16 Surgical Avoidance and Management of Operative Complications

Angela Smith and Michael Woods

Introduction

As already emphasized throughout this book, the development of robotic surgery has helped refine the more challenging technique of laparoscopic cystectomy, paving the way for robot-assisted radical cystectomy as a feasible alternative to the open method. Since the first reported series in 2003, there has been a marked increase in the number of manuscripts focusing on perioperative and postoperative outcomes following robot-assisted radical cystectomy (RARC).

While open radical cystectomy is associated with overall complication rates approaching 70 % when utilizing strict reporting criteria [1], complication rates following RARC vary widely. This disparity likely results from differences in reporting methodology and duration of postoperative follow-up, thus representing a major limitation when comparing techniques and institutions. In this chapter, we will briefly review these perioperative and postoperative outcomes while also discussing avoidance and management of complications during robot-assisted radical cystectomy (RARC).

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Review of Perioperative and Postoperative Complications

The existing literature on perioperative and postoperative complications is primarily compromised of single center series reporting complication rates for RARC. These rates vary widely in the literature presumably due to difficulty in event capture, as many RARC complications occur at local, non-tertiary hospitals, and are therefore not systematically collected or reported. Additionally, a number of prior studies did not adhere to standard reporting guidelines, such as the MSKCC (Memorial Sloan Kettering Cancer Center) grading system or the modified Clavien–Dindo classification system [1, 2]. However, recent studies routinely report complication categorizations following these criteria.

Several single center series now exist, many reporting complication rates for RARC. Kauffman et al. published their complication data on a series of 79 consecutive patients after RARC [3]. While 49 % of patients experienced complications within 90 days when using a standardized reporting system, most were minor, with infectious complications (41 %) occurring most commonly, followed by gastrointestinal (27 %) and thromboembolic events (10 %). Another series by Treiyer et al. evaluate 84 consecutive RARC patients with overall and major 30-day Clavien complication rates of 53 % and 12 %, respectively [4]. In another European series, Khan et al. reported outcomes of

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their first 50 robotic cystectomies [5]. The Clavien 90-day complication rate was 34 %, with major complications occurring in 10 % of this cohort. Despite use of a standardized complication reporting system, a major limitation of this study revolves around its selection bias, with the selected population representing only half of patients undergoing cystectomy at their institution.

Addressing this limitation seen in many single case reports, Hayn et al. studied 156 consecutive patients undergoing the procedure and calculated an overall complication rate of 52 % within 90 days, including a 33 % major complication and a 21 % readmission rate [6]. The authors classified all complications using the MSKCC system. The most common complications reported in Hayn's series were gastrointestinal (31 %), infectious (25 %), and genitourinary (13 %). As suggested above, the study is noteworthy in that all cystectomies at this institution were performed robotically. However, limitations of single institution studies are well known and have led to the construction of multi-institutional analyses, which provide more robust and generalizable data.

Kang et al. describes a multi-institutional evaluation of complications during and after RARC in seven participating Korean institutions [7]. Retrospectively analyzing data from 104 patients, the authors reported an overall complication rate of 27 % using the modified Clavien system, with 7.7 % considered major complications and 19 % minor complications. Intraoperative complications represented 3.8 % of the total number of complications, with three conversions to open surgery. Two were secondary to adhesions with one due to an external iliac vein injury. Our own multi-institutional study expands on this data through inclusion of a larger sample size of 227 patients spread between four institutions [8]. The overall complication rate was 30 % with 7 % having a major complication as defined by the Clavien classification system, with no perioperative deaths. Interestingly, younger patients in this series were more likely to experience complications.

Comparisons Between Robot-Assisted and Open Radical Cystectomy

While understanding robotic complication rates is an important tool in quality assurance, another important comparison is contrasting robotic procedures with the standard, open technique. A number of studies have offered comparisons between the robotic and open procedures, but the vast majority remain nonrandomized studies, which are inherently limited by patient selection and other selection biases.

