Status of Robot-Assisted Radical Cystectomy (RARC) in 2012

Amrith R. Rao · Andrew P. Stegemann ·
Shabnam Rehman · Michael A. Poch · Dawn Green ·
Khurshid A. Guru

Received: 9 January 2012 / Accepted: 17 January 2012 / Published online: 16 February 2012
© Indian Association of Surgical Oncology 2012

Abstract Robot-assisted radical cystectomy (RARC) for bladder cancer is increasingly becoming popular in specialist centres around the world. RARC has the advantage of being minimally invasive and also the dexterity of the instruments allow reconstruction such as ileal conduit urinary diversion or neobladder formation. Starting from the initial series demonstrating the feasibility of RARC and extended pelvic lymph node dissection, we now have mature series demonstrating equal oncological and functional outcomes in the medium term follow-up. In addition, literature suggests decreased hospital stay, less blood loss equating to less blood transfusion and a trend towards decreased complications as well. In the near future we would anticipate further refinement and reduced operating times with increased benefits for the patient undergoing RARC.

Keywords Robot-Assisted · Radical Cystectomy · Bladder Cancer · daVinci · Minimally Invasive Surgery

Abbreviations

RARC	Robot-assisted radical cystectomy
ORC	Open radical cystectomy
STSM	Soft tissue surgical margin
IRCC	International robotic cystectomy consortium
HRQOL	Health-related quality of life

Background

With the advent of the daVinci® Surgical System, the past decade has seen an increase in the treatment of benign and

malignant urological conditions with minimally invasive surgical techniques. The daVinci® Surgical System offers advantages over laparoscopic operations for both the patient and surgeon, including improved movement of the instruments and 3-dimensional magnified vision. These benefits decrease the steep learning curve of laparoscopic radical cystectomy.

RARC is rapidly gaining acceptance as an alternative to open radical cystectomy (ORC). Evidence in the literature suggests that the immediate and now intermediate results demonstrate acceptable outcomes compared to ORC [1, 2]. Robot-assisted radical cystectomy (RARC) offers decreased intraoperative blood loss, transfusion rate, opioid requirement, and length of stay. Furthermore, complication rates for RARC are no higher than those for ORC. Long-term oncological and functional outcomes are still needed though. Large series with long term follow-up in ORC have shown that approximately half of all cystectomy patients experience local recurrence or distant metastatic disease with subsequent mortality [3]. Surgeons should choose their patients early in their RARC learning curve due to concerns for oncologic control and the technically difficult nature of RARC [4, 5].

Techniques

Our technique for RARC at Roswell Park Cancer Institute has been previously described [6]. Many centers perform RARC and then carry out the ileal conduit urinary diversion or orthotopic neobladder extra-corporeally [7–9]. With increased experience and techniques as well as decreased operative times, more and more centers are now adopting intra-corporeal reconstruction [10, 11]. A few centers are adopting a team approach to RARC, where one team performs the cystectomy and lymphadenectomy and another performs the reconstruction [7]. Although this may decrease the surgical stress on the operating surgeon, whether this

A. R. Rao · A. P. Stegemann · S. Rehman · M. A. Poch ·
D. Green · K. A. Guru (✉)
Department of Urology, Roswell Park Cancer Institute,
Elm and Carlton Streets,
Buffalo, NY 14263, USA
e-mail: khurshid.guru@roswellpark.org

approach improves the functional and oncological outcomes is yet to be seen. Similarly techniques for standard and extended lymphadenectomy have been described [12]. This is a crucial and an integral part of RARC and will be described in detail below.

