Robotic Abdominoperineal Resection

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Introduction

Numerous advances in robotic colorectal surgery have been made since the first robotic colectomy was performed in 2002 by Weber et al. [1]. New technologies such as haptic feedback, single-port systems, and eye-sensing camera technology are only some of a plethora of advancements that will be seen in the near future. Initial drawbacks to robotic surgery were steep learning curves, operative time, cost, and availability. Now, as robotic-assisted techniques have become more widespread, many of these initial limitations have been mitigated. Increasing evidence is showing robotic-assisted surgery to be superior to traditional laparoscopic, as in the case of rectal surgery, given the increased visibility and degrees of freedom afforded by robotic instruments. Given the narrow surgical field and proximity to major reproductive organs and autonomic centers, rectal dissections are challenging even for experienced surgeons. Herein we describe our technique of robotic-assisted cylindrical abdominoperineal resection, where the abdominal dissection is carried through the levator muscles, providing a complete total mesorectal excision with adequate circumferential resection margins (CRM) specifically at the level of the levator plate, while limiting open pelvic floor dissection from the perineum.

Background

The abdominoperineal resection (APR) is performed primarily for cancers in the lower third of the rectum where the sphincter complex cannot be salvaged. An APR includes total mesorectal excision along with resection of the sphincter complex and a portion of the pelvic floor musculature and perineum. The original total mesorectal excision, as described by Heald, drastically improved overall survival and local recurrence of rectal cancer [2]. The technique is considered standard of care in both the low anterior resection and the abdominoperineal resection and involves carrying sharp dissection in the avascular presacral plane anterolaterally until the entirety of the mesorectal envelope and its contents are excised. In APR, the dissection is continued through the levator musculature either via an abdominal approach or as a continuation of the perineal dissection.

Miles described the original APR in two phases. The first consisting of the abdominal mobilization of the rectum until the levator musculature, with the maturation of a colostomy and abdominal closure. The patient was then flipped over into the prone position where an extensive perineal dissection could be performed [3]. Miles advocated for taking the levators "as far outwards from their origin from the white line" [3, 4]. This wide resection of the levator musculature yields a cylindrical specimen. A recent retrospective study using morphometric data performed by West et al. showed that this traditional cylindrical approach yielded lower rates of positive circumferential resection margins (14.8% vs. 40.6%) and lower rates of intraoperative perforations (22.8% vs. 3.7%) [5]. Major drawbacks to this technique were increased operative time given that the two dissections could not be performed at the same time, and there was a tendency to perform a much wider excision of the perineum than what was necessary, taking the resection through to the origins of the levator muscles near the pelvic sidewall. This led to an increased size of the perineal defect and greater perineal morbidity [6]. If the perineal dissection was performed in a more conservative approach, there was a greater risk of tumor perforation given the paucity of mesorectum at the anorectal junction [7, 8].

The current technique for abdominoperineal resection involves carrying the dissection down the mesorectal

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envelope to the levators, where a second surgical team works on the perineal dissection, carrying the dissection through the levator muscles until met from above [9]. Given that the mesorectum tapers significantly as the levator muscles are approached and is nearly absent at the level of the anorectal junction, carrying out the above dissection will yield a conical, rather than cylindrical, specimen. The incompleteness of the total mesorectal excision will yield higher rates of circumferential resection margin positivity and local recurrence. The Dutch TME/TME and radiotherapy trial found that APR total mesorectal excisions were poorly excised, with only 34% showing complete excision, whereas 73% of anterior resections showed complete excision [9].

Given the numerous benefits of minimally invasive colorectal surgery, including shorter length of stay, earlier return of bowel function, and less analgesic requirements, it is becoming at minimum the standard of practice [10]. The debate is now between whether robotic surgery is superior to traditional laparoscopic. In their study of 113 patients, Baik et al. provided evidence for the superiority of the robotic low anterior resection over laparoscopic low anterior resection, with robotic resections achieving a significantly better mesorectal grade [11]. Additionally, the overall complication rate was nearly double in the laparoscopic group when compared to the robotic group, 19.3% vs. 10.7%, respectively. Given the technical challenge of laparoscopic rectal dissections, six of the patients in the laparoscopic group required conversion to open secondary to rectal perforation, hemorrhage from lateral pelvic wall, or severely compromised visualization from an anatomically narrow pelvis. Operative times were not significantly different between the two groups. In a similar study, Bedrili et al. showed the quality of TME specimens was superior in patients undergoing robotic resections [10].

