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Current Applications of Robotic Abdominoperineal Resection

The evolution of surgical technique, instrumentation, and superior outcomes of minimally invasive surgery has made laparoscopy the standard of care for colon cancer treatment. The feasibility and the advantages of laparoscopic colectomy in terms of faster recovery, lower postoperative pain, and shorter hospital stay have been demonstrated by large prospective studies [1–5].

Laparoscopic abdominoperineal resection (APR) with total mesorectal excision (TME) for low rectal cancer has been shown to be safe and effective. It is associated with several advantages including lower morbidity, shorter duration of hospital stay, reduced cost, and reduced intensive care unit admissions [6]. However, laparoscopy has some limitations secondary to the anatomical structure of pelvis, rigid visualization system, instrument length, and articulation. The da Vinci robot has the potential to overcome some of the limitations of laparoscopy by providing improved three-dimensional vision, enhanced ergonomics, articulated instruments, and tremor elimination [7–9]. Early experiences with robotic rectal resection highlight the potential for decreased conversion rates, lower blood loss, and superior mesorectal grade compared to conventional laparoscopy [8–11].

Robotic APR can be performed utilizing a fully robotic technique or a hybrid laparoscopic–robotic technique whereby the robot is docked after mobilizing the sigmoid colon and dividing the vessels with conventional laparoscopic techniques.

Indications

Currently the most common indications for APR in the era of minimally invasive surgery are:

- Rectal cancer invading the sphincter complex
- Rectal cancer in patients who are not candidate for sphincter preservation because of poor functional status or comorbidities
- Recurrent rectal cancer
- Anal cancer, which recurs after or does not respond to chemoradiotherapy

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Robotic Positioning and Docking

Room setup is standard as for any robotic colorectal procedure keeping in mind the necessary space requirements for the surgeon, the assistant, and the operating room personnel. The patient is positioned in modified lithotomy in Trendelenburg position with a degree of right-sided table tilt enough to keep the small intestine out of the pelvic cavity. The robot cart is docked utilizing a left hip approach, more or less aligning the main post of the cart with the left anterior iliac spine and the camera port (Fig. 21.1).

Trocar Placement

A total of six ports are inserted under direct visualization. The camera port (C) is placed halfway between the xiphoid process and symphysis pubis. A 12 mm trocar (R1) is inserted in the midclavicular line (MCL) halfway in between C and the right anterior superior iliac spine (ASIS). This port can be used for ileostomy placement and will be used for the insertion of the stapler, if necessary. A second 8 mm trocar (R2) is inserted as a mirror image of R1. The third 8 mm robotic trocar (R3) is inserted 10–12 cm lateral to R2, usually directly above the left ASIS. The first 5 mm laparoscopic port (L1) is inserted in the MCL about 12 cm superior to R1. The second 5 mm laparoscopic trocar (L2) is inserted halfway between MCL and midline a handbreadth superior to L1 (Fig. 21.2).

Operative and Technical Steps (Hybrid Technique)

Laparoscopic Mobilization of Sigmoid Colon and Ligation of Vessels

Both surgeon and assistant stand on the patient's right side. Medial to lateral dissection of the sigmoid colon is begun at the inferior mesenteric artery (IMA). The sigmoid mesocolon is retracted anteriorly and dissection is begun at the sacral promontory. The parietal peritoneum medial to