Soft Tissue Surgical Margins

The lack of tactile feedback on the daVinci® Surgical System has created concerns over adequate wide excision and avoidance of positive soft tissue surgical margins in advanced bladder cancer. ORC series have shown that soft tissue surgical margins (STSM) are associated with higher local recurrence and directly impact cancer specific survival. A recommendation in 2005, from experienced expert open surgeons determined positive STSM rates of less than 10% for all cases and fewer than 15% for bulky tumor cases. In 2008, data from the International Laparoscopic Cystectomy Registry (ILCR) reported a positive STSM rate of 2% [13]. The International Robotic Cystectomy Consortium (IRCC), which is a consortium of over 40 robotic surgeons from 22 institutions, reported 513 patients with overall positive STSM of 6.8%. This data also showed that pathological T3 and T4 tumors were independently associated with increased likelihood for positive STSM, while case number and institution volume were not. These rates are similar to larger open series [14]. Recently, updated data was presented at the American Urological Association (AUA) 2011 annual meeting. Analysis of 799 patients revealed positive STSM of 8%, with 78% having extra-vesical disease on final histology [15]. These results indicate that STSM are associated with soft tissue boundary infiltration of the bladder rather than surgical error or learning curve. Most importantly, wide dissection of perivesical tissue is recommended to reduce STSM rates in patients with large tumors or possible extra-vesical disease. Recently Schumacher et al. reported a positive margin rate of only 2.2% in their cohort of patients ($n=45$) who underwent RARC with intra-corporeal urinary diversion. According to final histology, 22% of this cohort had non-organ confined bladder cancer ($>pT2$), suggesting that improving techniques and increasing experience can attain acceptable surgical margins [16].

Lymph Node Dissection and Yield

Data from large ORC series have categorically shown that a good pelvic lymph node dissection is both diagnostic and improves overall survival [17–19]. The incidence of node positivity at the time of radical cystectomy exceeds 20%, and corresponds to increasing pathological stage, grade, and differentiation of bladder tumor.

Guru et al. reported on the feasibility and safety of performing robot-assisted lymph node dissection and demonstrated higher lymph node yield with increasing case volume [12]. Wang et al. conducted a study to compare lymph node yield in open and robotic approaches and found no difference in the number of lymph nodes retrieved between the two approaches (20 vs. 17) [20]. A prospective, randomized, non-inferiority study by Nix et al. compared RARC and ORC. They reported a mean lymph node yield of 19 for the RARC group compared to 18 for the ORC group [21]. Analysis of IRCC data has demonstrated a mean lymph node yield of 19. Subsequent analyses found that high-volume centers (<100 cases) have the highest yields and high-surgeon volume (>50 cases) independently predicted the technique of lymphadenectomy (extended rather than standard) [5]. Another study employed one surgeon to perform lymph node dissection and an experienced open surgeon to conduct a second look open lymphadenectomy. Results showed a median of 43 nodes removed during the robot-assisted approach with minimal additional yield (range: 0–8 nodes) from the open surgeon [22]. Lavery et al. recently reported their small series of lymph node yield after extended pelvic lymph node dissection in patients undergoing RARC. The reported mean nodal yield was 41.8 (range 18–67) nodes in a series of 15 consecutive patients, with greater than 25 nodes in 13 patients. This compares with most high-volume ORC series [23].

It is important to remember that the number of lymph nodes retrieved depends on node viability, method of submission (en bloc or separately), and the processing technique utilized. Despite these considerations, a thorough anatomical dissection around the pelvic vessels at least up to aortic bifurcation, along with complete clearance of all nodal tissue within the anatomical boundaries, is recommended.

Postoperative Complications

Regardless of the approach used, radical cystectomy remains a morbid operation with complication rates ranging between 26 and 64% and mortality rates between 1 and 7% [24, 25]. Readmission following radical cystectomy is also common with bowel-related and urinary complications most prevalent. There is a perception that morbidity for radical cystectomy could be reduced with RARC compared to ORC. Published reports in minimally invasive series demonstrate that estimated blood loss (EBL) ranges from 100 to 1,100 ml, with most series reporting a mean EBL less than 500 ml and transfusion rates below 2%. RARC complication rates range from 6 to 65% and compare to ORC. However, experts agree that there is an urgent need for accurate and honest reporting of peri-operative outcomes, especially with regard to standardized complication reporting [24].

