Chapter 5
Robotic-Assisted Radical Cystectomy

P. Dasgupta, P. Rimington, A.K. Hemal, and M.S. Khan

Abstract: Robotic-assisted radical cystectomy (RARC) is an evolving procedure which combines the minimally invasive benefits of laparoscopy and the enhanced dexterity and vision of robotics. Over 150 of these have been performed worldwide in selected centers. Although the blood loss, hospital stay, and recovery are shorter than open surgery, operative times are longer. In nonrandomized comparisons, the complications appear to be lower than open and laparoscopic radical cystectomy. Actuarial and recurrence-free survivals at 3.5 years are 95 and 90%, respectively. A single port site recurrence has been reported.

Keywords: Robotics, Cystectomy, Urinary diversion, Oncologic outcome

5.1. Introduction

Although randomized controlled trials are lacking, radical cystectomy/anterior exenteration is currently regarded as the gold standard for managing invasive bladder cancer,extensive uncontrollable superficial cancer and refractory carcinoma in situ (CIS). At specialized centers the 5-year recurrence free survival for muscle invasive disease is 56–73% (Madersbacher et al. 2003). Herr et al. have proposed optimum standards for

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this procedure. These include 10% positive surgical margins overall and 15% in patients with T3 & T4 tumors. The median number of lymph nodes retrieved should be 10–14 (Herr et al. 2004). Although open radical cystectomy (ORC) has become safer in expert hands, it remains a formidable procedure with a complication rate of around 30–50%. Excessive bowel handling, fluid loss, and opiates can lead to prolonged ileus. In spite of improvements in surgical techniques blood loss during ORC is often significant. The hospital stay is consequently quite prolonged with 18–21 days quoted as the UK average (Nuttall et al. 2005).

Urologists experienced in advanced laparoscopy have reported promising results of laparoscopic radical cystectomy (LRC) in the hope of reducing patient morbidity. Within our own group LRC is performed by a team consisting of two experienced urologists to reduce surgical fatigue (Rimington and Dasgupta 2004). The procedure is sometimes difficult due to reduced maneuverability of laparoscopic instruments in the pelvis. The complication rate of LRC can be high even in expert hands. The overall complications during hospital stay and after discharge have been up to 46 and 19%, respectively (Haber and Gill 2007). Another large LRC series of 84 patients showed that the complication rate can be reduced to 18% which is better than reported in most series of ORC (Cathelineau et al. 2005). The da Vinci^{TM} system (Intuitive Surgical, California) has the potential to overcome some of the technical difficulties of LRC. We published the first UK experience with this system (Dasgupta et al. 2005) and now review the oncologic and functional outcomes of robotic-assisted radical cystectomy (RARC). At the time of writing >150 procedures have been performed worldwide.

5.2. Surgical Technique

The Guy's technique is derived from ORC and LRC and has evolved over 4 years (Raychaudhuri et al. 2006). Patients

FIGURE 5.1 Position of patient during robotic cystectomy.

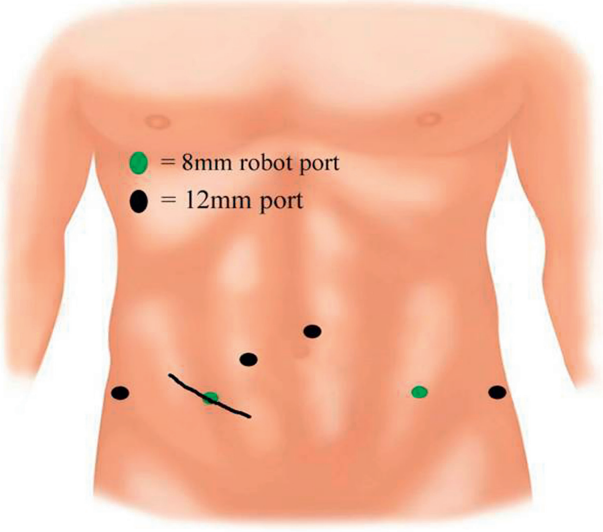

FIGURE 5.2 Schematic diagram of port positioning.