The benefits of robotic surgery are numerous. Dissection of the rectum requires tremendous precision given the proximity to reproductive organs and major autonomic nerves [12, 13]. We would agree with deSouza et al. that the robot offers superior retraction, an enhanced three-dimensional field of view, and human anatomical articulation, all allowing for a more precise and superior dissection. These "7 degrees of freedom" and 90-degree articulation mimic human anatomy allowing the surgeon real-life ergonomic control [13].

Our approach, first described by Marecik et al., employs robotic transabdominal transection of the levator muscles with robotic dissection carried into the subcutaneous tissue [7]. This allows for an appropriate oncologic resection that limits the risk of tumor perforation and perineal morbidity while providing the benefits of minimally invasive surgery with the technical superiority of robotic surgery. Though large trials have yet to be performed specifically analyzing robotic transabdominal levator resection, our experience leads us to believe that it offers a tailored approach of dividing the levator muscles leading to adequate R0 resection and minimizing larger perineal defects and subsequent morbidity.

Preoperative Planning

Indications

The robotic abdominoperineal resection is primarily performed for adenocarcinoma in the lower third of the rectum where the sphincter complex cannot be spared and patients with preexisting fecal incontinence. Additional indications include recurrent anal squamous cell carcinoma.

Contraindications

Relative contraindications are extensive adhesive disease discovered during initial exploration.

Workup

All patients require a complete colonoscopy to evaluate for synchronous disease. Obtaining accurate information about the size and distance from the sphincter complex is necessary by digital rectal exam and proctoscopy. Staging includes a CT of the chest abdomen pelvis to evaluate for distant metastases, and a pelvic MRI should be performed not only for local staging but particularly in anterior tumors to rule out invasion into adjacent organs and need for exenteration. Patients will then undergo stage-dependent neoadjuvant therapy or immediate surgery.

Room Setup and Positioning

The best technique is to place the patient in the modified lithotomy position with both arms tucked. The lithotomy positioning allows for on-table colonoscopy to be performed. The robot will be docked from the left of the patient. It is important to secure the patient such that sliding will not occur, as the patient will need to be placed in steep Trendelenburg position to facilitate exposure. Some find the usage of a bean bag or a gelpad to be helpful. All extremities should be appropriately padded to prevent nerve injury.

Operative Steps

To facilitate easier reading, all technicalities are in reference to the da Vinci Xi system (Intuitive Surgical, Inc., Sunnyvale, CA).

Exploratory Laparoscopy, Port Placement, and Docking

Port placement will vary with patient body habitus; however it is important to have a general set of rules. The da Vinci Xi system requires a minimum of 8 cm distance between ports. The optimal distance from the camera to the area of interest is between 10 and 20 cm. If the camera is placed greater than 20 cm away, there will be difficulty obtaining appropriate reach with the instruments.

There are numerous ways to enter the abdomen and obtain capnoperitoneum. We prefer to place a 5 mm left upper quadrant laparoscopic port for using the OptiView technique, which is then exchanged to an 8 mm robotic port. The insufflation is then attached to this port (R4). A 12 mm staple port (R1) is then placed in the right lower quadrant either medial or lateral to the inferior epigastric ports depending on the patient's body habitus. The distance between these two ports is then measured, and the remaining two 8 mm robotic ports (R2, R3) are placed equidistant in this oblique line. An assistant 5 mm port is to be placed in the right upper quadrant. We prefer to use the AirSeal access port (CONMED, Utica, NY) (Fig. 16.1). An alternative port configuration can be used if reconstruction will be performed with a robotic rectus muscle flap (Fig. 16.2).

Exploratory laparoscopy with a thorough examination of the abdominal and pelvic cavity should be performed as the first step to rule out metastatic disease and determine the feasibility of a robotic approach. Both the surgeon and the assistant stand on the patient's right side, and the patient is placed in steep Trendelenburg with the left side up, approximately 15° to facilitate movement of small bowel and omentum out of the pelvis.