Ng et al. performed a prospective comparison of complications in 187 consecutive patients who underwent radical cystectomy with either ORC or RARC found that the RARC group experienced significantly fewer total complications and major complications at 30 and 90 days [26]. There is only one published randomized control trial of RARC versus ORC, but it was designed as a non-inferiority study regarding lymphadenectomy and nodes retrieval. Nix et al. reported no difference in complications between the two small groups ($n=20$) within this trial. However, complication rates were not the primary outcome measure in this study and the numbers were underpowered to clearly define this relationship [21].

Complication reporting after RARC is limited by patient selection bias, possible under-reporting and non-standardized documentation. To avoid these biases, we reported 3-month complication rates on 156 consecutive patients who underwent RARC at our institution using the standardized Memorial Sloan Kettering methodology and modified Clavien grading system. Our 90-day complication rate was 52% and overall 90-day mortality was 5.8%. We reported a complication-related mortality rate of 2.6%. The overall complication rate was 65% at a median follow-up of 9 months, and the majority of complications were low grade (63%), which is comparable to those reported by open series [27]. Recently Khan et al. reported their early complication results after RARC in 50 patients using a standardized reporting system. They reported an overall peri-operative complication rate of 34%, of which 10% experienced Clavien grade III and above. Of note, 28% of their patients had pathological stage pT3 and pT4 [28]. These reports indicate that careful reporting of complications following RARC revealed rates similar to high volume open cystectomy centers.

Critics of RARC frequently question the bias of including only younger patients in analyses. A recent study by Coward et al. investigated outcomes of 61 patients younger than 70 years and 38 patients older than 70 years who underwent RARC and extra-corporeal urinary diversion. No differences were found between the two groups for blood loss, time to discharge, or complication rate (<30 days). They found the operating time to be longer in the younger patients, although this may be skewed due to a higher number of younger patients receiving a neobladder as compared to the older patients. They also found no difference in the margin positivity rates, histo-pathological findings or lymph node yield. Coward et al. concluded that in an appropriately selected elderly population (>70 years), RARC with extracorporeal urinary diversion is technically feasible with no difference in clinico-pathological outcomes as compared to the younger population [29].

Recently Schumacher and Colleagues reported complications related to RARC with intracorporeal urinary diversion in 45

patients (36 neobladder and 9 ileal conduit diversions). Early surgery-related complications (<30 days) were reported to be 40% and late complications were 30%. They had 3 conversions (6.6%) to open surgery and re-operated in the post-operative period on 4 patients (9%). Clavien grade III complications were more common in the first 15 cases, indirectly suggesting an improvement in the learning curve. What is encouraging about this study was that positive margins were reported in only one patient and the mean operating time decreased from 477 min to 415 min, suggesting continuing improvement in the learning curve. However, this paper only reported surgery-related complications and not over-all complications [16].

The IRCC, which was established in 2007 and began collecting complication related data soon thereafter, has recently created a secure web-based means of reporting complications and other cystectomy related data. This new resource will allow members from all participating centers to easily collect data across multiple institutions and countries that is standardized and uniform.

Health Related Quality of Life Assessment

Health related quality of life (HRQOL) outcomes after any major surgery remain critical for measuring its impact on the patient. Several studies investigating HRQOL in patients undergoing ORC lack universality. Most of the present series are retrospective in nature and do not use validated questionnaires with baseline assessments.

Gilbert et al. evaluated HRQOL outcomes for patients managed with various treatment modalities, including cystoscopy alone, cystoscopy with intravesical therapy, radical cystectomy with ileal conduit diversion, and radical cystectomy with neobladder diversion using a standardized Bladder Cancer Index (BCI) in 315 patients. BCI included urinary, sexual, and bowel function domains. In general, patients in the cystectomy groups displayed lower sexual function scores compared to the native bladder group and as expected, the type of urinary diversion in the cystectomy group impacted the urinary and bowel function domains [30].