are given clear fluids orally, an enema the day before their operation and overnight intravenous normal saline to prevent dehydration. This is part of an enhanced recovery program derived from colorectal surgery where formal bowel preparation is deliberately avoided. Intravenous cefuroxime and metronidazole and subcutaneous low molecular weight heparin are administered perioperatively. Patients above 60 are digitalized as recommended by urologists experienced in open cystectomy, to prevent atrial fibrillation (Stein and Skinner 2004). They are placed in the extended lithotomy position with a 45° Trendelenburg tilt (Fig. 5.1). A disposable sigmoidoscope is introduced per rectum in male and a methylene blue-soaked swab per vaginam in female patients. After sterile catheterization, a six-port transperitoneal approach is used as previously described (Hemal et al. 2004) (Fig. 5.2). The ports are usually placed in a fan-shaped configuration (Fig. 5.3). The procedure involves three surgeons—one at the console and one on each side of the patient. A fourth robotic arm can be used in place of the left side assistant.

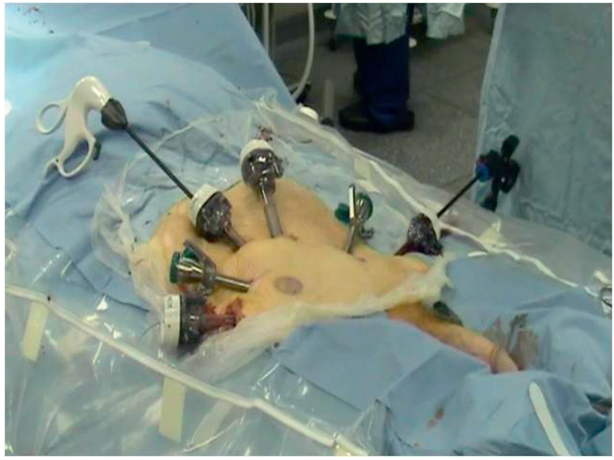

FIGURE 5.3 Port positioning.

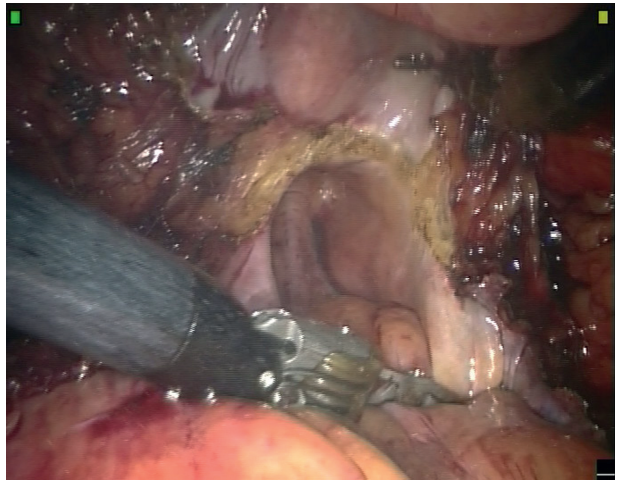

FIGURE 5.4 Posterior dissection.

5.2.1. Posterior Dissection

The ureters are mobilized in the pelvis while keeping adequate tissue around them so as not to compromise their vascularity. The distal ends are clipped and cut and sent for frozen section analysis. An inverted U-shaped incision is made in the peritoneum of the cul-de-sac (Pouch of Douglas) (Fig. 5.4). The posterior layer of Denonvillier's fascia is then incised in the midline and the plane between the rectum and the prostate developed. In patients wishing to preserve potency, diathermy is avoided at the tips of the seminal vesicles to avoid injury to the pelvic plexus. In females, the ovarian vessels are controlled with Hem-o-lok clips (Weck Closure Systems, NC, USA) and divided. The plane between the rectum and uterus is developed and the uterine arteries controlled with Hem-o-loks.

5.2.2. Lateral Dissection

Dissection is continued medial to the external iliac veins to carefully preserve the obturator nerves and expose the lateral

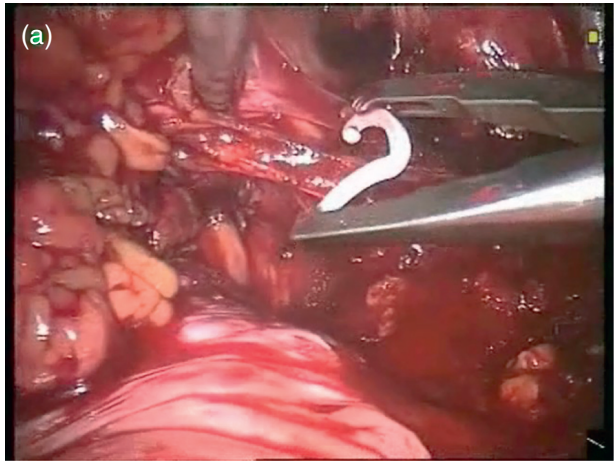

FIGURE 5.5A Control of lateral pedicles of the bladder with clips.

