Robot-Assisted Radical Cystectomy: The MD Anderson Approach

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105.1 Introduction

Radical cystectomy with bilateral pelvic lymphadenectomy is the standard treatment for patients with muscle invasive bladder cancer and those with recurrent, high-grade BCG-unresponsive non-muscle invasive disease. The robotic approach to radical cystectomy was first described by Menon et al. in 2003, and since then the technique has been adapted and increasingly utilized worldwide [1]. Radical cystectomy is among the most morbid procedures in urology, with complication rates exceeding 50% in several published series [2, 3]. Among the challenges faced by physicians caring for this patient population include addressing pulmonary, vascular, and cardiac comorbidities that are often encountered, in addition to addressing needs related to advanced age and diminished performance status.

Minimally invasive approaches to radical cystectomy including with the use robotic platforms are of interest for their potential to mitigate the morbidity of the procedure. Several investigations have been undertaken to assess the question of oncologic equipoise between open and robot-assisted approaches. To date, there have been five published randomized studies comparing the modalities [4]. Nix and colleagues reported the first prospective randomized controlled trial (RCT) comparing outcomes following open versus robot-assisted radical cystectomy; in it, 41 patients were randomized to either approach and the authors found that lymph node yield for the robotic approach was non-inferior to the open cases, with a mean of 19 nodes removed in the robotic group compared with 18 in the open group [5]. This endpoint was selected as a surrogate for oncologic surgical quality in patients undergoing cystectomy. Parekh and colleagues subsequently conducted a single-center trial at the University of Texas San Antonio randomizing 47 patients to either technique, with findings consistent with the Nix study. The robotic approach offered decreased blood loss but no major differences in complications [6]. A larger RCT (n = 118) was reported by Bochner et al. from Memorial Sloan Kettering Cancer Center in 2015 [7]. This trial differed from the others in that it focused on complication outcomes in addition to pathologic data and additionally compared operative time, quality of life outcomes, and operating room and inpatient hospitalization costs. The authors reported similar 90-day complication rates, length of hospital stay, pathologic outcomes, and 3- and 6-month quality of life outcomes for both techniques [7]. However, this trial, like the Nix and Parekh studies, all included patients who underwent an open urinary diversion. A follow-up study reporting on secondary outcomes from the same trial found no differences in cancer outcomes between the modalities at a median follow-up of 4.9 years (IQR 3.9–5.9), but did note differences in recurrence patterns, including a greater number of local/abdominal recurrence sites among those undergoing robot-assisted cystectomy (HR 0.34, p = 0.035) [8]. Khan and colleagues compared open radical cystectomy to both robot-assisted and pure laparoscopic radical cystectomy, with 93 patients enrolled in one of the three arms [9]. The authors found that 30-day Clavien-Dindo complication rates were significantly lower in the robot-assisted (55%) and laparoscopic radical cystectomy (26%) arms compared to the open approach (70%, p = 0.024), although 90-day complications rates were similar (p = 0.068) [9].

The largest and most definitive study published to date is the RAZOR trial [10]. In this study, 350 patients from 15 medical centers in the United States were randomized to either open or robot-assisted radical cystectomy, with all patients undergoing an open urinary diversion. Two-year progression-free survival was reported to be 72.3% (95% confidence interval 64.3–78.8) in the robotic group compared with 71.6% (95% CI 63.6–78.2) in the open group [10]. The difference indicated non-inferiority of robotic cystectomy for the PFS outcome. Adverse events were similar between the two groups, as were the proportion of

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patients with local recurrences. The robotic approach was associated with both significantly lower blood loss and significantly lower risk of requiring an intraoperative or postoperative blood transfusion. Patients undergoing robotic cystectomy also had a modestly decreased mean length of stay: 6 days (robot-assisted) vs 7 days (open), on average ($p = 0.0216$) [10].