Initial setup includes fenestrated bipolar grasping forceps on R3 and a tip up grasping forceps on R4 to facilitate rectosigmoid retraction to the abdominal wall. The camera is used through the R2 port, while monopolar curved scissors are placed through R1.

Establishment of the Presacral Plane and Ligation of the IMA

Steep Trendelenburg is maintained with the left side up, the small bowel and omentum are retracted out of the pelvis, and the rectosigmoid is elevated to the abdominal wall.

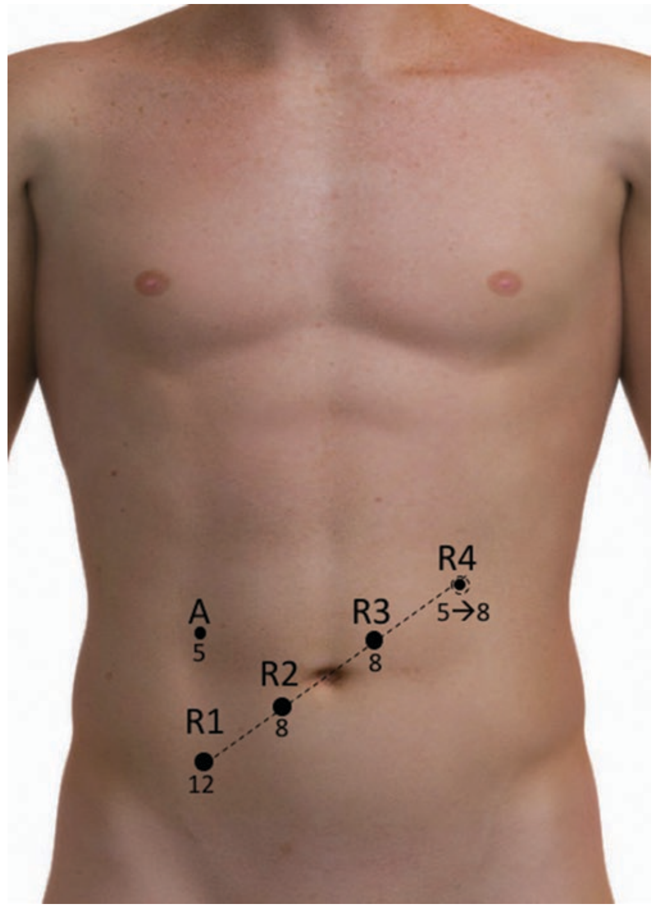

Fig. 16.1 Port configuration: R1, 12 mm staple port; R2, camera port; R3, fenestrated bipolar grasping forceps; R4, grasping forceps; A, assistant port. All numeric values in millimeters

Using monopolar shears through R1, the peritoneum is incised posterior to the inferior mesenteric vessels at the level of the sacral promontory, allowing entrance into the avascular presacral plane (Fig. 16.3). This "holy plane" is anterior to the presacral fascia, otherwise known as the endopelvic fascia. It is important not to violate this layer, as the pelvic and sacral splanchnic nerves as well as the inferior hypogastric plexus lie behind it. At this point the superior rectal artery should be identified along with the left ureter. The ureter can be found posterior to the inferior mesenteric artery (IMA), deep to the parietal peritoneum and medial to the gonadal vessels. It is important however to not perform deep dissection in order to facilitate ureter exposure as there are nearby autonomic centers and the iliac vessels. Occasionally, the ureter will be found on the posterior portion of the inferior mesenteric pedicle. The inferior mesenteric artery pedicle, including the inferior mesenteric vein, should be visualized at this point and taken with a robotic vessel sealer or stapler (Fig. 16.4).