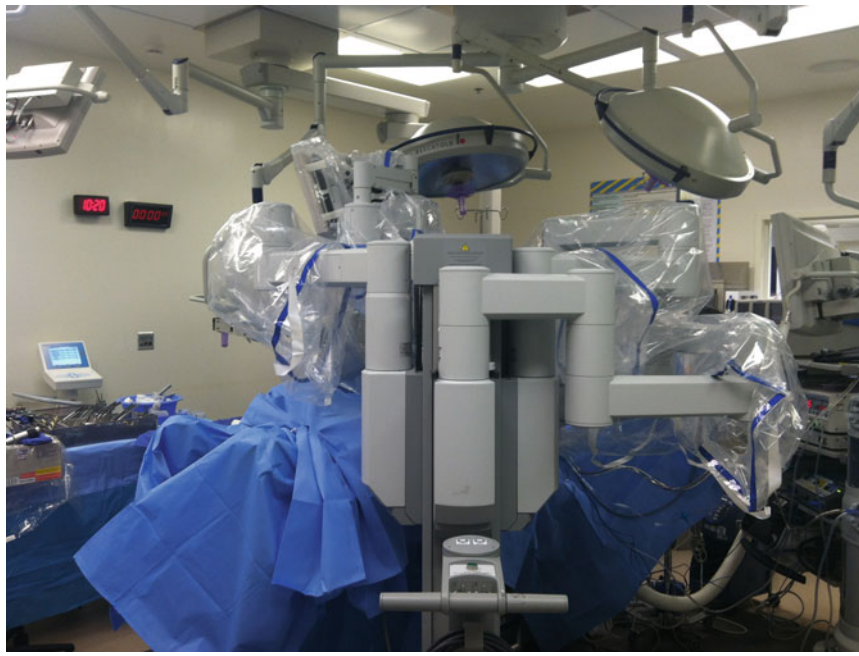

Fig. 21.1 The robot is docked from the left hip and the surgeon assistant stands on the right of the patient

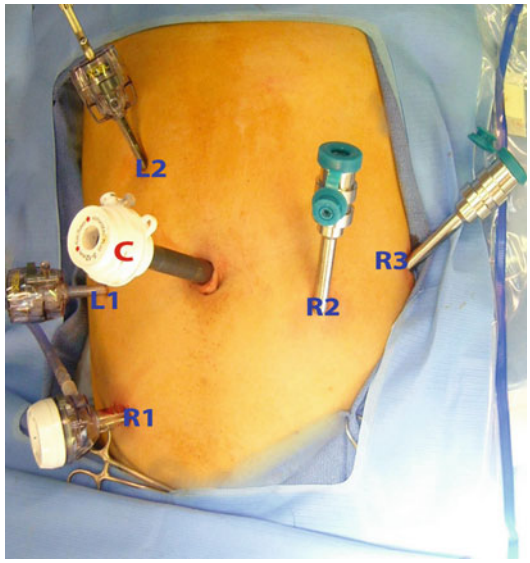

Fig. 21.2 Robotic laparoscopic port placement

the right common iliac artery at the sacral promontory is incised. A combination of sharp and blunt dissection is used to isolate the IMA avoiding injury to the hypogastric nerve plexus. The retroperitoneal structures including the left ureter are identified and swept posteriorly. The IMA (either at the origin or distal to the takeoff of the left colic artery) is skeletonized and divided via vessel sealer device and/or vascular stapler (Fig. 21.3). Atraumatic graspers are fundamental as with any laparoscopic bowel resection case to minimize injury.

In contrast with robotic low anterior resection, splenic flexure mobilization is not necessary in abdominoperineal resection. A shorter length of the colon is needed for creation of a colostomy in APR compared to the colorectal anastomosis in LAR. In general, the colon is able to reach the abdominal wall without the need of further mobilization. However, in certain patients, including patients with high BMI, further mobilization may be necessary. The lateral reflections of the left colon are taken down with a combination of blunt dissection and electrocautery. The colon is then divided above the IMA stump via an Endo GIA stapler.