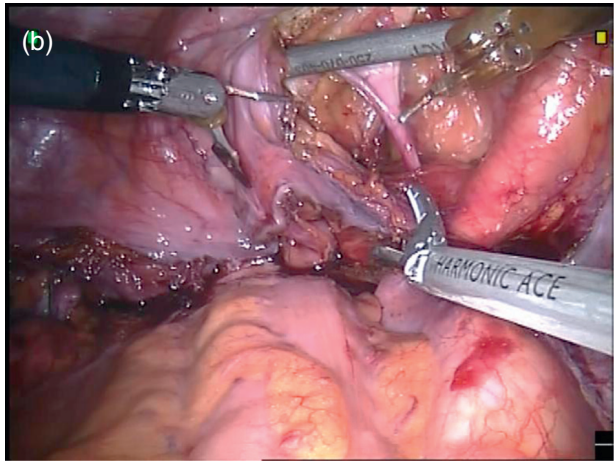

FIGURE 5.5B Control of lateral pedicles of the bladder with staples.

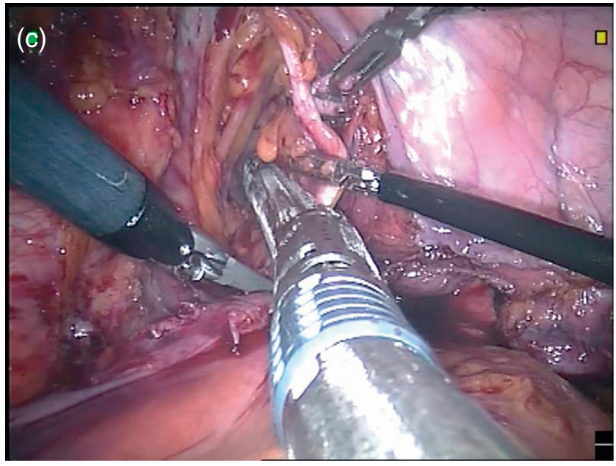

FIGURE 5.5C Control of lateral pedicles of the bladder with harmonic scalpel.

pelvic wall. This delineates the lateral pedicles to the bladder (and uterus in females). We initially used Hem-o-lok clips for control of the lateral pedicles but subsequently switched to an Endopath™ ATW45 linear stapler (Ethicon Endosurgery, Livingston, UK). This was prompted by our perception that blood loss was somewhat higher with clips. Currently, an ACE Harmonic™ scalpel (Ethicon Endosurgery, Livingston, UK) seems to be the most efficient (Fig. 5.5a–c) for this purpose. It is also more cost-effective ~£300 for harmonic as opposed to £1200 for staplers since multiple firings of cartridges are required.

5.2.3. Anterior Dissection

The bladder is filled with 200 ml of formol-saline for easy identification and dropped by an inverted U incision to include the urachus. The endopelvic fascia is opened and the dorsal vein controlled by a stitch. Nerve sparing is performed

in potent patients. The dorsal vein complex and urethra are cut and a clip placed on the specimen side of the urethra to prevent any spillage. The distal urethral margin is sent for frozen section. In females the urethra is dissected fully to the external meatus. The posterior vaginal fornix is opened. The previously placed methylene blue swab becomes visible indicating that the correct plane had been entered. The lateral vaginal walls are transected. The cystectomy specimens are placed in a 15-mm EndoCatch II™ bag (Tyco Healthcare, Hampshire, UK) for later retrieval. Leakage of carbon dioxide from the vagina is reduced by a water-proof dressing applied externally. The vagina is then closed longitudinally by continuous intracorporeal suturing.

