the bladder and then the prostate or the vagina. With the anterior pelvic peritoneum now open, the dissection is extended just inferior to the cervix or the seminal vesicles. Careful dissection should be carried out with meticulous hemostasis to avoid unnecessary bleeding in the lower pelvis.

Division of the Colon and Creation of a Colostomy

Once the mesorectal excision is completed, the mesocolon and the colon should be divided. The artery stump and all the lymphovascular tissue excised should be included in the specimen. The colon should be divided with an endostapler, and tension of the proximal colon must be evaluated for the creation of a proper terminal colostomy. The surgical specimen is then abandoned in situ for extraction during the perineal phase. Pelvic drains should be secured before placing the patient in the prone position. The drains should be secured to the specimen. After examination of the abdominal cavity, with careful attention paid to dissection planes, the ports are closed and a colostomy is created at a previously marked location.

Perineal Dissection

The perineal dissection in a robotic APR can be performed with the patient in either the classic lithotomy position or a prone position. Both approaches have pros and cons, but they share the same oncological principle of exposing and sectioning the levator muscle from below. There has been some discussion regarding the degree of sectioning of the levators in the context of a standard APR. An intralevator dissection entails more medial sectioning of the levator muscles, sometimes resulting in a surgical specimen in the shape of an hourglass and increasing the risk of circumferential resection margin positivity and intraoperative perforation [10]. This technique can be the definitive treatment for smaller T1/T2 tumors, helping to preserve tissue for more effective closure of the perineal wound. For bigger tumors, a wider dissection known as extralevator APR is more appropriate. An extralevator APR produces a truly cylindrical specimen, diminishing the risk of a positive resection margin [11]. This procedure is usually associated with wider perineal defects requiring flaps and/or mesh for closure.

Perineal Lithotomy Dissection

For perineal dissection, a second tray is used in order to reduce potential contamination between surgical fields. As the patient is placed in a supine position, care should be taken to ensure that the patient's buttocks are at the very end of the table, providing good exposure of the perineum. A high lithotomy position is recommended for visualization of the levator muscles during dissection. Usually, two surgeons are needed, with an assistant helping with retraction in the anterior perineum.

An elliptical incision is made around the anus, and the dissection is carried out through the ischiorectal fat just outside the sphincter complex. Anteriorly, the dissection proceeds until the perineal body is reached. The anococcygeal ligament is used as an anatomical landmark in the posterior dissection to facilitate exposure of the levator muscles lateral to it.

One of the main advantages of the perineal approach is that it allows abdominal visualization via the robotic camera to guide dissection. Usually, the levator muscles are initially sectioned in the posterior aspect above or with the coccyx, with sectioning continuing bilaterally, creating an opening in the posterior aspect.

Anterior dissection can be difficult, especially in men with a narrow pelvis, elevating the risk of lesion in the membranous urethra and prostate. Partial extraction and eversion of the surgical specimen can facilitate the dissection, but care must be taken during manipulation not to tear or expose the tumor. In women, dissection can be completed with intermittent palpation of the posterior vaginal wall.

The use of the lithotomy position for APR also offers the advantages of shorter operative time, if two surgical teams are used, and safer access in case of major bleeding.

Perineal Prone Dissection

The use of a second operating table is ideal for minimizing the time required for patient repositioning. This table is secured and all equipment required for this portion is obtained while beginning the first portion of the operation. A large hip roll is used at the break in the table, and secondary rolls are used to support the patient's chest in order to avoid brachial nerve plexus injury (Fig. 27.5). The patient should be secured at the level of the legs and trunk. The patient's legs can be separated if a split table is used, allowing the surgeon to face the surgical site directly.

An elliptical incision is made immediately outside the lateral edge of the external sphincter and medial to the ischial tuberosity. Once the skin is open, the use of a Lone Star retractor (Cooper Surgical, Inc.) can be helpful. Anteriorly, the perineal body should be sectioned, and in the posterior dissection, the incision should be made at the midline between the coccyx and anus. For tumors that do not involve the sphincter or the levator ani muscle, a narrower incision can be made, sparing the ischiorectal fascia and facilitating wound closure. Wider resections may be necessary in cases of recurrent disease or minimal response to multimodal therapy with a bulky tumor. The dissection is made with electrocautery. A helpful maneuver is to palpate the coccyx

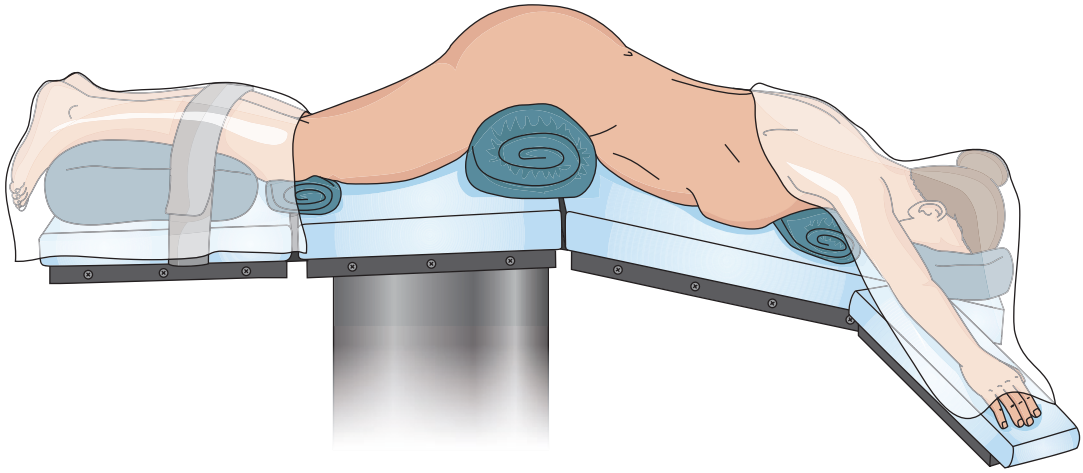

Fig. 27.5 Prone jackknife position for perineal dissection. Padding is used under the chest, hips, knees, and feet