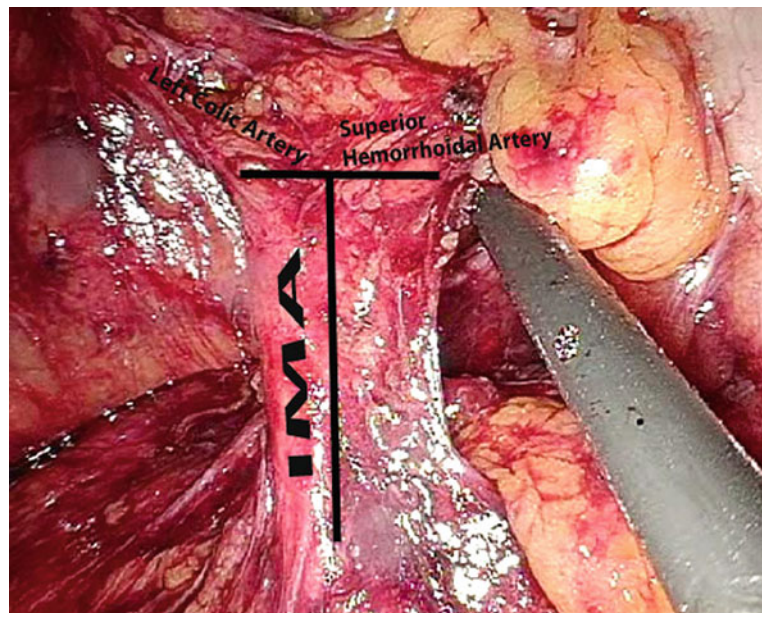

Fig. 21.3 The "T" configuration is visualized at the junction of the left colic artery and the superior hemorrhoidal artery

Robotic Setup and Instrument Selection

The four-arm da Vinci robot is docked using the left hip approach once the mobilization of the sigmoid colon is completed (Fig. 21.1). A 0° robotic camera is inserted in port C. Robotic arm 1 is docked to the R1 port; robotic arms 2 and 3 are docked to R2 and R3 trocar, respectively, in sequence. A monopolar scissors is inserted in R1. Alternatively a hook with monopolar energy source can be useful for dissection. A fenestrated bipolar forceps with bipolar energy source is inserted in R2 for holding, traction, and coagulation of vessels. A fenestrated forceps or a robotic suction irrigator devices inserted in R3 for traction. Grasping of the mesorectum should be avoided with the robotic graspers. The assistant uses the two laparoscopic ports. A laparoscopic grasper is used via the L2 port for retraction and manipulation of the sigmoid colon and rectum, and an irrigation and suction system is used via the L1 port for countertraction.

Total Mesorectal Excision

A total mesorectal excision is begun at the sacral promontory using only monopolar and bipolar cautery. The dissection begins posteriorly while the assistant surgeon retracts the rectum cephalad and anteriorly (Fig. 21.4). The avascular plane is between the presacral fascia and the mesorectum. The dissection is continued laterally around the rectum preserving both hypogastric nerves, which are located anterolaterally. Anteriorly, the rectovesical/rectovaginal fold of the peritoneum is incised to expose Denonvilliers' fascia or the rectovaginal septum. Maintaining a plane posterior to Denonvilliers' fascia prevents bleeding from the pampiniform plexus surrounding the seminal vesicles in men. The third arm allows for the retraction of the rectum during posterior dissection, the lateral sidewalls during lateral dissection, and the bladder/vagina during anterior dissection.

