

A comparison of robot-assisted and traditional radical hysterectomy for early-stage cervical cancer

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Received: 25 December 2008 / Accepted: 12 February 2009 / Published online: 27 February 2009
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Abstract A robotics surgery program was introduced into the division of gynecologic oncology at Northwestern University Feinberg School of Medicine in June 2007. A prospective database of all patients undergoing a type III radical hysterectomy for stage IB1 cervical cancer between July 2007 and June 2008 was collected and analyzed. Demographic data and perioperative outcomes were analyzed between a traditional and robot-assisted approach. A total of 14 patients were identified who underwent a type III radical hysterectomy for stage IB1 cervical cancer. Seven patients underwent robotic surgery and seven patients underwent traditional surgery. There were no significant differences in median age or body mass index between the two groups. A significant difference in blood loss between robotic (75 cc) and traditional (700 cc) surgery was detected ($P = 0.002$). A significant difference in hospital stay between robotic (1 day) and traditional (5 days) surgery was observed ($P = 0.0007$). No significant difference in operative time (260 vs. 264 min) or lymph node yield (19 and 14) was identified between the robotic and traditional approaches. No major operative complications occurred with robotic radical hysterectomy. Robot-assisted radical hysterectomy was associated with a significant reduction in

blood loss and hospital stay. Improved nodal yields, fewer operative complications, and less pain was observed with the robotic approach. Robot-assisted radical hysterectomy appears safe and feasible and further investigation is warranted in a prospective fashion.

Keywords Robotic radical hysterectomy · Radical hysterectomy · da Vinci · Cervical cancer · Robotics · Gynecologic oncology · Laparoscopy · Minimally invasive surgery · Surgical techniques

Introduction

The use of conventional laparoscopy for treatment of early stage cervical cancer was first described in the early 1990s [1–3]. These initial and more recent reports have demonstrated the safety and feasibility of a minimally invasive approach to treatment of this disease [1–9]. The literature also demonstrates that minimally invasive surgery is associated with less blood loss, shorter hospital stay, less post-operative pain, improved cosmesis, and a faster recovery when compared with traditional approaches [10–13]. Yet, despite these advantages, recent surveys of practicing gynecologic oncologists have revealed that most respondents believed conventional laparoscopy had only a minimal role in the management of cervical cancer. It is likely that well-known barriers to the utilization of advanced minimally invasive procedures, for example association with a long learning curve, lack of training, complexity of operations, limitation of technology and instrumentation, and the need for an expert assistant, are responsible for this sentiment [14]. Recently, advances in the field of minimally invasive surgery have focused on the incorporation of robotic technology to treat certain gynecologic malignancies [15–17].

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The da Vinci surgical system is a robotic surgical platform that was FDA approved in April 2005 for gynecologic applications. The system incorporates a 3D stereoscopic vision system and wristed instrumentation that provides improved dexterity and precision. The system enables complex procedures to be completed by a single surgeon with a novice bedside assistant alleviating the need for an expert assistant. It more mimics traditional surgical approaches to pelvic surgery than to conventional laparoscopy and has recently been associated with a shortened learning curve [18, 19]. These advantages potentially make it the ideal tool for performing complex oncologic procedures such as a radical hysterectomy, that requires delicate dissection (cardinal ligament, ureter, pelvic vessels) while maintaining oncologic radicality.

Recognition of the potential advantages of robotic technology for radical hysterectomy led to some early reports examining the use of robotics for treating cervical cancer [20, 21]. Recently, additional investigators have reported their experience with robotic surgery for the treatment of cervical cancers, with promising results [22–26]. Thus far, robotic radical hysterectomy appears safe and feasible. However, few comparisons with traditional radical hysterectomy have been reported in the literature [22, 23]. Our program has, until recently (July 2007), treated endometrial and cervical cancer with traditional (open) surgical methods. We sought to compare our experience with robot-assisted and traditional radical hysterectomy for early-stage cervical cancer during the initial 12-months of instituting our robotic surgical program.

Materials and methods

A prospective database was collected for all patients undergoing a type III radical hysterectomy for stage IB1 cancer via traditional laparotomy and robotics at Northwestern University between July 2007 and July 2008. Approval for this study was obtained by the Northwestern University Institutional Review Board. After diagnosis with early-stage cervical cancer, patients were counseled on treatment modalities (surgery and radiation) available at our institution. Those patients who were deemed surgical candidates and/or elected for surgery were then counseled regarding their surgical options available at our institution (traditional and robotics). All patients were counseled that the traditional approach was the standard of care. Patients gave informed consent, and those electing robotic surgery participated in a discussion of the limited extent of robotics previously performed at the institution. Limitations of patients eligible for robot-assisted radical hysterectomy included multiple prior abdominal surgeries, BMI > 35, documented history of

extensive abdominopelvic adhesions, and large uterine size (>12 weeks).