These data provide ample evidence that robotic approaches to radical cystectomy provide oncologically similar outcomes to open cystectomy. However, no study to date has been able to provide evidence of superiority of one approach over the other. It is worth noting that all of the aforementioned trials included patients who underwent an open urinary diversion, which may mitigate some of the benefits conferred by the minimally invasive extirpative portion of the procedure [4]. Consistently reported benefits include decreased blood loss and shorter length of stay, particularly when combined with enhanced/early recovery after surgery (ERAS) pathways. To this end, there are likely subsets of patient populations that derive more benefit from minimally invasive radical cystectomy, and additional investigation is required to better define these populations. For example, women who undergo radical cystectomy have anatomic variations that can confer additional bleeding compared to men undergoing the procedure, and the robotic approach may mitigate some of this bleeding risk [11]. Additionally, patients who may be at higher risk for wound complications (such as diabetics) may benefit from smaller incisions, particularly when the diversion is also completed intracorporeally. The iROC trial (University College, London, NCT03049410) is a prospective, multicenter RCT comparing open versus robot-assisted radical cystectomy, with all patients in the robotic arm undergoing an intracorporeal diversion. This study is currently recruiting patients with an estimated completion date in early 2020.

105.2 Patient Selection

Surgical indications for robot-assisted radical cystectomy do not vary from open radical cystectomy. Patients with muscle invasive (T2) bladder cancer or those with residual or recurrent high-grade cT1 non-muscle invasive disease should be considered for radical cystectomy with pelvic lymphadenectomy, following a staging and medical workup to ensure they are candidates for surgery. Historically, restrictions on which patients are suitable for robotic pelvic surgery had been determined in part by anesthesia-related concerns, particularly with respect to challenges conferred by the steep Trendelenburg positioning that is required [12]. Considerations include increased pulmonary pressures, ventilation mismatch, increased intraocular pressures, and decreased cardiac output caused by Trendelenburg positioning [12]. These issues are more acute in obese patients in whom the increased abdominal weight on the diaphragm can make ventilation challenging. In our experience, close coordination with experienced anesthesiologists who are familiar with robotic pelvic surgery can mitigate many of these issues and expand the availability of robotic cystectomy to the majority of patients, including those with obesity. Strategies to mitigate some of the challenges include use of the AirSeal iFS system (ConMed Corporation, Utica, NY), which can provide consistent pneumoperitoneum sufficient for visualization even at lower insufflation pressures (8–10 mmHg compared to the traditional 15 mmHg) or the TruSystem 7000dV OR table (Trumpf Medical/Hill-Rom, Saalfeld, Germany), which can pair with the Da Vinci Xi surgical system to provide dynamic repositioning of the operating table while docked, thereby allowing the surgeon to temporarily take the patient out of Trendelenburg without having to undock the robotic arms if needed to help with ventilation issues. Despite this, surgeons who are early in their learning curve should exercise discretion in selecting patients for robotic cystectomy, as prolonged operative times which are encountered early on in one's robotic experience can exacerbate the aforementioned anesthetic concerns. Patients who have had prior surgery, particularly prior partial cystectomy, pelvic radiation, or ureteral reimplantation may additionally confer challenges to the novice robotic surgeon and caution is advised.

105.3 Preoperative Preparation

As in open radical cystectomy, patients should be appropriately staged preoperatively with cross-sectional imaging of the chest, abdomen, and pelvis to evaluate for metastatic disease. A CT urogram is preferred for patients with adequate renal function and without an iodinated contrast allergy, but an MRI can also be used if the patient has contraindications to contrast administration. A thorough medical evaluation should also be performed to optimize health status prior to surgery, with particular attention paid to patients with poorly controlled diabetes, cardiac risk factors, poor pulmonary function, and poor nutritional status. Selection of a urinary diversion is beyond the scope of this chapter's discussion; however, preoperative stoma marking should be performed by enterostomal therapists in all cases. In patients without a history of prior pelvic surgery or radiation, we advise against the use of routine bowel preparation. There is no clear evidence that bowel preparation provides for improved wound infection rates, anastomotic leak rates, or overall complication rates; however, patients who undergo a bowel preparation may be at higher risk for postoperative ileus.

The use of enhanced recovery after surgery pathways should be routine with robotic radical cystectomy, although components and implementation of ERAS pathways vary widely between institutions [13]. In general, patients should be advised to maintain a normal diet up until the night before surgery and be provided with written counseling on the expected postoperative recovery course. Additionally, close coordination with anesthesia is required to ensure judicious administration of fluids, maintain normothermia, and utilize multimodal pain management strategies including with rectus sheath local anesthetic blocks using infiltrated bupivacaine, bupivacaine infusions, or liposomal bupivacaine [13]. The mu-opioid receptor antagonist alvimopan should be administered 30–90 minutes prior to surgery in patients without a contraindication, and it should be continued postoperatively until the return of bowel function. This medication has been demonstrated to provide a benefit in return of bowel function and decreased length of hospitalization in several trials [14, 15]. Intravenous antibiotics should be administered within an hour of surgical incision and patients should undergo both mechanical and pharmacologic thromboembolic prophylaxis prior to the induction of anesthesia.