There is a scarcity of data evaluating HRQOL in patients undergoing RARC, but this should change as more centers adopt this approach. Yuh et al. used the Functional Assessment of Cancer Therapy–Bladder (FACT-BL) questionnaire to prospectively evaluate short-term HRQOL after RARC and ileal conduit diversion. FACT-BL uses 5 domains (well-being, physical, social/family, emotional, and functional) and 12 bladder cancer specific questions to assess HRQOL. Thirty-four patients completed preoperative and follow-up questionnaires at 1, 3 and 6 month postoperative time periods. Results from this study showed a significant decrease in HRQOL during the immediate postoperative period with improvement to baseline at 6 months. Interestingly, the

emotional domain improved almost immediately postoperatively and then exceeded baseline scores at 6 months [31].

Preliminary work to measure HRQOL shows acceptable return to quality of life following RARC. The majority of long term morbidity associated with cystectomy is associated with urinary diversion and not extirpation. Data on long-term morbidity of RARC and intracorporeal urinary diversion is still awaited and its impact on HRQOL needs to be evaluated and compared with ORC series

Oncologic Outcomes

Early studies to assess the long-term oncologic efficacy of RARC suffer from selection biases, such as younger patients, minimal co-morbidities, and lower stages, when compared to most contemporary open series. Open series have reported that patients who experience recurrence after cystectomy do so at a median of 12 months.

One group published results investigating intermediate oncologic outcomes in RARC cohorts. Martin et al. used a cut off of at least 6 months with a mean of 25 months. Twenty-seven percent of patients in this cohort had extravesical disease and 34% had lymph node positivity. They found overall survival rates of 69% and disease free survival of 72% at 36 months [32]. Although it included some of the longest published follow up data, this study was limited by its retrospective nature. Most groups lack long-term follow-up due to the novelty of RARC. Kauffman et al. investigated outcomes in 85 RARC patients and reported 2 year recurrence free, cancer specific, and overall survival rates of 74%, 85%, and 79%, respectively [33]. Recent reports from the IRCC revealed overall survival rates of 82% and 71% at 1 and 2 years, respectively. Thirty-eight percent of those patients had extravesical disease and 22% had positive lymph nodes [15].

A recent critical review of the literature for the oncological and functional outcome after RARC in 350 patients was reported [34]. Orvieto et al. found that there was sufficient data available to suggest that RARC duplicates the oncological principles of ORC, including adequacy of lymph node dissection. They go even further to say that “indeed, in select patients, peri-operative endpoints after RARC have appeared similar, and at times even favorable, when compared to ORC.” [34]

Preliminary results currently suggest that RARC is comparable to ORC with regard to early oncologic outcomes. However, longer and more structured prospective analyses are required to definitively answer the questions that remain. Results from the phase I and phase II randomized study comparing open vs. laparoscopic vs. robotic cystectomy that is currently underway by the British groups (CORAL and BOLERO) and the American group (RARC vs. ORC) is still

awaited and should shed some additional light on this topic [35, 36].

Economics and Feasibility

Smith et al. reported on their economic analysis comparing RARC and ORC. They looked at the fixed and variable costs in the operating theatre and hospital. The mean fixed operating room costs for RARC were \$1,634 higher than for ORC. The variable costs in the OR were also \$570 higher due to the increased operating time in the RARC group. However, the fixed hospital costs were nearly identical with a savings of \$564 in the RARC group from lower transfusion rates and shorter hospital stays. Smith et al. concluded that RARC was \$1,640 more expensive than ORC [37]. The authors were careful to note that there will be a decrease in operating time with increasing surgeon experience. Furthermore, it remains to be definitively seen if there is a decrease in over-all complication rates in RARC. This may off-set the current imbalance as well.

More recently, Lee et al. reported the cost comparison between open versus robotic cystectomy. They compared 103 ORC and 83 RARC. Direct cost of the operation, consumables and stay were taken into account. The indirect cost of the complications was also considered. They concluded that RARC was less expensive than ORC when performing an Ileal Conduit or a cutaneous continent diversion but became more expensive with orthotopic neobladder formation [38]. The same group also systematically reviewed the available literature to carry out cost-analysis comparisons of RARC versus ORC. They found that despite an increased materials cost, RARC was less expensive than ORC when the cost of complications were taken into consideration. The reviewed literature similarly revealed that RARC was less expensive than ORC for ileal conduit but was more expensive if the patient had an orthotopic neobladder. They found that operative duration, length of stay, and daily hospitalization costs were the major determinants in the overall cost of the procedure [39].