With regards to robotics, a dedicated program was introduced into our division in July 2007. Our primary goal was to evaluate the utility of robotic technology for the management of cervical and endometrial cancer. A secondary goal was to introduce into our institution a minimally invasive surgical option for the management of early-stage cervical cancer. At that time, the hospital system owned one da Vinci standard surgical system, and later acquired a da Vinci S surgical system in September 2008 (Intuitive Surgical, Sunnyvale, CA, USA). The initial two procedures were performed on the standard system with the remaining five on the S system. The development of a robotics program at our institution was fully supported by all members of the division of gynecologic oncology prior to its implementation. The program was initiated under the guidance of a single gynecologic oncologist, who served as proctor for the four other gynecologic oncologists in the group after their company-sponsored training program. Surgical videos were reviewed and a porcine-based laboratory session was attended by all faculty and fellows-in-training in the division of gynecologic oncology. A dedicated operating room team composed of a scrub technologist and circulating nurses was developed and trained in robotic technology. It was the intent that the faculty undergoing training in robotics would transition through a stepwise progression from simple to more difficult robotic cases over time. Thus, for the first 12 months a single gynecologic oncologist performed all robot-assisted radical hysterectomies while the remaining four faculty members performed traditional radical hysterectomies. The robotic surgeon in this series had received advanced laparoscopic training in fellowship and had some experience with robot-assisted radical hysterectomy (five cases) prior to joining our division. No surgeon in our division had previously performed a laparoscopic radical hysterectomy. All members of the division were well versed in the technique of traditional type III radical hysterectomy. The technique utilized for robot-assisted radical hysterectomy at our institution was modeled after the technique developed by Dr John Boggess [27].

Variables collected and analyzed included age, BMI, stage, grade, operative time, estimated blood loss (EBL), length of hospital stay, total lymph node count, and postoperative analgesia used. Conversion from a robotic to an open procedure was recorded, and intraoperative and postoperative complications (major and minor). Major complications analyzed included EBL > 1500 cc, unplanned admission to the intensive-care unit, reoperation, readmission within 15 days of discharge, conversion to laparotomy, transfusion of more than four units of packed red blood cells, vascular injury, bowel injury, or injury to the bladder, ureter, or urethra. Minor complications analyzed included

postoperative blood transfusion, postoperative ileus, prolonged intubation, persistent tachycardia, pneumonia, and wound infection not requiring admission. A case was considered converted if the robot was docked to the patient or any laparoscopic instrumentation was introduced into the patient's abdomen prior to converting to laparotomy. Operative time was defined as time from the beginning of skin incision to the completion of skin closure. Estimated blood loss was determined by the anesthesiologist and recorded accordingly. Parametric continuous variables were compared using the Student *t* test for independent samples. Nonparametric continuous and dichotomous variable comparisons were performed using the Mann–Whitney *U* test and the chi-squared test, respectively. Median values are reported unless otherwise noted. A *P*-value of 0.05 was considered statistically significant.

Results

A total of 14 patients were identified who underwent a type III radical hysterectomy for early-stage cervical cancer between July 2007 and July 2008. Seven patients underwent a robot-assisted radical hysterectomy and seven patients underwent a traditional radical hysterectomy. All patients were diagnosed with stage IB1 according to FIGO staging. Squamous cell carcinoma of the cervix was diagnosed in 64% of patients with the remaining patients diagnosed with adenocarcinoma of the cervix. There was no significant difference in the median age or body mass index between the two groups. However, there was a difference in the range of BMI between the robotics cohort (range 24–34) and the traditional cohort (range 21–51). Operative outcomes are included in Table 1. A statistically significant difference in blood loss between robot-assisted (75 cc) and traditional (700 cc) surgery was observed ($P = 0.002$). In addition, a statistically significant difference in hospital stay between robot-assisted (1 day) and traditional (5 days) surgery was identified ($P = 0.0007$). There were no significant differences with regard to operative time (260 vs. 264 min) and lymph node yield (19 and 14) between robot-assisted and traditional surgery, respectively. In the robotic cohort, all surgical margins were adequate (negative) and no lymph nodes were positive for metastatic disease. Six of seven (86%) robotic radical hysterectomy specimens contained residual cancer on final pathology. Complications are listed in Table 2. There were no conversions from robotics to an open traditional approach. In addition, there were no major operative complications for the robotic cohort. Two minor complications were reported in the robotic cohort and included a cuff separation and transient unilateral vulvar edema postoperatively for the first week postoperatively. Two patients experienced a total of seven major operative

Table 1 Operative findings

Operative findings	Robotic	Traditional	<i>P</i> -value
Median operative time	260 min	264 min	NS
Median nodal count	19	14	NS
Median estimated blood loss	75 cc	700 cc	0.002
Mean postoperative stay	1 day	5 days	0.0007
Conversion to laparotomy	None	–	
Mean pain score POD #0	2.0	5.0	
Mean pain Score POD #1	2.5	3.5	

Table 2 Operative and postoperative complications

Complications	Robotic (<i>n</i> = 7)	Traditional (<i>n</i> = 7)
Bladder/ureteral injury	0	0
Ileus/obstruction	0	1
Postoperative hemorrhage	0	1
Blood transfusion	0	1
Hernia/dehiscence	0	1
Acute renal failure	0	1
Reoperation rate	0	1
ICU admission	0	1
Cuff separation	1	0
Vulvar edema	1	0
Lymphedema	0	0
Symptomatic lymphocyst	0	0
Conversion to laparotomy	0	–
Total complications	2	7

complications in the traditional cohort including a bowel obstruction, postoperative hemorrhage, blood transfusion (four units), a fascial dehiscence requiring reoperation and repair, acute renal failure, and an unanticipated postoperative ICU admission. A dramatic change in our surgical approach was observed for early-stage cervical cancer within the first 12 months with the incorporation of robotics. At the conclusion of our pilot study, our management of early-stage cervical cancer had changed to include a robotics approach 50% of the time. At the time of manuscript submission, no patient who underwent robot-assisted radical hysterectomy has experienced a disease recurrence.