105.4 Equipment

The steps described in this chapter assume the use of the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA). The operating table should provide adequate and for women, the attachment of spreader bars or low lithotomy positioning to provide access to the vagina. As noted earlier, we also recommend use of the AirSeal iFS system to maintain continuous pneumoperitoneum and allow for adequate visualization even with lower insufflation pressures [16]. With respect to robotic instrumentation, availability may vary depending on the institution and specific robotic platform being used (e.g., Si vs Xi). In general, we recommend use of the monopolar curved scissors (HotShears), the Maryland bipolar forceps, and the large needle drivers for the majority of the case. The Cadiere forceps should also be available as it provides safer handling and manipulation of bowel, particularly if an intracorporeal urinary diversion is planned. All cases can typically be done using the 0-degree lens. For the bedside assistant, access to a suction irrigator device, Weck clips (Teleflex, Wayne, PA), and specimen retrieval bag are required.

105.5 Positioning

The patient should be positioned supine on the operating table with the anterior superior iliac spine positioned over the table's flexion point. For women or men with a history of prior pelvic radiation or surgery, low lithotomy positioning is advised to provide access to the vagina and rectum. Lithotomy positioning is also required if using a da Vinci S, Si, or X system, as docking of the patient side cart must be performed between the legs. If using an Xi system, the rotating boom allows for supine positioning with the patient side cart docked to the right side of the patient. The arms should be tucked on each side and appropriately padded to avoid neuropraxic injury. Pneumatic compression devices should be administered. Foam products should be positioned under the patient to help prevent sliding once the patient is in the Trendelenburg position. We recommend use of the 3M Reston foam product (3M, Minneapolis, MN) which can be adhered to the operating table with the foam side in contact with the patient's back, helping to prevent both pressure injuries and inadvertent sliding. A chest strap should be secured at the mid chest with foam padding. The abdomen should then be shaved and prepped in the standard surgical fashion, with the ostomy site marking still visible.

105.6 Initial Access and Port Placement

The Foley catheter should be placed on the sterile field. Initial access to the peritoneal cavity can be achieved either with a Veress needle following a meniscal drop test or with a Hassan approach. Initial insufflation should be to 15 mm Hg and the abdominal contents should be carefully inspected with a camera to ensure there are no entry injuries. The patient can then be positioned in 25 degrees of Trendelenburg after which time additional ports are placed.

1. The initial camera port is placed approximately 5–7 cm above the umbilicus. This is significantly more cephalad to the camera port placement used for robotic prostatectomies and allows for an extended lymphadenectomy as well as appropriate dissection of the terminal ileum and cecum for robot-assisted urinary diversions. A 0 degree lens is used.
2. Two right-sided robotic ports are placed in line with the camera port, approximately 9 cm apart from one another. The right medial robotic port will be used for a monopolar curved scissors (HotShears), while the right lateral robotic port will be used for a Cadiere forceps.
3. A left-sided robotic port is placed at the level of and approximately 15 cm lateral to the umbilicus. This port will be used for the Maryland bipolar forceps.
4. We recommend the use of two assistant ports on the left side: either a 5 mm or 12 mm assistant port (this port can utilize the AirSeal iFS device) in between the left-sided robotic port and camera port and a 15 mm assistant port just cephalad to the anterior superior iliac spine. The 5 or 12 mm port can be used for suctioning and exchanging of needles, while the 15 mm port is ideal for providing

access to staple bowel for robotic urinary diversions and for extracting large lymph node packets en bloc.

5. We advise closure of the 12 and 15 mm assistant ports and closure sutures should be pre-placed using a Carter-Thomason device or similar at the time of port placement.

105.7 Surgical Steps

These steps assume familiarity with the da Vinci robotic platform, including the mechanics of clutching, pedal configurations, and ergonomic adjustments at the surgical console. We advise use of the Quick (1.5:1) scaling ratio for the majority of the case, although for bowel work if a robotic urinary diversion is being planned, the Fine (3:1) scaling ratio may be preferred.