Martin et al. compared the complete cost analysis between RARC versus ORC and concluded that the actual patient costs revealed a 38% cost advantage in favor of RARC due to increased hospitalization costs for ORC [40]. However, Zehnder and Gill looked at the cost-effectiveness of open versus laparoscopic versus robotic-assisted laparoscopic cystectomy and urinary diversion and concluded that economic cost evaluations are complex analyses influenced by numerous factors that hardly allow an inter-institutional comparison [41].

One of the perceived advantages of RARC would be quicker recovery and hence reduced length of stay in the

hospital. Clinical pathways (Enhanced Recovery Program) are being outlined for early discharge with enhanced recovery for patients undergoing RARC. Within this model, patients do not routinely go to the ICU, nasogastric tubes are removed and intra-venous narcotics are avoided. Patients are ambulant on day 0. Clear fluids are administered on day 1 with regular diet introduced on passage of flatus. Shah and Abaza introduced this program in a small series of 30 patients. They reported a mean hospital stay of 3.3 days (22 patients were discharged on day 3 and the remaining 8 on day 4), with only two unplanned visits during the first 10 days [42]. Choi et al. similarly showed a beneficial effect of chewing gum in initiating flatus and hence faster return to normal diet. There were no complications attributed to gum chewing [43, 44].

Another factor that would need further economic analysis would be the impact of early return to normal activities/work that some RARC series have demonstrated as compared to the open or laparoscopic series [45].

Future Direction

RARC and pelvic lymph node dissection will be further refined with increasing collaboration between centers of excellence. Many surgeons have already adopted intracorporeal urinary diversion into their armamentarium and offer RARC to the elderly population as well.

The formation of the International Robotic Cystectomy Consortium, and its recent introduction of web-based standardized reporting system for collection of cystectomy-related data, provides the foundation for reporting long-term outcomes that are needed. There is also an urgent need for quantifying health-related quality of life in patients undergoing RARC.

Although some series describe the learning curve in RARC, keep in mind that this operation is frequently performed by surgeons who have vast experience with robot-assisted radical prostatectomy. Therefore, their past robotic experience may not translate to a novice robotic surgeon. The establishment of data-driven training programs that emphasize familiarization to the robot and development of skills and techniques is paramount. Simulation is poised to become an integral piece to the training environment for teaching both basic skills as well as advanced surgical techniques. It is essential to train the younger generation so that they can continue to refine techniques for robot-assisted radical cystectomy.