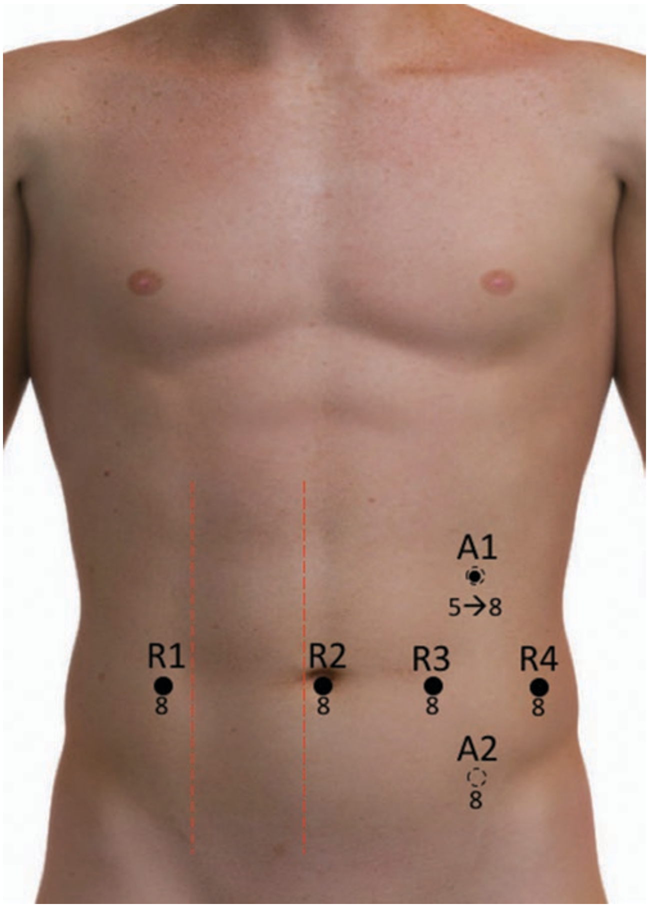

Fig. 16.2 Alternative port configuration for robotic rectus muscle flap. R1–R4, robotic arm configurations; A1, 5 mm assistant AirSeal port changed to 8 mm robotic port for flap; A2, 8 mm robotic port placed for flap. All numeric values in millimeters

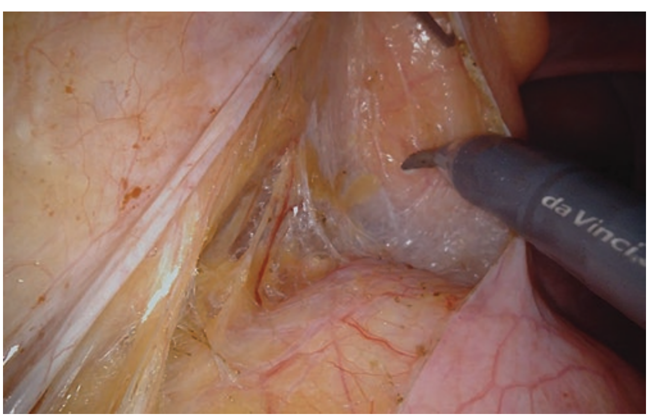

Fig. 16.3 Entry into the presacral space

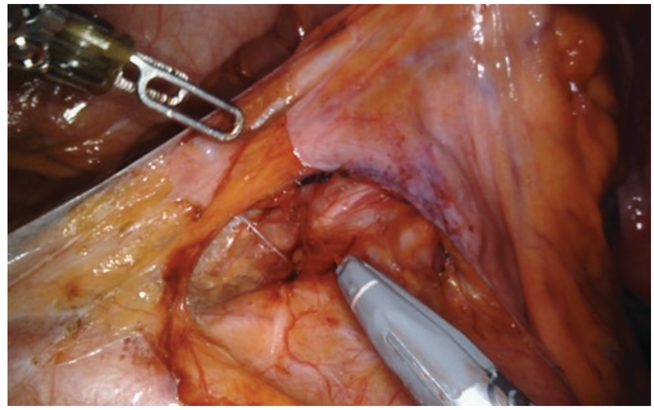

Fig. 16.4 Isolation of the IMA

Mobilization and Division of the Left Colon

Mobilization and division of the left colon proceed in a medial to lateral fashion. The left colon mesentery is divided using the vessel sealer in R1 or R3 cranially starting at the previously divided IMA pedicle toward the junction of sigmoid colon and descending colon. Dissection then proceeds laterally up the white line of Toldt. Mobilization of the splenic flexure is not usually required and dissection only needs to be carried out to obtain adequate reach of the descending colon to the abdominal wall. The colon is then divided with a 45 mm green load robotic stapler through the R1 port.