1. Begin by sharply releasing the sigmoid peritoneal attachments using the curved monopolar scissors. Performing the sigmoid release will allow the large bowel to retract cephalad as a result of the Trendelenburg positioning. In obese patients, excess mesenteric fat can sometimes limit this "auto-retraction" of the large intestine and the bedside assistant can use a bowel grasper to gently pull the bowel out of the pelvis. Attachments to the pelvic sidewall and left white line of Toldt should be taken down as far proximally as possible.
2. The left ureter should be visualized lateral to the sigmoid and the peritoneum at this level should be opened medially with care taken to avoid entry into the sigmoid mesentery. Typically, an avascular plane can be identified between the sigmoid mesentery and the left ureter. This dissection should be carried proximally. If bleeding is encountered here, dissection should be adjusted as the sigmoid mesentery may be violated. The dissection should be continued until the common iliac artery is identified. The right ureter can be similarly identified and isolated.
3. In males, the posterior dissection is next carried out by incising the peritoneum in the posterior cul de sac near the seminal vesicles, as in a robotic prostatectomy. The dissection is carried out toward the prostatic apex. The seminal vesicles themselves do not need to be released unless a nerve sparing procedure is planned. The lateral dissection is then performed by identifying and tracing the gonadal vessels; in female patients, the ovarian vessels should be identified and clipped using a large Weck clip or similar.
4. The medial umbilical ligament is then identified and retracted medially on one side, exposing the interface of the peritoneum between the bladder and anterior abdominal wall. The peritoneum is then incised at this level and carried toward the inguinal ring. This maneuver will in most patients result in partial pneumodissection of the areolar tissue within the space of Retzius. The vas deferens or round ligament is then identified and ligated, with care taken to use bipolar cautery or clips to control the associated vasculature. The space of Retzius is can be bluntly developed and is carried toward the endopelvic fascia distally and the hypogastric artery posteriorly. This process is then repeated on the contralateral side. It should be noted that this dissection should ideally be carried out in a manner such that bladder fat is maintained separately from lymphatic tissue. Lymphatic tissue, which typically lies laterally, will appear more lobular than bladder fat, which will appear more homogenous and as a slightly lighter shade of yellow. Following this natural plane of dissection is uniquely possible with the robotic modality and will minimize entry into perforating bleeders, in addition to allowing for a more meticulous lymph node dissection.
5. The endopelvic fascia is then incised in males and bluntly developed toward the mesorectal fat on either side. Caution should be exercised as perforators from the distal hypogastric vein are often encountered in this region.
6. Next, the anterior vascular pedicles of the bladder are identified and controlled. These are relatively straightforward to identify, beginning with the obliterated umbilical artery that can be retracted medially and upward in order to identify its origin. The structure is controlled with Weck clips and divided, after which the avascular plane medial to the anterior vascular pedicle is visualized and the pedicle is sequentially controlled with clips. The anterior vascular pedicles of the bladder are then identified and controlled. The obliterated umbilical artery can be retracted medially and upward in order to identify its origin. The avascular plane medial to the anterior vascular pedicle is visualized and the pedicle is sequentially controlled with clips until the endopelvic fascia is reached. Again, this is repeated on each side.
7. The ureters can be mobilized by retracting the bladder close to the detrusor hiatus, allowing for visualization of the perforating vessels surrounding the ureter. These can be controlled using bipolar cautery close to the bladder. More proximally, the nontraumatic portions of the robotic instruments can be used to gently retract and mobilize the ureter, with care taken to avoid excess stretch and grasping of the ureter avoided entirely. The periureteral adventitia should be maintained throughout the ureteral mobilization. Some surgeons advocate use of a vessel loop during this dissection but we have not found it to be necessary. Of note, transection of the ureter should be deferred until after completion of the

lymphadenectomy, to preserve antegrade flow of urine to the bladder as long as possible.