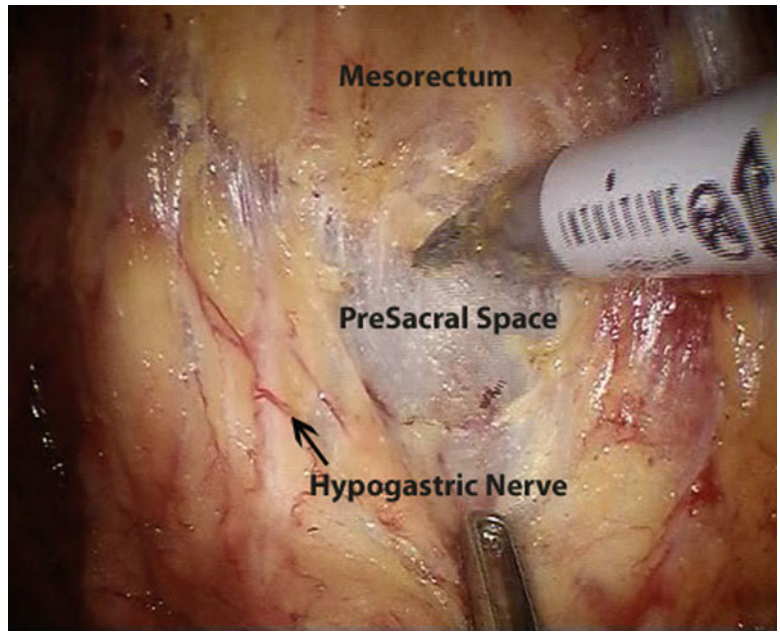

Fig. 21.4 Posterior dissection

Extralevator Abdominoperineal Resection

The dissection is continued distally, and a wide resection of the levators near their origin is carried out using robotic scissors in order to minimize the possibility of a positive circumferential margin (Fig. 21.5a). Care is taken not to lift the rectum off the levator muscle as in a conventional low anterior resection. Instead, the muscle will be taken widely at its origin along the bony structures of the deep pelvis, and the ischiorectal fat will be dissected en bloc using robotic instruments (Fig. 21.5b). The posterior limit of the rectal dissection can be decided by palpating the position of the coccyx tip via digital rectal examination from below while manipulating a robotic instrument on the coccyx from above.

The levator transection is continued posteriorly toward the midline and the anococcygeal ligament is transected (Fig. 21.6). The lateral limit of transection of the levator muscle is the medial edge of the obturator fascia, where autonomic nerve and vessels originating from the internal iliac artery and vein are found. Anteriorly, the levator transection is continued along the plane posterior to Denonvilliers' fascia/posterior wall of the vagina toward the perineum. Extreme care must be taken to avoid urethral injury in male patients. The dissection is continued distally into the ischiorectal fat as far as feasible just before encountering the perineal skin.

Robotic-assisted transabdominal resection of the levator muscles allows for a controlled transection of the pelvic floor and minimizes the risk of accidental injury to vascular structures under direct vision. This approach also renders the perineal resection very quick and simple, without the need to turn the patient prone and thus potentially improving the perineal wound healing rate [12]. In addition, this technique may offer the flexibility of varying the extent of levator muscle excision depending on the location of the tumor [12].

Perineal Procedure and Stoma Creation

Once the rectum is freed and hemostasis is achieved, the robot is undocked. The patient is placed in steep Trendelenburg, and a member of the surgical team via a perineal approach creates a circumferential incision around the anus from the perineal body to the coccyx. Because the levator muscles have been divided, the prior dissection plane is quickly encountered

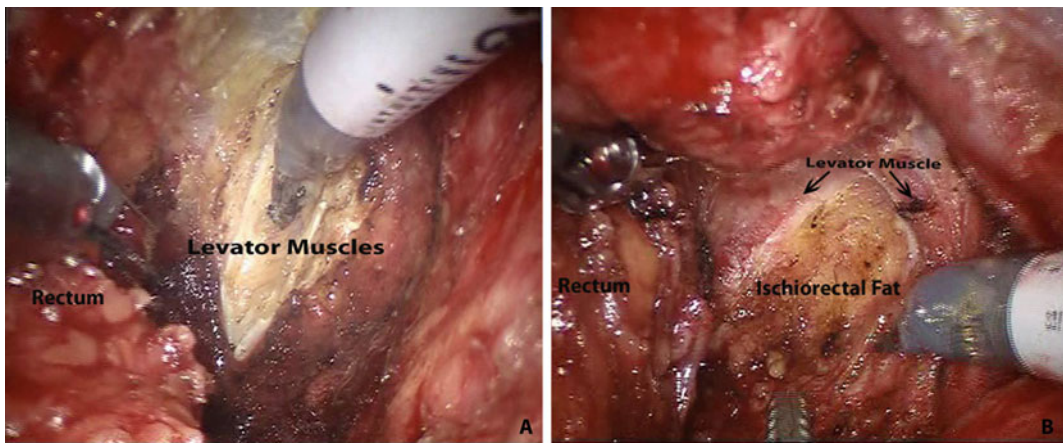

Fig. 21.5 (**a**) The division of the right levator muscles; (**b**) complete division of the levator muscles