Ng et al. performed a prospective cohort study of 187 consecutive patients (104 ORC and 83 RARC) who underwent radical cystectomy [9]. Thirty- and ninety-day Clavien complications revealed a higher overall rate in the open group at 30 days (59 % vs. 41 %, $p=0.04$), as well as a significant increase in major complications (30 % vs. 10 %; $p=0.007$). At 90 days, the overall complication rate, while greater in the open cohort, was not statistically significantly different. However, there did appear to be more major complications in the open cohort at 90 days (31 % vs. 17 %; $p=0.03$). In a multivariate analysis controlling for a variety of comorbidities, RARC remained an independent predictor of fewer overall and major complications at both 30 and 90 days. The types of complications observed were similar to those in contemporary open series, including gastrointestinal, infectious, thromboembolic, and stomal events. Although this study was strengthened by prospective data collection, a large sample size, and procedures performed by a single surgeon, it remains limited by its observational methodology.

Only one randomized trial comparing ORC and RARC has been published to date [10]. Nix et al. reported results of our prospective, randomized study, including 20 patients undergoing ORC and 21 in the RARC cohort. Although designed as a non-inferiority study comparing lymph node yield, several secondary endpoints were evaluated, including complication rate. Comparing those undergoing open and robotic procedures, no difference in complication rates were noted

(50 % vs. 33 %, respectively; $p=0.28$). In a multivariate analysis controlling for age, body mass index, and pathologic stage there was a trend toward a lower complication rate in the robotic group, but it did not reach statistical significance ($p=0.0503$). A multi-institutional, randomized study is currently in the recruitment phase, the results of which will clarify this question.

Factors Associated with Perioperative Complications

While comparisons between open and RARC remain important, a more clinically relevant question involves examining preoperative predictors of postoperative RARC complications. Butt et al. evaluated 3-month complication rates among 62 consecutive patients undergoing RARC at a single institution. Stratifying patients into low- and high-risk groups based on age, prior surgery, comorbidities, body mass index (BMI), revised cardiac risk index (RCRI) and ASA score, they examined whether any of these preoperative factors were predictive of increased risk of complications. Although they found no association between any of these factors and complications rates during this time interval, advanced age was independently associated with a higher RCRI score ($p=0.014$) and increased likelihood of admission to the ICU ($p=0.007$) [11]. Evaluating 90-day outcomes, minor complications occurred in 24 % of patients, while 24 % had a major complication, with 11 % requiring reoperation. The same author published a study evaluating the effect of BMI on outcomes of RARC. Assessing a cohort of 51 patients categorized by three BMI subgroups, no significant differences were noted in postoperative complication rates between the cohorts [12]. Expanding on this group of patients, a subsequent study of 156 patients revealed a negative association between increased BMI and high grade complications in univariate analysis [6]. However, no significant predictors for complications following RARC were noted in multivariate analysis.

In the same study described earlier in this chapter, Kauffman et al. used two reporting methods for complications (MSKCC grading system and modified Clavien systems) to identify predisposing risk factors of 79 consecutive patients with bladder cancer undergoing RARC by a single surgeon at a single institution [3]. Forty-nine percent of patients experienced one or more complications within 90 days of surgery with 16 % experiencing major complications. Multivariate analysis identified pre and intraoperative factors which predicted complications, including preoperative renal insufficiency and intraoperative intravenous fluids >5,000 mL where were independent predictors across grades. Greater age ≥65 years, blood loss ≥500 mL, and intraoperative intravenous fluids of >5,000 mL were predictive of high-grade complications.

As described above, we recently participated in a multi-institutional study examining perioperative outcomes of 227 patients from four institutions undergoing RARC [8]. ASA score was a significant predictor of complication rate with higher scores associated with higher complication grades ($p=0.0258$). Age (stratified by age 65) was found to be a significant predictor of worse complications ($p=0.0230$) with those <65 years being twice as likely to experience a higher Clavien complication rate when controlling for other variables. While this finding is certainly different from prior studies, this may be explained by selection bias. Older patients with more comorbidities may be selected for the open procedure, thereby limiting our sample to healthier older surgical candidates in the robotic cohort. Conversely, the majority of younger patients may have been offered the procedure, therefore skewing the results. Certainly, this is a recognized limitation of retrospective case series which will hopefully be resolved through anticipated findings of the ongoing multi-institutional randomized trial comparing ORC and RARC.