5.2.4. *Lymphadenectomy, Transposition of Left Ureter*

Using robotic bipolar forceps and scissors, careful bilateral lymphadenectomy is performed. The limits of the dissection are the genitofemoral nerve laterally, the bifurcation of the common iliac artery proximally and the node of Cloquet distally. Care is taken to preserve the obturator nerve. The da Vinci™ S-HD gives better quadrantic access and it is possible to extend the lymph node dissection to the aortic bifurcation with this new system. The lymph nodal packs are placed in separately marked laparoscopic sacks. An Endoloop™ (Ethicon Endo-surgery, Livingston, UK) is applied on the distal end of the left ureter which is then transposed under the sigmoid mesocolon to the left by pulling the Endoloop through. The distal ends of the ureters are held together with a laparoscopic grasper introduced through the left-sided 5-mm assistant port.

5.2.5. *Urinary Diversion*

It is easier and quicker to perform urinary diversions extracorporeally although complete robotic-assisted intracorpo-

real diversion has been reported. For ileal conduits a 15-cm segment of ileum about 15-cm proximal to the ileo-cecal junction is held in laparoscopic graspers introduced through the most lateral right-sided 10-mm port. The robot is undocked. The previously bagged bladder and lymph nodal specimens are extracted through a 5–7-cm incision (Fig. 5.6). In thin patients this is an appendix muscle-splitting incision made by extending a lateral port while in overweight patients (BMI $>30\,kg/m^2$) a subumbilical midline incision is preferred for easier left ureteric access. The graspers holding the ureters and ileal segment are brought to the surface through this incision. The ileal loop is isolated on its mesentery, bowel continuity restored with staplers and the mesenteric window closed. Ureteroileal anastomosis is performed over 8F feeding tubes by a Wallace I technique. The distal end of the conduit is fashioned as a stoma at a previously marked site on the abdominal wall. A sump drain is introduced into the conduit to prevent any anastomotic pressure and leak from subsequent stomal edema. Studer

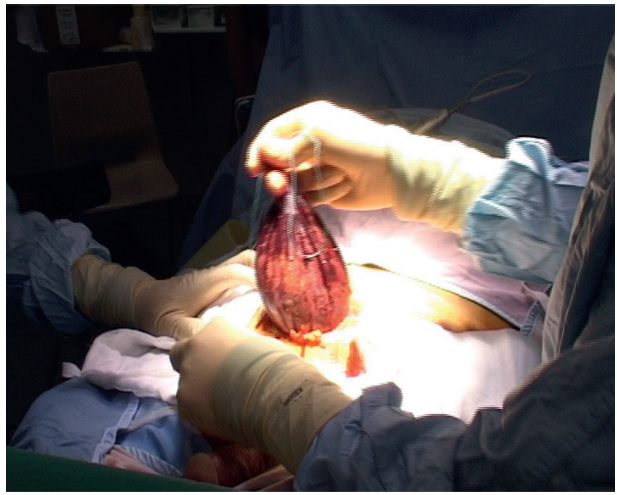

FIGURE 5.6 Specimen extraction in laparoscopic sack.

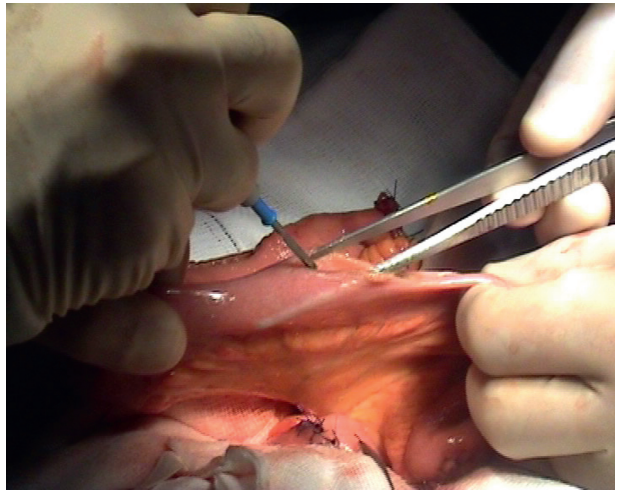

FIGURE 5.7 Studer pouch formation through a small incision.