posteriorly and aim in a plane directly anterior to it. The coccyx can be removed, but we do it only if it is compromised by the tumor or if necessary to remove a large, bulky tumor. A key point is to divide the anococcygeal ligament at the tip of the coccyx, connecting the perineal surgical field with the posterior mesorectal dissection. The levator ani muscle should be sectioned bilaterally, beginning at the apex of the ischiorectal fossa and close to the obturator internus muscle (Fig. 27.6). The puborectalis muscle should be sectioned anteriorly before reaching the transverse perineal muscle.

The complete specimen is then extracted (note that the drain from above should be attached), and the dissection is continued proximal to distal and medial to lateral rather than from the bottom. The prone position facilitates exposure of the neurovascular bundle and can help prevent injury to the urethra, especially in men.

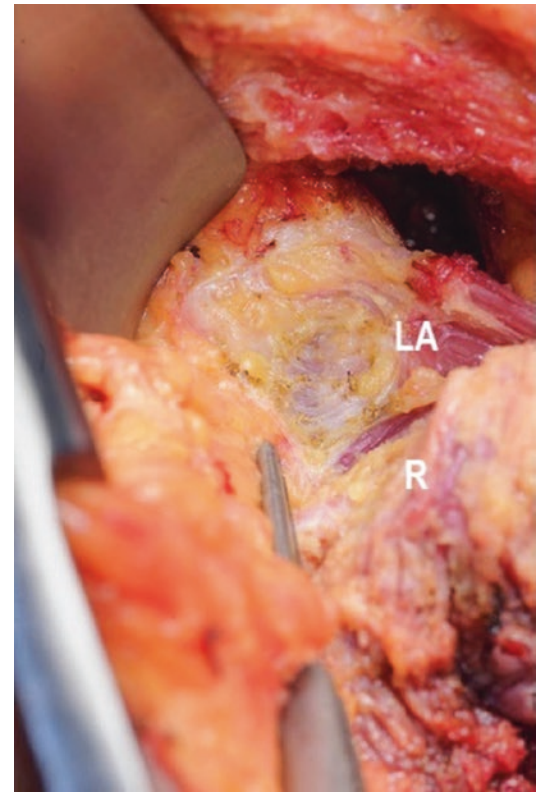

Fig. 27.6 Exposure of levator ani (LA) muscles for proper division. R: rectum

Perineal Defect Closure

Once the specimen is removed, copious irrigation of the surgical site is performed. The pelvic drains are now secured in the final position before wound closure. In a primary closure, large absorbable sutures are used in a multilayer fashion to close the ischiorectal fat. Discontinuous nylon sutures are used to close the skin, and we prefer a vertical mattress method. It is the authors' preference to use a negative-pressure surface dressing over an antibiotic impregnated dressing for the first 3 days to keep the wound

clean and dry. To prevent surgical site infection and perineal hernia, especially in wider resections, a biological absorbable mesh or autologous tissue flaps can be used. Previous studies have shown no difference in the rates of morbidity or dehiscence between the different options of reconstruction [12, 13].

Postoperative Management and Complications

Postoperative care for APR follows a routine pathway at Memorial Hospital. We advocate the use of an enhanced-recovery-after-surgery protocol with early oral ingestion of fluids, early ambulation, and a standardized pain-control strategy minimizing or avoiding use of opiates. The urinary catheter is removed on post operative day (POD) 3 after an extensive pelvic dissection and on POD 2 on a standard dissection. Drainage continues for some time due to the excessive amount of fluid. If a flap was used, drainage may continue after hospital discharge. The perineal wound should be protected, and strenuous physical activity and direct pressure with sitting must be restricted. Perineal sutures remain in place for 3–4 weeks, until the wound is completely closed. Special care should be taken regarding activities like excess bending or prolonged sitting, in order to avoid shear or tension in the flap area. Most of the morbidity associated with APR is related to the perineal wound due to the extensive defect. The rates of wound dehiscence and infection can be as high as 30% [14], and the etiology can be multifactorial. Reduced rates of surgical site infection and recurrence have been reported [15, 16], but the data were obtained in observational studies. In our local series, robotic APR is associated with less abdominal surgical site rate of infection compared with the open approach (unpublished data). Aggressive management of dehiscence with early intervention, local wound care, and negative-pressure dressings can salvage most wounds with a good outcome.

Conclusion

Abdominoperineal resection (APR) has been considered the operation of choice for lower rectal and anal canal tumors. According to the authors' experience, robotic APR is a safe approach for low rectal tumors, and it is associated with less morbidity mainly due to less abdominal surgical site infection rates. Prone patient positioning for the perineal portion of APR is a feasible approach and should be used in accordance with the surgeon's preference and expertise.

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