Learning Curve and Complication Correlation

While preoperative patient factors may serve as important predictors of subsequent complications, surgeon experience and the effect of the learning curve on the RARC procedure must also be acknowledged. Hayn et al. performed an analysis on their first 164 consecutive patients [13]. Dividing patients into three groups according to sequential case number (<50, 50–100, >100 cases), no significant differences were observed with both estimated blood loss as well as complication rates. Pruthi et al. similarly evaluated the learning curve for their initial 50 patients [14]. When evaluating estimated blood loss, a significant decline was observed after the 20th patient, but no further improvements were noted thereafter. Comparing complication rates between the first and second cohort of 25 patients, no differences were observed. Schumacher et al. published a report evaluating complications in 45 patients [15]. This series is unique since all diversions were created intracorporeally with 80 % of patients choosing an orthotopic neobladder. Dividing patients into three groups of 15 patients, no differences were noted in estimated blood loss between cohorts. However, a significant decrease was observed in late complications after the initial group of 15 patients. An important consideration includes the fact that 70 % of patients in this study underwent RARC in the last 3 years of the 7-year study period.

These studies offer conflicting data regarding the role of the learning curve for RARC, thereby making it difficult to draw definitive conclusions and provide recommendations of when a surgeon can expect to overcome these hurdles. Understandably, this is based on numerous factors, including the surgeon's prior experience, institutional support, patient selection, and many other variables. However, through our use of recommendations in this chapter, we hope to lessen the burden of the learning curve.

Avoidance of Perioperative Complications

Patient Selection

As we outline above, the incidence of complications following radical cystectomy remains significant regardless of approach. However, we believe that there are specific keys to avoiding operative complications when performing RARC. Here we offer several preventative strategies which may help reduce complications.

First, appropriate patient selection cannot be overemphasized during the primary stages of transition to RARC. As an initial case, we would recommend beginning with a thin male patient and non-bulky tumor. Because of several parallels drawn from the maneuvers used during robotic prostatectomy, a male patient will provide familiarity and comfort during the initial, most challenging steps involved in mastering the procedure. This will additionally lessen operative times early in the learning curve. Furthermore, patient size is often an important factor in the level of difficulty, with some of the most challenging RARC cases occurring in morbidly obese patients. Technical issues are often more challenging in obese patients, due to the need for appropriate retraction, which an especially difficult during left ureteral identification due to the large amount of epiploic, mesenteric, and retroperitoneal fat.

As a final recommendation, avoidance of locally advanced and large tumors is imperative. Bulky tumors can produce significant challenges with anterior retraction of the bladder during the posterior dissection. This particular problem will place the surgeon at risk for inadvertent entry into the bladder or rectal injury secondary to the lack of a posterior working space. We feel it is advisable to wait until surgeons have reached a more advanced stage in their learning curve before taking on these challenging cases.

Perioperative Pathways

While many complications during one's early operative experience may be avoided through patient selection, an emphasis should also be placed on standardized preoperative and postoperative pathways. From our experience, we have developed a "fast track" method to maximize outcomes and minimize morbidity. While many series in the literature continue the use of bowel preparation prior to cystectomy and urinary diversion, we have eliminated this based on recent colorectal literature suggesting no significant benefit [16]. To study this in our patient population, we evaluated two sequential case series of 70 patients undergoing radical cystectomy and urinary diversion. While the first patient group was given a regular diet with no mechanical preparation (other than an enema prior to surgery to reduce rectal distension), the second patient group underwent a preoperative mechanical bowel preparation with clear liquid diet, magnesium citrate, and an enema [17]. This study revealed no differences in overall complication rates (or gastrointestinal complications), length of stay, or return of bowel function between the two cohorts. Based on this evidence, we exclude a mechanical bowel preparation.