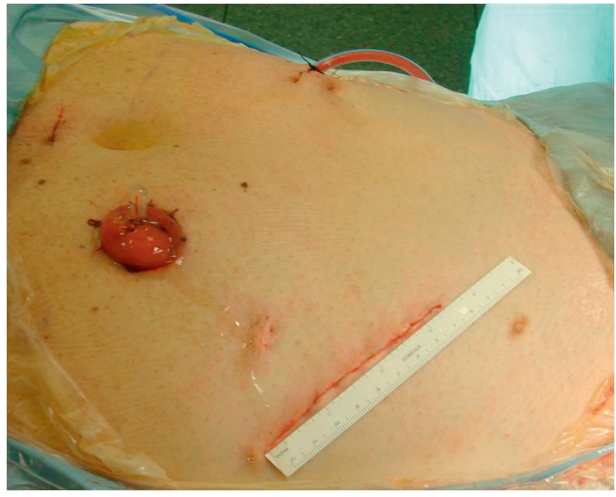

FIGURE 5.8 Postoperative wounds.

pouches are created through lower midline incisions and anastomosed to the urethral stump by six robotically placed 3–0 Monocryl sutures (Fig. 5.7). Alternatively, a continuous 3–0 Monocryl anastomosis can be performed as in radical prostatectomy, after redocking the robot. A 20 F drain is placed in the pelvis. The port sites and wounds are closed with absorbable sutures (Fig. 5.8). A liter of icodextrin (Adept, ML Pharmaceuticals,Warrington, UK) is instilled into the abdomen and drained after an hour to reduce the risk of bowel adhesions.

5.3. Postoperative Care

All patients are electively managed in an overnight recovery or high dependency unit immediately after the operation. The naso-gastric tube is removed and oral liquids started as tolerated. Early mobilization and chest physiotherapy are encouraged. Most patients are discharged with their pelvic drains and ureteric catheters in situ which are removed at 3 weeks. Patients are seen again at 6 weeks, have an abdominal ultrasound at 3 months, CT scans at 6 months and then at 6-monthly intervals. At these visits they also undergo clinical examination and assessment of serum hemoglobin, electrolytes, creatinine, chloride, and bicarbonate.

5.4. Outcomes of RARC

RARC and urinary diversion was initially reported in 2003 (Menon et al. 2003). Similar to LRC, it involved a six-port transperitoneal approach. The procedure was performed in three stages: initially pelvic lymphadenectomy and cystoprostatectomy, secondly extracorporeal formation of a neobladder, and thirdly intracorporeal urethroneovesical anastomosis following redocking of the robot. The operative times ranged from 260–308 min depending on whether an ileal conduit or orthotopic neobladder was formed. Blood

loss was <150 mls and surgical margins were clear in all cases. One patient had N1 disease. Long-term oncologic or functional results were not reported although a port-site metastasis was subsequently mentioned (El-Tabey and Shoma 2005). Around the same time Beeken et al. described robotic cystectomy and intracorporeal Hautmann orthotopic neobladder with an operating time of 8.5 hours and a blood loss of 200 ml (Beecken et al. 2003), whilst Balaji et al. successfully performed robotic-assisted totally intracorporeal laparoscopic ileal conduit urinary diversion in three patients (Balaji et al. 2004) with operative time of 630–830 min and a hospital stay of 5–10 days. The longest operative time was in one patient who underwent concomitant RARC. Menon's group subsequently refined the robotic technique for women with preservation of the uterus and vagina (Menon et al. 2004). Other authors have excluded patients with prior extensive abdominal surgery, pelvic irradiation, neoadjuvant chemotherapy, and extravesical mass on CT from RARC (Miller and Theodorescu 2005), making a selection bias quite likely. Guru et al. reported their early results on 20 RARC with average age of 70 and BMI of 26 kg/m^2. The mean operative duration was 442 min, blood loss 555 ml, and hospital stay of 10 days. The procedure was unsuccessful in a patient with fixed pelvic mass and another needed conversion to open surgery as the patient could not tolerate the Trendelenburg position. There were three bowel obstructions, one of whom died of sepsis and one readmission with pyelonephritis. Thus, the overall complication rate was 20%. One patient had positive vaginal margins and 9 of 26 lymph nodes were positive (Guru et al. 2007). In 30 patients at Guy's the operative time was between 5.5–8 hours depending on whether an ileal conduit or Studer pouch was created, estimated blood loss 200 ml, and hospital stay either 1 week for the conduits or 2 weeks for the pouches. One patient needed blood transfusion due to bleeding from an inferior epigastric artery and one patient with a large urethral adenocarcinoma needed a colostomy for rectal injury. Delayed functional complications occurred in three patients. One patient with a Studer

pouch developed a neovesico-urethral stricture which needed urethral dilatation. Another developed a left upper ureteric stricture at 6 months. This was assumed to be malignant and hence treated with nephroureterectomy. The final pathology was that of a benign inflammatory stricture. A third patient needed repair of an incisional hernia at 12 months. Serum creatinine levels were maintained in all patients. Three of four previously potent male patients who underwent nerve sparing were potent with Tadalafil.