Dissection of the Mesorectum and Total Mesorectal Excision

The dissection of the mesorectum proceeds in the "holy plane" using Heald's technique, starting the dissection posteriorly and finishing in the anterior plane.

Posterior Dissection

Using R4, the rectosigmoid is elevated to the anterior abdominal wall. Dissection then proceeds in this presacral space using R1 and R3 that has previously been exposed. We prefer to use sharp dissection with monopolar scissors through R1 (Fig. 16.5). It is important to identify and preserve the fascia propria of the rectum. The dissection is continued down well above the anorectal junction through Waldeyer's fascia. It is crucial not to proceed to the anorectal junction as it would be in a low anterior resection in order to prevent coning of the specimen. Initial complete posterior dissection greatly facilitates further lateral and anterior dissection.

Lateral Dissection

The lateral pelvic space is exposed by applying medial and superior traction on the rectosigmoid and countertraction of the pelvic sidewall through R3 and R4. The hypogastric nerve and its branches can be seen directly posterolateral to the dissection plane, protected by the lateral pelvic wall fascia. It is very important to not violate the fascia as damage to the nerves may lead to autonomic dysfunction. Dissection starts on the patient's right side, taking down the lateral rectal stalk. The anterior reflection of the peritoneum is divided, and dissection of the left lateral stalk is performed in the same fashion (Fig. 16.6).

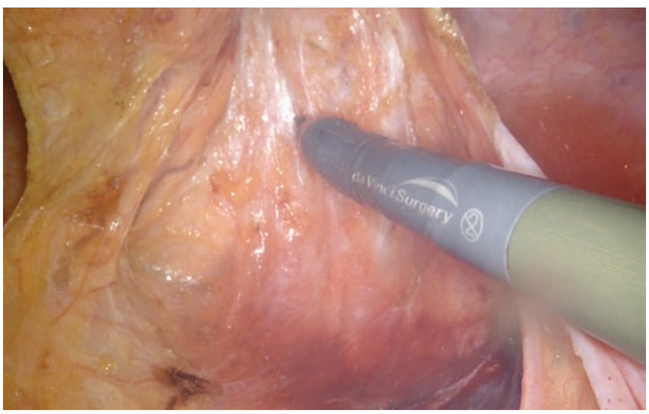

Fig. 16.5 Posterior TME dissection

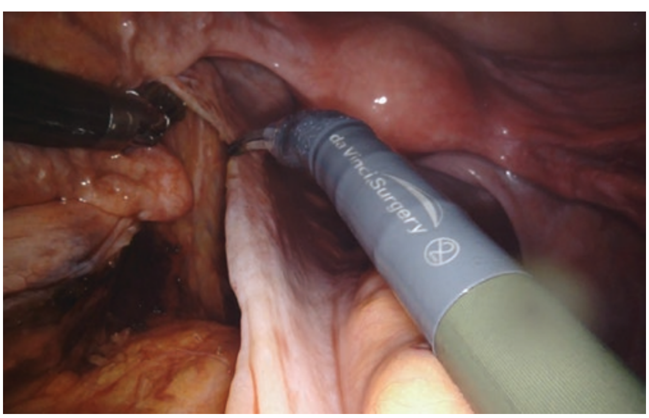

Fig. 16.6 Lateral TME dissection

Anterior Dissection

The location and stage of the rectal cancer will determine whether or not dissection will proceed either anterior or posterior to Denonvilliers' fascia. In males, the prostatic and vesicle plexus along with the seminal vesicles is located in the space just anterior to Denonvilliers' fascia. The risk of damage is much greater when dissection is to be performed anterior; however it may be necessary. The anterior peritoneal reflection is incised at the rectovesicular or rectouterine pouch. An assistant can facilitate anterior dissection by retracting the rectum out of the pelvis. R3 and R4 should be used to retract either the prostate and seminal vesicles in males or the vagina in females upward, while the R3 or R4 provides countertraction pulling the rectal wall out of the pelvis and downward (Fig. 16.7). It is helpful here to grasp the peritoneal reflection which was created with the initial incision within the Douglas pouch. Sharp dissection proceeds distally taking care to avoid excessive lateral dissection given the proximity of autonomic nerves as well as hypogastric veins and tributaries. Any remaining portions of the lateral rectal stalks are divided.