Postoperative pathways for radical cystectomy are equally important and also can benefit from standardization. Our recommended "fast track" program has been studied using 362 consecutive patients undergoing open or robot-assisted radical cystectomy and urinary diversion, each undergoing this perioperative care plan [18]. The plan includes extensive preoperative counseling with regard to expectations as well as an intraoperative surgical plan which includes DVT prophylaxis with sequential compression devices and TED hose, removal of the orogastric tube at the end of the procedure, and perioperative antibiotics in accordance with the American Urological Association guidelines, continued for 24 h postprocedure. Postoperatively, DVT prophylaxis is begun with early ambulation (on postoperative day 0–1), TED hose, and subcutaneous low molecular weight heparin (or unfractionated heparin if poor renal function) begun on postoperative day 1. Additionally, patients are given a pro-kinetic agent (metacloproamide 10 mg daily × 48 h), non-narcotic analgesics (e.g., ketorolac 30 mg IV q6h × 48 h, converted to celecoxib 200 mg po BID), and supplemental pain management with narcotics. The fast-track program emphasizes a strict dietary regimen, beginning with NPO status and chewing gum (ad lib) on postoperative day 1, 8 oz of noncarbonated clear liquids every 8 h on postoperative day 2, followed by unrestricted noncarbonated clear liquids on postoperative day 3, and finally a regular diet on postoperative day 4. Diet advancement is performed regardless of bowel function and is only held or decreased in the setting of vomiting or intractable nausea. With this pathway, we have found a lower rate of overall and gastrointestinal complications with a favorable complication profile [18]. This particular pathway represents the authors experience in the postoperative management of radical cystectomy patients. Other clinical care pathways have been published and ultimately postoperative care will depend on surgeon preference [19].

Equipment and Materials

Prior to embarking on a RARC, the use of proper equipment and materials is crucial to avoidance of complications. First, the robotic instruments most commonly used include a Fenestrated Bipolar instrument in the left robotic arm and Monopolar Scissors in the right. A Prograsp is most commonly used in the fourth robotic arm, but use of robotic bowel grasper is an alternative. The latter instrument is larger in length and can provide more depth with troublesome bowel retraction. However, if this instrument is used, it is imperative to visualize the instrument when changing its position due to the potential for damage of adjacent structures due to its size.

With regard to bedside assistant ports, the use of a 12-mm and 15-mm port is essential regardless if the assistant is placed on the right or left. The 15-mm port can be placed in the lateral position, and this larger port will allow easier extraction of lymph node packets as well as placement of a 15-mm extraction bag for the final specimen. The 12-mm assistant port is placed in the medial position, cephalad, and just medial to the left robotic arm (for a left-sided bedside assistant). This allows direct placement of an endovascular stapler to the pedicles of the bladder. If this port is placed lateral to the ipsilateral working arm, the approach to the bladder pedicle can be difficult as the stapler cannot articulate enough to overcome the acuity of the angle.

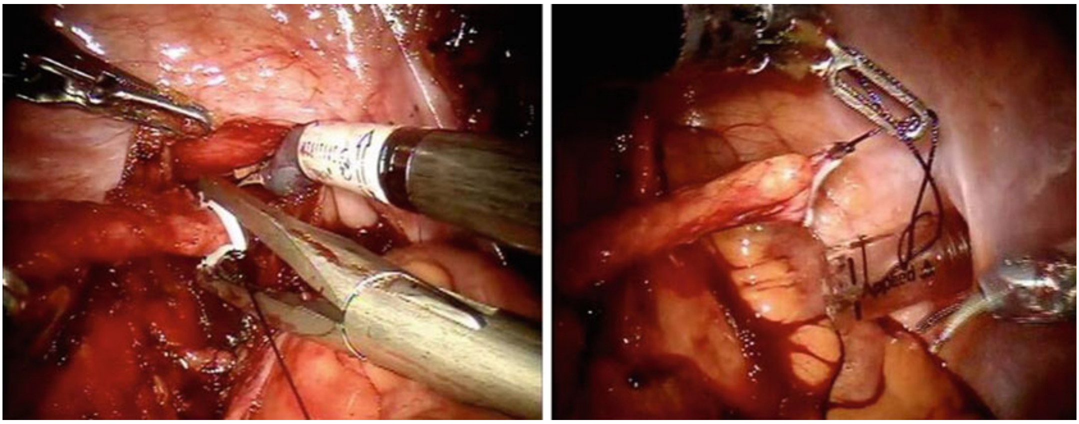

Fig. 16.1 Technique of ureteral clipping and division with pre-tied hem-o-lok clip

We use a bariatric/long stapler (Covidien EndoGIA Ultra XL, Mansfield, MA) which will easily reach the pelvis despite the fairly cephalad port location. As these are vascular pedicles, we often use tan Covidien 60 mm loads (for vascular/medium tissues). However, if one finds the pedicle too thick, a purple load can suffice in this situation, compressing tissue up to 2.25 mm in thickness, compared to tan reloads which compress up to 1.5 mm. Hem-o-lok (Weck, Research Triangle Park, NC) clips are also commonly used for portions of the cystectomy, with 15 mm (gold) clips recommended to allow control of larger tissue pedicles.