The operation has also been performed in patients without cancer. Two men, 41 and 38 years old, with complete post-traumatic C7–C8 quadriplegia underwent total intracorporeal cystoprostatectomy and ileal conduit urinary diversion with robotic assistance. The procedures were completed without open conversion. The total surgical time was 9.25 and 6.75 hours, respectively. There were no intraoperative complications. In the postoperative period, both patients had complications (pulmonary and urinary infections) that were treated medically. The postoperative hospital stay was 13 days (Hubert et al. 2006).

5.5. Comparison of ORC and RARC

Rhee et al. compared 23 ORC to seven RARC and found that although blood loss was lower for RARC, four of seven patients (57%) needed transfusion. The operative duration was 638 min for RARC vs. 507 min for ORC and hospital stay 11 and 13 days, respectively (Rhee et al. 2006). In another study of 37 patients, 24 (64.9%) had ORC and 13 (29.7%) were treated with RARC. RARC resulted in significantly lower blood loss, hospital stay, and longer operating time compared with ORC. Four (16.7%) perioperative complications occurred in the open group compared with two (15.4%) in the robotic group (Galich et al. 2006). Pruthi and Wallen compared 20 men undergoing RARC and extracorporeal urinary diversion to 24 matched men who underwent ORC. Mean operative time for RARC was 6.1 hours as opposed to

3.8 hours for ORC. Mean blood loss was significantly less for RARC. On surgical pathology 14 RARC cases were pT2 or less, four were pT3, and two were N+. There were no positive surgical margins. A mean of 19 lymph nodes was removed. Mean time to flatus and bowel movement was significantly shorter than in men undergoing ORC. There were six post-operative complications (30%) in five patients (Pruthi and Wallen 2007). Likewise, Wang et al. compared 20 ORC and 33 RARC patients and found similar complication rates (24% open, 21% robotic). The open cohort had more patients with extravesical disease (57 vs. 28%) and nodal metastasis (34 vs. 19%), although this may be a reflection of small sample size. There were three patients in the open group and two in the robotic with positive margins. The median number of lymph nodes removed was similar between groups (Wang et al. 2008).

5.6. Comparison of ORC, LRC, and RARC

Thirty age-matched patients (ten in each group) had ORC, LRC, or RARC and ileal conduit diversion by three surgeons (Table 5.1). RARC and LRC took longer than ORC but were associated with less blood loss and quicker recovery. Hospital stay was shortest for RARC, which also had the lowest complication rate (Elhage et al. 2007a).

5.7. Oncologic Outcomes

For RARC to stand the test of time, the oncologic outcomes have to be equivalent to ORC and LRC. In their series of 1054 patients undergoing ORC, Stein et al. reported recurrence-free survival at 5 and 10 years of 68 and 66%, respectively (Stein et al. 2001). The recurrence-free survival appears to be worse for patients with stage >pT2N0 (Madersbacher et al. 2003). On the basis of their results in ten LRC patients, five of whom died, Simonato et al. reported poorer

TABLE 5.1 Comparison of ORC, LRC, RARC

Op	Op time (mins)	Blood loss (mls)	Complication (%)	Hosp stay (days)	Recovery (weeks)	Oncologic follow-up
ORC	325	1300	60	16	8	60% RFS@5 yr
LRC	345	350	50	16	3	60% RFS@4 yr
RARC	365	150	20	10.5	4	90% RFS@3 yr