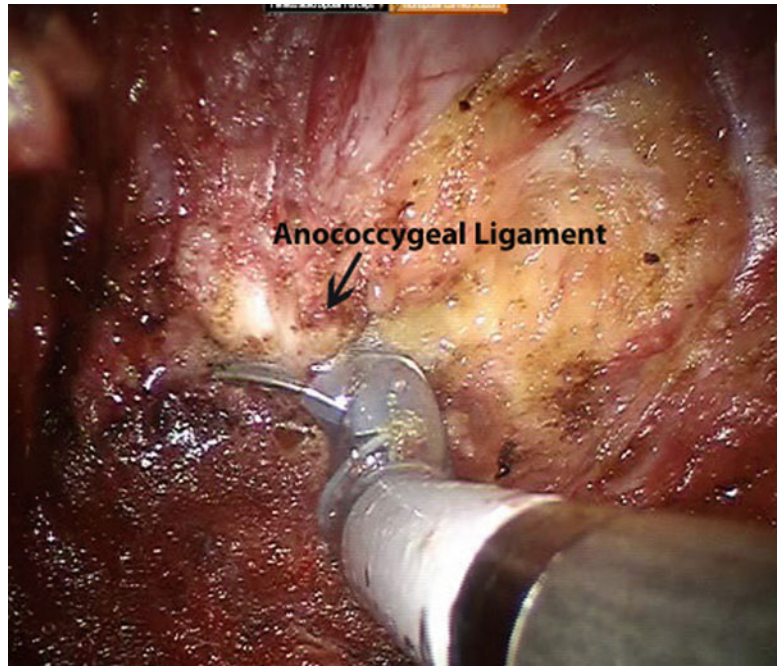

Fig. 21.6 Division of the anococcygeal ligament

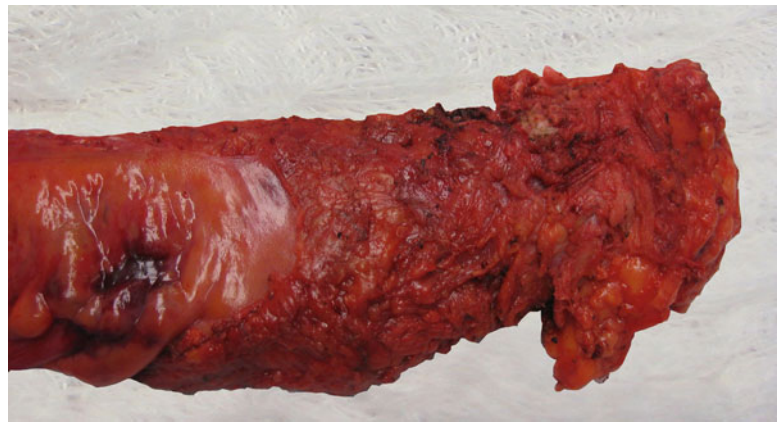

Fig. 21.7 Cylindrical APR specimen

and the "cylindrical"-shaped specimen is easily delivered through the perineum (Fig. 21.7). The perineal incision is closed in three layers. A transabdominopelvic drain is placed. The abdomen is re-insufflated and inspected; an end colostomy is brought out at an appropriate location.

Outcomes

Total mesorectal excision has been shown to dramatically reduce rates of local recurrence and is the accepted standard of care for rectal cancer [13–15]. However, the benefits of TME in LAR

have not been reproduced in abdominoperineal resection. This has been thought to reflect, in part, a higher rate of circumferential resection margin (CRM) involvement leading to a higher rate of local recurrence, and lower survival rates after APR compared with LAR [13, 14, 16, 17]. A higher rate of positive CRMs can be attributed, in part, to the hourglass-shaped resection of the rectum seen with traditional APR techniques that exposes the tumor-bearing area around the anorectal ring. Extralevator abdominoperineal resection (EAPR) has been proposed in an effort to decrease the rate of CRM positivity, lower rectal perforation incidence, and lower local recurrence rates [18–22]. These beneficial results are achieved by wide resection of the levator muscles surrounding the tumor in the deep pelvis producing a cylindrical surgical specimen rather than an hourglass-shaped specimen and decreasing the chance of a close, or involved, surgical margin [22]. EAPR allows for en bloc resection of tissue and is associated with lower CRM positivity and lower chances of rectal perforation, resulting in lower rates of local recurrences. We believe this technique is especially suited for a robotic approach given the versatility of robotic surgical instruments in rectal cancer surgery [18–23].

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