Intraoperative Techniques to Minimize Morbidity

We will now touch on several intraoperative techniques that can be employed to avoid postoperative complications. To start with, ureteral dissection is an important part of RARC. Ureteral strictures represent an extremely troubling late complication of urinary diversions, and the majority of these can be attributed to ischemia of the distal ureter, in some cases resulting from poor surgical technique during ureteral mobilization. Care must be taken to avoid tension during dissection. After dissection, a robotic arm is often employed to elevate the ureter, and due to the lack of tactile feedback, excessive tension may be unintentionally placed on the ureter. It is therefore essential to use visual cues to constantly assess this degree of tension. Additionally, it is imperative to leave periureteral tissue surrounding the ureter to allow for a non-ischemic anastomosis. A technique which we have found effective and efficient to minimize ureteral trauma involves the use of a pre-tied Hem-o-lok clip. We place a 15-mm clip with a 20-cm silk tie proximal to the site of ureteral transection. Once divided, the tie/clip functions as a secure stay for all future manipulation without direct handling of the ureter (Fig. 16.1).

An additional technique we utilize to minimize ureteral ischemia, limitation of proximal mobilization to just above the common iliac vessels allows for mobilization of the ureter away from the working field during extended pelvic lymphadenectomy while maintaining perforating vessels to the ureter above the aortic bifurcation. Although tempting, additional proximal dissection is rarely needed to complete the urinary diversion, even if done through a limited incision during extracorporeal reconstruction.

While a small incision is possible, it is still important to make a large enough incision to accommodate construction of the urinary diversion. This allows for creation of the ureteroenteric anastomosis without additional ureteral tension aggravated by a small incision. We believe that the benefits of a robotic approach will not be undone through limited extension of this incision.

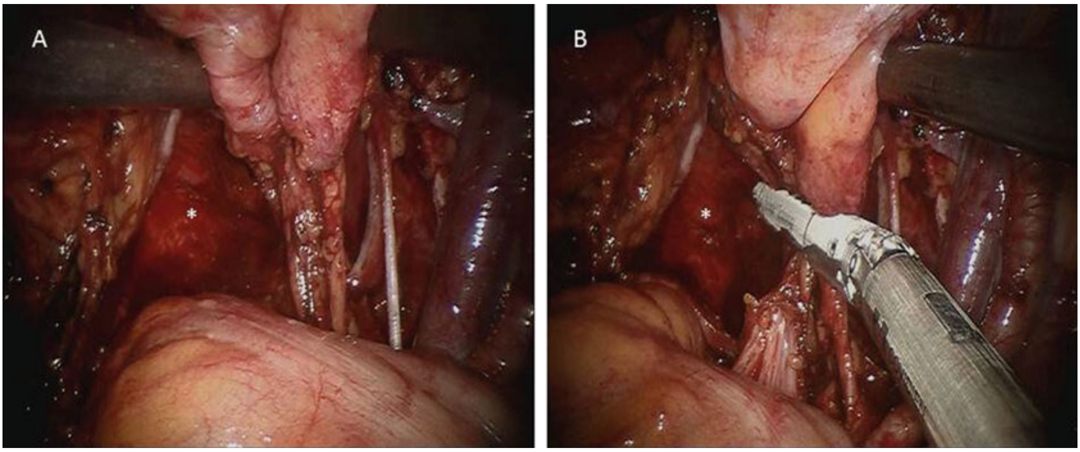

Fig. 16.2 (**a**) Isolation of right bladder pedicle after complete mobilization of the rectum. (**b**) Safe application of laparoscopic stapler above rectum (* = rectum)

Ultimately, performance of an incorporeal urinary diversion may help avoid tension-related insults to the ureteral blood supply.