Note: RFS = Recurrence-free survival

oncologic outcomes with LRC compared to ORC (Simonato et al. 2005). In a recent study of 37 patients undergoing LRC, followed-up for up to 5 years, Haber and Gill reported actuarial overall and recurrence-free survival of 63 and 92%, respectively. However, only eight patients had completed 5 years of follow-up and oncologic data was not available in seven patients. Assuming that all these seven patients had died from metastatic disease, the recalculated 5-year overall and cancer-specific survival were 58 and 68%, respectively. The outcomes were poorer in those with concomitant CIS, extraorgan disease, and nodal metastasis. Patients having extended laparoscopic lymph node dissection had slightly better cancer specific survival compared to those having a limited template lymphadenectomy, although not reaching statistical significance (Haber and Gill 2007). With strict adherence to oncologic principles during RARC to prevent spillage of cancer cells, we reported 100% overall and recurrence-free survival at 2 years (Dasgupta et al. 2007). At a maximum follow-up of 3.5 years, the actuarial overall and recurrence-free survival, were 95 and 90%, respectively. A median of 16 (6–28) lymph nodes were removed. In our patient group, 10% had lymph nodal disease, 10% incidental prostate cancer, and 10% prostatic urethral CIS. There were no positive margins, no local pelvic recurrences, and no port-site metastasis. Lymph node metastasis, higher grade and concomitant CIS were predictors of poor medium-term outcome.

5.8. Quality of Life and Patient Satisfaction

Using quality of life questionnaires Guru et al. found time to normal activity to be 4 weeks, time to driving 6 weeks, and time to strenuous activity 10 weeks (Guru et al. 2007). Using the SF-8 validated questionnaire we found no change in physical quality of life scores at 6 weeks after RARC but significantly better mental scores (Fig. 5.9). Patient satisfaction was high (median 30 out of a maximum of 32 on a validated client satisfaction-8 survey; range 27–32). We found that 93% of

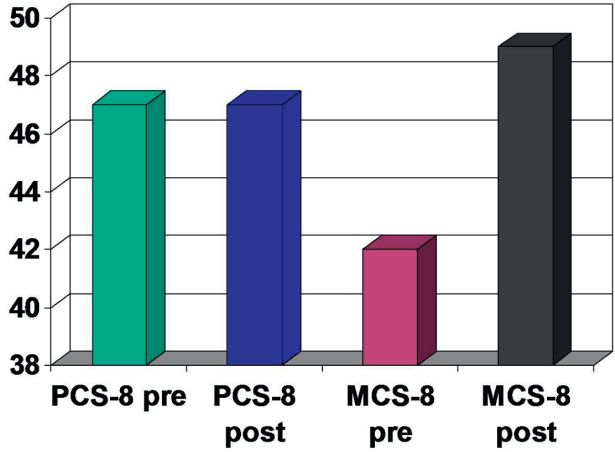

FIGURE 5.9 Assessment of physical and mental quality of life after robotic cystectomy.

FIGURE 5.10 Assessment of surgical fatigue by motion analysis in a gait laboratory (Courtesy of: Adam Shortland).

patients read and understood the patient information leaflet provided and 60% elected to watch a robotic patient information video. This had been screened by the British Broadcasting Corporation (BBC) after appropriate patient consent.

5.9. Ergonomics

One of the advantages of RARC over ORC and LRC may be reduced surgical fatigue during a long procedure (Elhage et al. 2007b). This has been studied using motion analysis and EMG recordings in a gait lab (Fig. 5.10).

5.10. Conclusions

The medium-term surgical, oncologic, and functional outcomes of RARC are encouraging. A randomized controlled trial of ORC, LRC, and RARC is planned and will include detailed health economic modeling.

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References

Balaji KC, Yohannes P, McBride CL, Oleynikov D, Hemstreet GP 3rd (2004) Feasibility of robot-assisted totally intracorporeal laparoscopic ileal conduit urinary diversion: Initial results of a single institutional pilot study. Urology 63:51–55

Beecken WD, Wolfram M, Engl T et al. (2003) Robotic-assisted Laparoscopic Radical Cystectomy and Intra-abdominal Formation of an Orthotopic Ileal Neobladder. Eur Urol 44:337–339

Cathelineau X, Arroyo C, Rozet F, Barret E, Vallancien G (2005) Laparoscopic assisted radical cystectomy: the Montsouris experience after 84 cases. Eur Urol 47:780–784

Dasgupta P, Hemal A, Rose K, Guy's and St. Thomas' Robotics Group (2005) Robotic urology in the UK: establishing a programme and emerging role. BJU Int 95:723–724