8. The lymph node dissection is then carried out on each side. We prefer performing the lymphadenectomy prior to the radical cystectomy to minimize the amount of time the ureters remain occluded. The borders of the lymph node dissection are identical to those performed in open radical cystectomy cases, with a standard template consisting of the a dissection carried to the genitofemoral nerves laterally, the internal iliac artery medially, superiorly to the crossing of the ureter at the common iliac artery, and distally to Cooper's ligament. For an extended lymph node dissection, appropriate for all patients with cT2 disease or greater, the common iliac lymph node packet and presacral nodes are also obtained.
9. To start, the spermatic cord is identified and can be retracted to delineate the lateral border of the external iliac packet. The packet is released over the eternal iliac artery in a split and roll fashion, collecting the tissue between the external iliac artery and vein. This packed can be separated from the obturator node packet and carried distally toward the epigastric vessels. The genitofemoral nerve is frequently encountered during this dissection and injury should be avoided. Judicious use of bipolar electrocautery is often sufficient to identify and control small perforating lymphatic channels as well as blood vessels. The assistant uses a reusable specimen retrieval bag through the 15 mm assistant port to collect the node packets as they are dissected.
10. Attention is then turned to the obturator lymph node packet, which is best identified following gentle retraction of the external iliac artery by the assistant with the suction tip. The packet is separated from the vein wall and lateral pelvic sidewall attachments. Again, the Maryland bipolar forceps can be used to efficiently control perforating structures to the packet as the contralateral robotic instrument retracts the node packet en bloc away from the sidewall. The obturator nerve and vessels should be identified and protected.
11. Next, the internal iliac (hypogastric) lymph node packet is then dissected deep to the obturator nerve toward the lateral pelvic sidewall toward the endopelvic fascia. The hypogastric lymph node packet is often found to be in close proximity to perforating vessels from the distal hypogastric vein, and caution should be exercised during this dissection. The hypogastric lymphadenectomy is carried posteriorly toward the mesorectal fascia.
12. For patients requiring an extended lymphadenectomy, the common iliac lymph node packet is next addressed, with the first release being carried from the lateral border of the common iliac artery and posteriorly toward the common iliac vein wall. The presacral nodes are then retrieved by opening the peritoneum overlying the right common iliac artery, with the node packed found directly below the sigmoid mesentery. The ureters should be visualized and protected during this dissection.
13. With the lymphadenectomy completed, the ureters can be clipped near the detrusor hiatus with adequate space left to send a margin.
14. The posterior pedicles of the bladder are then identified by laterally retracting the bladder toward the shoulder contralateral to the pedicle and upward, and the pedicle can be controlled with either clips or an energy sealing device such as the robotic vessel sealer. This dissection is carried toward the genitourinary diaphragm and, in males, through the prostatic pedicle and to the prostatic apex.
15. In male patients, the cystectomy is then completed by releasing the urachal attachments with bipolar cautery and performing an apical prostatic dissection. The dorsal venous complex is controlled with 2–0 V-Loc suture ligature placed in a figure of eight fashion.
16. In female patients, a well-lubricated EEA sizer is placed vaginally by the bedside assistant and manipulated to distend the vaginal wall and assist in the identification of the posterior cervical fornix or apex of the vagina (in cases where a prior hysterectomy has been performed). This dissection is then carried to separate the structures until a hysterectomy is completed (if applicable) or a vaginal sparing plane is identified and developed.
17. The urethra is isolated and controlled with the placement of a Weck clip proximally and distally to the point of planned transection. If an orthotopic diversion is planned, a clip can be placed proximally, and a margin is sent. Care should be taken to minimize spillage of urine into the surgical field.
18. The vaginal defect is closed with a running 2–0 V-Loc suture, with mucosa to mucosa apposition and watertight closure required to prevent the formation of fistulae. Premarin or similarly coated vaginal packing is then placed and removed on postoperative day#2 for hemostasis. The specimen can generally be extracted through the vaginal defect, following placement in a bag. In men, or in women for whom vaginal extraction does not appear to be possible, extraction is performed by slightly elongating the midline abdominal port site at the conclusion of the procedure.

105.8 Conclusion

Robot-assisted radical cystectomy appears to provide an oncologically equivalent operation to open radical cystectomy and potentially provides patients with a less morbid postoperative course. Data to date have demonstrated shorter length of stays and decreased blood loss and transfusion rates. Additional studies are ongoing to identify the incremental benefit of true intracorporeal diversions, as randomized data to date have all included patients who underwent open diversions. As always, meticulous surgical technique, appropriate patient selection, and adequate surgeon experience with the robotic platform are required to ensure excellent outcomes for these patients.

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