While ureteral complications are certainly troublesome, a rectal injury can be a disastrous complication which could result in a colostomy, rectal fistula, and even death if unrecognized. When performing the posterior dissection in male patients, particular attention should be paid to careful and thorough mobilization of the rectum to avoid injury during division of the vascular pedicles. Our preference for division of these pedicles is with use of a vascular stapler. The posterior dissection usually becomes more difficult as one progresses distally, and it should be kept in mind that the rectum lies in a more anterior location when approaching the prostatic apex. We recommend allotting adequate time to fully mobilize the distal aspect of the rectum away from the prostate in much the same fashion as one prepares for neurovascular bundle preservation during a robot assisted radical prostatectomy. Once this is accomplished, the surgeon will be left with a narrow column of vascular tissue from the superior vesical artery to the prostatic apex. This will allow safe application of the vascular stapler above all rectal tissue as shown in (Fig. 16.2). When employing the stapler, we recommend the larger, more blunt blade be positioned medially to avoid inadvertent placement of the sharper, thinner blade into the rectum; also helpful is upward (anterior) articulation of the stapler away from the rectum.

If the separation of the bladder/prostate and rectum is difficult, we would then recommend proceeding cautiously through isolation of individual pedicles as one progresses distally, using Hem-o-lok (weck) clips for vascular control (Fig. 16.3). Blunt and sharp dissection should be employed avoiding the use of excessive cautery to thereby avert any thermal injury. If at any point a bulky tumor impedes visualization of the posterior plane, use of a 30° upward-facing lens may be warranted, which may improve visualization of the underside of the bladder.

Although the extirpative portion of RARC is undeniably the focus of the procedure, the prognostic and therapeutic benefits of an extended pelvic lymphadenectomy (PLND) at the time of radical cystectomy are also important and have been well established [20]. The ability to perform an adequate pelvic lymph node dissection during RARC has been a popular target for opponents of the robotic approach. However, this has been refuted by several authors [10, 21, 22], and we uphold that a meticulous dissection of any template can be performed robotically if the surgeon is committed to this goal. One of the most challenging aspects of the PLND is performing an adequate and safe dissection of the lymphatic