References

- Challacombe BJ, Bochner BH, Dasgupta P et al (2011) The role of laparoscopic and robotic cystectomy in the management of muscle-invasive bladder cancer with special emphasis on cancer control and complications. *Eur Urol* 60(4):767–775
- Chade DC, Laudone VP, Bochner BH, Parra RO (2010) Oncological outcomes after radical cystectomy for bladder cancer: open versus minimally invasive approaches. *J Urol* 183(3):862–869
- Stein JP, Lieskovsky G, Cote R et al (2001) Radical cystectomy in the treatment of invasive bladder cancer: long-term results in 1,054 patients. *J Clin Oncol: Offic J Am Soc Clin Oncol* 19(3):666–675
- Hayn MH, Hellenthal NJ, Seixas-Mikelus SA et al (2011) Is patient outcome compromised during the initial experience with robot-assisted radical cystectomy? results of 164 consecutive cases. *BJU Int* 108(6):882–887
- Hayn MH, Hussain A, Mansour AM et al (2010) The learning curve of robot-assisted radical cystectomy: results from the International Robotic Cystectomy Consortium. *Eur Urol* 58(2):197–202
- Guru KA, Mansour AM, Nyquist J (2010) Robot-assisted intracorporeal ileal conduit ‘Marionette’ technique. *BJU Int* 106(9):1404–1420
- Murphy DG, Challacombe BJ, Elhage O et al (2008) Robotic-assisted laparoscopic radical cystectomy with extracorporeal urinary diversion: initial experience. *Eur Urol* 54(3):570–580
- Buffi N, Motttrie A, Lughezzani G et al (2009) Surgery illustrated—surgical atlas robotic radical cystectomy in the male. *BJU Int* 104(5):726–745
- Richards KA, Kader K, Hemal AK (2010) Robotic radical cystectomy: where are we today, where will we be tomorrow? *Sci World J* 10:2215–2227
- Hosseini A, Adding C, Nilsson A, Jonsson MN, Wiklund NP (2011) Robotic cystectomy: surgical technique. *BJU Int* 108(6b):962–968
- Rehman J, Sangalli MN, Guru K et al (2011) Total intracorporeal robot-assisted laparoscopic ileal conduit (Bricker) urinary diversion: technique and outcomes. *Can J Urol* 18(1):5548–5556
- Guru KA, Sternberg K, Wilding GE et al (2008) The lymph node yield during robot-assisted radical cystectomy. *BJU Int* 102(2):231–234, discussion 234
- Haber GP, Crouzet S, Gill IS (2008) Laparoscopic and robotic assisted radical cystectomy for bladder cancer: a critical analysis. *Eur Urol* 54(1):54–62
- Hellenthal NJ, Hussain A, Andrews PE et al (2010) Surgical margin status after robot assisted radical cystectomy: results from the International Robotic Cystectomy Consortium. *J Urol* 184(1):87–91
- Hayn MH, Stegemann AP, Agarwal PK et al (2011) 1415 pathologic and early oncologic outcomes after robot-assisted radical cystectomy: results from the international robotic cystectomy consortium. *J Urol* 185(4):e567
- Schumacher MC, Jonsson MN, Hosseini A et al (2011) Surgery-related complications of robot-assisted radical cystectomy with intracorporeal urinary diversion. *Urology* 77(4):871–876
- Konety BR, Joslyn SA, O'Donnell MA (2003) Extent of pelvic lymphadenectomy and its impact on outcome in patients diagnosed with bladder cancer: analysis of data from the Surveillance, Epidemiology and End Results Program data base. *J Urol* 169(3):946–950
- Kim SP, Kames RJ (2011) Standard or extended lymphadenectomy in radical cystectomy: what metric of surgical quality for lymph node dissections matters in improving patient outcomes? *Eur Urol* 60(5):953–954
- Dorin RP, Daneshmand S, Eisenberg MS et al (2011) Lymph node dissection technique is more important than lymph node count in identifying nodal metastases in radical cystectomy patients: a comparative mapping study. *Eur Urol* 60(5):946–952
- Wang GJ, Barocas DA, Raman JD, Scherr DS (2008) Robotic vs. open radical cystectomy: prospective comparison of perioperative