At this point, once all tissue has been dissected off close to the levator complex and it is circumferentially exposed, transection of the levators is performed using electrocautery as lateral as possible to allow a cylindrical excision. Based on preoperative MR imaging, this dissection can also be tailored to perform a wider excision on one side only. It is important to not carry the dissection between the levators and the rectal

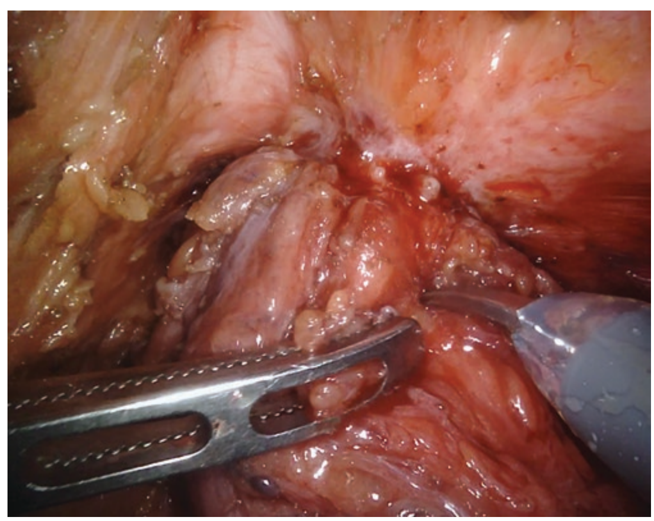

Fig. 16.7 Anterior TME dissection, tumor invasion into vaginal wall prior to perineal dissection

wall, as violation of the tumor plane may occur. Dissection is then carried into the ischiorectal fat, completing the robotic portion of the procedure. Of note when performing a proctectomy for benign disease, the levator is not transected, and dissection should continue between the levators and the rectal wall, as having the levators and external sphincter complex preserved will aid in closure of the perineum and potentially decrease perineal morbidity and hernia rates. Thus, a tailored robotic dissection of the levator muscles may allow an R0 excision and decreased morbidity.

Perineal Dissection

In a circumferential fashion, wide excision of the anus and perineal tissue is performed. The lateral margin should be about 1–2 cm from the anal verge. Dissection is carried into the ischiorectal fat until the previous robotic dissection is met. Once circumferential excision has been performed, the specimen is extracted from the perineal wound. If performed in an appropriate fashion, the specimen will be cylindrical in nature with intact fascia propria.

Port Site Closure and Colostomy Maturation

A colostomy is completed in a standard fashion according to surgeon preference. The 12 mm RLQ port is closed using an assisted closure device such as the Carter-Thomason (CooperSurgical, Trumbull, CT).

Perineal Closure and Reconstruction

Depending on the size of the perineal defect, closure may be performed primarily or with various pedicle flaps. If performing primary closure, the levators are imbricated with 2–0 Vicryl sutures with the subcutaneous and superficial tissues closed with 3–0 Vicryl. The skin is closed with interrupted 2–0 nylon sutures.

Preoperative radiation has been shown to greatly increase the odds of developing a perineal wound complication when primary closure is performed, with some authors quoting a 2–10-fold increase in complications [14]. Flap reconstruction provides volume as well as highly vascularized healthy tissue with the primary goal of maximizing healing and minimizing complications. However, flap reconstruction is not without substantial risks. Longer operative times, the risk of flap failure, and additional donor site morbidity are complications that can arise [14].

Reconstructive flaps can be separated into two main categories: fasciocutaneous flap and myocutaneous flaps. Common fasciocutaneous flaps include the anterolateral flap, the tensor fascia lata flap, and the V-to-Y advancement flaps. Pedicled myocutaneous flaps include the vertical rectus abdominus myocutaneous (VRAM) flap, the gracilis flap, and the gluteus maximus flap. A recent single-institution study by Scheckter et al. demonstrated that pedicled muscle flaps had overall lower rates of complications than local fasciocutaneous flaps, with the VRAM flap being superior to the gracilis flap [15]. In our institution we utilize a robotically harvested VRAM flap or gracilis flap.

The reconstructive technique for each of these flaps is beyond the scope of this text. Consultation with an experienced reconstructive surgeon should be initiated prior to resection.

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