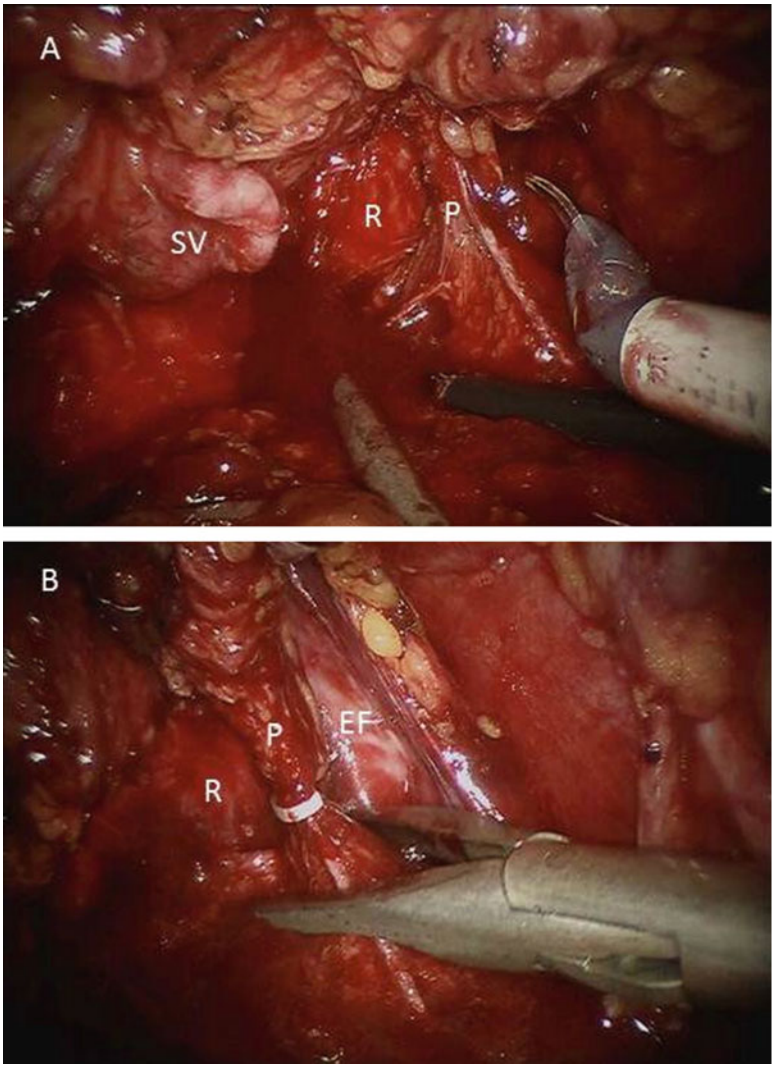

Fig. 16.3 (**a**) Distal right prostatic pedicle seen during a RARC where the application of a laparoscopic stapler would be potentially hazardous due to the proximity of the rectum. (**b**) Application of Hem-o-lok clip allowing precise division of pedicle anterior to rectum (R = rectum, P = pedicle, SV = seminal vesicle, EF = endopelvic fascia)

tissue in the bifurcation of the common iliac vessels. The difficulty of dissection can be decreased by medial mobilization of the external iliac vessels and all associated lymphatic tissue. This will expose the medial aspect of the psoas muscle and the most proximal aspect of the obturator nerve while releasing all lateral attachments of this nodal packet as shown in (Fig. 16.4a). It will further allow the surgeon to return to the medial side of the vessels and easily withdraw the entire lymph node packet from the bifurcation of the vessels (Fig. 16.4b). Overall, this will not only help decrease the risk of a vascular injury to the hypogastric vessels and alleviate the anxiety associated with dissection in this challenging area but also allow excellent access for the hypogastric vein dissection (Fig. 16.4c).

With the use of the above-mentioned advice for patient and instrument selection, perioperative care pathways, and intraoperative technique, we believe that many complications can be avoided.

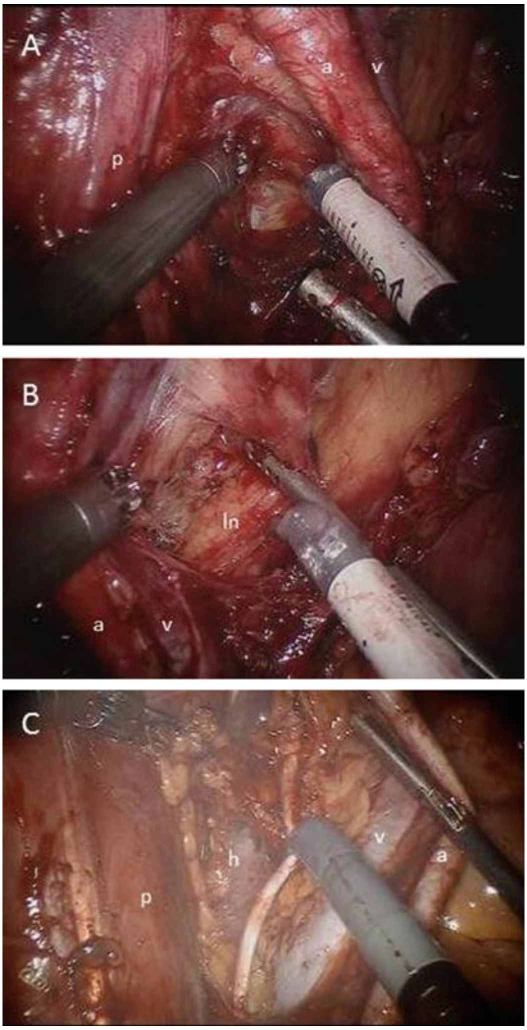

Fig. 16.4 (**a**) Medial mobilization of left external iliac vessels with the obturator/hypogastric lymph node packet. (**b**) Separation of lymph node packet from external iliac vessels. (**c**) Exposure of left hypogastric vein and obturator nerve (a = external iliac artery, v = external iliac vein, p = psoas muscle, ln = left hypogastric/obturator lymph node packet, h = hypogastric vein)