- outcomes and pathological measures of early oncological efficacy. *BJU Int* 101(1):89–93
21. Nix J, Smith A, Kurpad R, Nielsen ME, Wallen EM, Pruthi RS (2010) Prospective randomized controlled trial of robotic versus open radical cystectomy for bladder cancer: perioperative and pathologic results. *Eur Urol* 57(2):196–201
 22. Davis JW, Gaston K, Anderson R et al (2011) Robot assisted extended pelvic lymphadenectomy at radical cystectomy: lymph node yield compared with second look open dissection. *J Urol* 185(1):79–83
 23. Lavery HJ, Martinez-Suarez HJ, Abaza R (2011) Robotic extended pelvic lymphadenectomy for bladder cancer with increased nodal yield. *BJU Int* 107(11):1802–1805
 24. Novara G, Ficarra V, Zattoni F (2011) Is robot-assisted radical cystectomy the right way to reduce complications in patients undergoing radical cystectomy? *Eur Urol* 59(2):219–221
 25. Kulkarni JN (2011) Perioperative morbidity of radical cystectomy: a review. *Indian J Urol: IJU: J Urol Soc India* 27(2):226–232
 26. Ng CK, Kauffman EC, Lee MM et al (2010) A comparison of postoperative complications in open versus robotic cystectomy. *Eur Urol* 57(2):274–281
 27. Hayn MH, Hellenthal NJ, Hussain A, Stegmann AP, Guru KA (2011) Defining morbidity of robot-assisted radical cystectomy using a standardized reporting methodology. *Eur Urol* 59(2):213–218
 28. Khan MS, Elhage O, Challacombe B, Rimington P, Murphy D, Dasgupta P (2011) Analysis of early complications of robotic-assisted radical cystectomy using a standardized reporting system. *Urology* 77(2):357–362
 29. Coward RM, Smith A, Raynor M, Nielsen M, Wallen EM, Pruthi RS (2011) Feasibility and outcomes of robotic-assisted laparoscopic radical cystectomy for bladder cancer in older patients. *Urology* 77(5):1111–1114
 30. Gilbert SM, Wood DP, Dunn RL et al (2007) Measuring health-related quality of life outcomes in bladder cancer patients using the Bladder Cancer Index (BCI). *Cancer* 109(9):1756–1762
 31. Yuh B, Butt Z, Fazili A et al (2009) Short-term quality-of-life assessed after robot-assisted radical cystectomy: a prospective analysis. *BJU Int* 103(6):800–804
 32. Martin AD, Nunez RN, Pacelli A et al (2010) Robot-assisted radical cystectomy: intermediate survival results at a mean follow-up of 25 months. *BJU Int* 105(12):1706–1709
 33. Kauffman EC, Ng CK, Lee MM, Otto BJ, Wang GJ, Scherr DS (2011) Early oncological outcomes for bladder urothelial carcinoma patients treated with robotic-assisted radical cystectomy. *BJU Int* 107(4):628–635
 34. Orvieto MA, Decastro GJ, Trinh QD, et al. (2011) Oncological and functional outcomes after robot-assisted radical cystectomy: critical review of current status. *Urology*, Sep 2
 35. Ismail AF EO, Rimington P, Kelly JD, Dasgupta P, Khan MS (2010) Initial experience with a randomised control trial of Open, Robotic and Laparoscopic (CORAL) radical cystectomy. *BJU Int* 106(S1):1
 36. <http://www.mskcc.org/mskcc/html/2270.cfm?IRBNO=10-016>. Accessed 12/10/2011, 2011
 37. Smith A, Kurpad R, Lal A, Nielsen M, Wallen EM, Pruthi RS (2010) Cost analysis of robotic versus open radical cystectomy for bladder cancer. *J Urol* 183(2):505–509
 38. Lee R, Ng CK, Shariat SF, et al. (2011) The economics of robotic cystectomy: cost comparison of open versus robotic cystectomy. *BJU Int*, Apr 18
 39. Lee R, Chughtai B, Herman M, Shariat SF, Scherr DS (2011) Cost-analysis comparison of robot-assisted laparoscopic radical cystectomy (RC) vs. open RC. *BJU Int* 108(6):976–983
 40. Martin AD, Nunez RN, Castle EP (2011) Robot-assisted radical cystectomy versus open radical cystectomy: a complete cost analysis. *Urology* 77(3):621–625
 41. Zehnder P, Gill IS (2011) Cost-effectiveness of open versus laparoscopic versus robotic-assisted laparoscopic cystectomy and urinary diversion. *Curr Opin Urol* 21(5):415–419
 42. Shah AD, Abaza R (2011) Clinical pathway for 3-day stay after robot-assisted cystectomy. *J Endourol / Endourol Soc* 25(8):1253–1258
 43. Choi H, Kang SH, Yoon DK et al (2011) Chewing gum has a stimulatory effect on bowel motility in patients after open or robotic radical cystectomy for bladder cancer: a prospective randomized comparative study. *Urology* 77(4):884–890
 44. Koupparis A, Dunn J, Gillatt D, Rowe E (2010) Improvement of an enhanced recovery protocol for radical cystectomy. 3(6): 237–240
 45. Dasgupta P, Rimington P, Murphy D, Elhage O, Challacombe B, Khan MS (2008) Robotically assisted radical cystectomy. *BJU Int* 101(12):1489–1490