Dasgupta P, Rimington P, Murphy D et al. (2007) Robot-assisted radical cystectomy for bladder cancer and 2 year follow-up. BJU Int 99S1:P62

Elhage O, Keegan J, Varma P et al. (2007a) A comparative analysis of open, laparoscopic and robotic radical cystectomy for bladder cancer. J Endourol 21(S1):142A

Elhage O, Murphy D, Challacombe B, Shortland A, Dasgupta P (2007b) Ergonomics in minimally invasive surgery. Int J Clin Pract 61:186–188

El-Tabey NA, Shoma AM (2005) Port site metastases after robot-assisted laparoscopic radical cystectomy. Urology 66:1110

Galich A, Sterrett S, Nazemi T et al. (2006) Comparative analysis of early perioperative outcomes following radical cystectomy by either the robotic or open method. JSLS 10:145–150

Guru KA, Kim HL, Piacente PM, Mohler JL (2007) Robot-assisted radical cystectomy and pelvic lymph node dissection: initial experience at Roswell Park Cancer Institute. Urology 69: 469–74

Haber G-P, Gill IS (2007) Laparoscopic radical cystectomy for cancer: oncological outcomes at up to 5 years. BJU Int 100: 137–142

Hemal AK, Eun D, Tewari A, Menon M (2004) Nuances in the optimum placement of ports in pelvic and upper urinary tract surgery using the da Vinci robot. Urol Clin North Am 31:683–92, viii

Herr H, Lee C, Chang S, Lerner S for the bladder cancer collaborative group (2004) Standardization of radical cystectomy and pelvic lymph node dissection for bladder cancer. A collaborative group report. J Urol 171:1823–1828

Hubert J, Chammas M, Larre S et al. (2006) Initial experience with successful totally robotic laparoscopic cystoprostatectomy and ileal conduit construction in tetraplegic patients: report of two cases. J Endourol 20:139–143

Madersbacher S, Hochreiter W, Burkhard F et al. (2003) Radical cystectomy for bladder cancer today—a homogeneous series without neoadjuvant therapy. J Clin Oncol 21:690–696

Menon M, Hemal A, Tewari A et al. (2003) Nerve-sparing robot-assisted radical cystoprostatectomy and urinary diversion. BJU Int 92:232–236

Menon M, Hemal AK, Tewari A et al. (2004) Robot-assisted Radical Cystectomy and Urinary Diversion in Female Patients: Technique with Preservation of the Uterus and Vagina. J Am Coll Surg 198:386–393

Miller NL, Theodorescu D (2006) Status of robotic cystectomy in 2005. World J Urol 24:180–187

Nuttall MC, van der Meulen J, McIntosh G, Gillatt D, Emberton M (2005) Changes in patient characteristics and outcomes for radical cystectomy in England. BJU Int 95:513–516

Pruthi RS, Wallen EM (2007) Robotic assisted laparoscopic radical cystoprostatectomy: operative and pathological outcomes. J Urol 178(3 Pt 1):814–818

Raychaudhuri B, Khan MS, Challacombe B, Rimington P, Dasgupta P (2006) Minimally invasive radical cystectomy. BJU Int 98: 1064–1067

Rhee JJ, Lebeau S, Smolkin M, Theodorescu D (2006) Radical cystectomy with ileal conduit diversion: early prospective evaluation of the impact of robotic assistance. BJU Int 96:1059–1063

Rimington P, Dasgupta P (2004) Laparoscopic and robotic radical cystectomy. BJU Int 93:460–461

Simonato A, Gregori A, Lissiani A et al. (2005) Laparoscopic radical cystoprostatectomy: our experience in a consecutive series of 10 patients with a 3 years follow-up. Eur Urol 47:785–790

Stein JP, Lieskovsky G, Cote R et al. (2001) Radical cystectomy in the treatment of invasive bladder cancer: long-term results in 1054 patients. J Clin Oncol 19:666–675

Stein JP, Skinner DG (2004) Surgical atlas radical cystectomy. BJU Int 94:197–221

Wang GJ, Barocas DA, Raman JD et al. (2008) Robotic vs open radical cystectomy: prospective comparison of perioperative outcomes and pathological measures of early oncological efficacy. BJU Int 101:89–93

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