Management of Operative Complications

As described in the subsection above, avoidance of complications may be equally important to the ability of managing these same complications, most of which can be controlled robotically. Perhaps one of the most common intraoperative issues involves shortened ureteral length. Whether one has decreased length due to patient habitus or the necessity of decreasing length to attain negative margins, this can create difficulty in ureteroileal anastomoses. Furthermore, one can find additional length through elongation of the created ileal conduit (or neobladder limb). To enable adequate visualization of the anastomosis, one may need to lengthen the incision used for extracorporeal diversion, and the surgeon should not hesitate to do so, since this may decrease the possibility of ureteral tension and improve the quality of the anastomosis, reducing the chance of postoperative stricture.

While ureteral length may be a common intraoperative issue, a less common but more dangerous complication is intraoperative vascular injury, often experienced during lymph node dissection. Should this occur, vascular injuries can often be managed robotically. Additionally, a suture should be ready at all times to enable quick ligation of a bleeding vessel. In the setting of a venous injury the pneumoperitoneum should be increased to 20 mmHg to help tamponade the bleeding. In the case of a small to medium vessel with a visible stump or partial division, a clip may be employed. However, if a large en-face injury occurs (for example, in the external iliac vein), it may be necessary to grasp the opening (or apply pressure) with the left hand instrument (Fenestrated Bipolar) while placing a figure-of-eight suture around the defect with the contralateral hand. In this situation, the scissors in the right hand will need to be exchanged to a needle driver while the left hand maintains hemostasis. A shorter suture ($\leq$6 in.) will suffice and ensure ease of tying. In the event of a larger injury, proximal and distal control of the vessel may be required to adequately visualize and repair the defect. To accomplish this maneuver, the bedside assistant will likely be required to hold pressure on the injury while the console surgeon gains vascular control. Once the dissection is complete, either a tourniquet or laparoscopic bulldog clamps may be used. While controlling bleeding vessels, it is imperative to be cognizant of adjacent structures, particularly the obturator nerve, which can inadvertently be injured if one is not careful.

Equally disturbing but perhaps less emergent is the complication of a rectal injury. If an injury is encountered, consideration can be made for primary repair and closure, both of which may be accomplished robotically [23, 24]. If the patient has had radiation and appears to be a poor candidate for primary repair, one should consider colostomy with judicious use of general surgery consultation. It is important to stress preoperative counseling to these patients, so that they are made aware of this possibility before the day of surgery. However, if primary closure appears feasible, the edges of the defect should be freshened (and perhaps even resected further if cautery was the etiologic factor), and closure should proceed with at least two layers of absorbable suture (at the discretion of the surgeon) with some authors recommending a third imbricating layer of non-absorbable suture [23]. An omental interposition may be performed, and we recommend the use of an intraperitoneal drain.

Conclusions

An increasing number of case series of robot-assisted radical cystectomy describe complication rates comparable to open series. Conflicting reports describe various preoperative factors as predictors of postoperative complications. Furthermore, learning curves complicate these predictors and should also be taken into account. Despite these variables, there are a number of considerations, including patient selection, equipment choice, perioperative pathways, and intraoperative technique that we have found to decrease postoperative complications and improve patient outcomes. We hope that this chapter provides a primer to best avoid and manage these complications, enabling the surgeon to achieve a smooth transition to performing robotic cystectomies.

Editors' Commentary

Erik P. Castle and Raj S. Pruthi

A successful outcome with radical cystectomy is not only related to surgical technique and safe extirpation of the bladder but also to factors such as patient selection and coordinated perioperative care. Indeed, minimally invasive surgery seeks to reduce surgical morbidity in all of its forms—including complications.

Indeed, perioperative outcomes and complications will be among the most important outcomes measured as physicians, patients, and payers. Such factors have a major impact on quality of care as well as cost of care. As such, it is highly relevant that surgeons strive to reduce complications and improve outcomes through appropriate patient selection, use of perioperative pathways, and proper intraoperative techniques. These highly experienced authors provide an insightful description of these important considerations to reduce complications and improve outcomes. Hopefully, the reader will be able to shorten their own learning curve by adopting the lessons and techniques put forth in this chapter.

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