Patients in the robotics cohort reported a lower average post-operative pain score of 2.5 (scale 0–10) from the day of surgery (POD #0) to the day of discharge (POD #1) as compared with the traditional cohort average pain score of 5.0 during the same time period. It should be noted that most of the robotic patients required no IV narcotics and were well managed with an oral narcotic or oral non-narcotic analgesic medication while in the hospital. The traditional cohort was managed with routine IV and po narcotics from POD #0 to POD #1 (Table 1).

Discussion

Laparoscopic management of gynecologic malignancies has been a fully recognized option for patients with cervical cancer since the mid to late 1990s. [1–3] The goal of laparoscopic surgery is to duplicate traditional open procedures via small incisions in the skin with surgical outcomes equivalent or superior to those of a traditional surgical approach. Unfortunately, a laparoscopic approach has not been fully recognized or accepted as an option to treat endometrial and/or cervical cancers by most gynecologic oncologists in the United States according to surveys by Frumovitz et al. [14]. Recently, robotic surgery was reported as an option in the definitive surgical management of early-stage cervical cancer. To date, reports have described techniques and outcomes for robotic hysterectomy, robot-assisted radical hysterectomy, and robotic lymph node dissections [15–25].

Our institution established a dedicated robotics program in July 2007 to evaluate its utility for treating gynecologic malignancies. Presently, all members of our division are credentialed for robotic surgery and participate in fellowship training in robotics. At our institution, robotics is primarily utilized to treat endometrial and cervical cancers. Prior to the establishment of our robotics program, most of our faculty members had limited experience with advanced laparoscopy which comprised less than 5% of our combined surgical practice for cervical and endometrial cancer. Thus, a traditional open surgical approach had been our standard technique for radical hysterectomies at Northwestern University for many years.

In this report we were able to demonstrate the safety and feasibility of robot-assisted radical hysterectomy for early-stage cervical cancer at our institution. While this only represents a small data series, we are encouraged by the fact that we were able to significantly reduce blood loss (robotics, 75 cc; traditional, 700 cc) and hospital stay (robotics, 1 day; traditional, 5 days) with a robot-assisted approach. In addition, operative times and lymph node yields were similar between the robot-assisted and traditional approaches. Morbidity was reduced for the patients who underwent a robot-assisted radical hysterectomy, with no major operative complications reported. At this time we are unable to report outcomes on overall recurrence rates and survival. However, no patient has experienced a recurrence to date. Finally, we were able to successfully introduce a minimally invasive surgical option for the treatment of cervical cancer into our institution. One-half (50%) of all patients in our study were treated with robot-assisted radical hysterectomy between July 2007 and July 2008. The authors acknowledge that some limitations were placed on patient selection, as described in [Materials and methods](#), and these could influence our data outcomes because of

selection bias. It is likely that some of these outcomes (operative time, complications, blood loss, and nodal yield) may change for the better or worse as more cases are performed within our program. We also acknowledge limitations of our study because of its small size and the fact that a single surgeon performed all robot-assisted radical hysterectomies. The strengths of our study are that data were collected prospectively and a comparison group (traditional approach) was included. Nonetheless, our initial experience with robot-assisted radical hysterectomy compared with a traditional approach demonstrated that equivalent (operative time, nodal yields) and/or superior (blood loss, hospital stay, and complication rate) outcomes can be achieved in a short period of time (12 months) with robotic technology.

A review of the literature on robot-assisted radical hysterectomy reveals that our experience is consistent with recent data published on the technique. Sert and Abeler [20] described their initial experience with robotic radical hysterectomy with an operative time of 241 min and a blood loss of 71 cc. Kim et al. [21] reported on ten cases with an operative time of 207 min, blood loss of 355 cc, and a nodal yield of 27. No conversion to laparotomy was reported. Fanning et al. [24] reported on their recent experience with robotic radical hysterectomy for early-stage cervical cancer. They reported an operative time of 390 min with no conversion to laparotomy in 20 cases. Their reported hospital stay was one day and estimated blood loss was 300 cc. Nezhat et al. [25] reported on a small cohort of thirteen patients with an operative time of 323 min, blood loss of 157 cc, and a hospital stay of 2.7 days. Magrina et al. reported their experience with open, laparoscopic, and robot-assisted radical hysterectomy from a prospective database. Robotic surgery was associated with less blood loss and a shorter operative time than laparoscopy, with equivalent nodal yields. In the robotics subgroup, no intraoperative complications were reported [22]. Recently, in the largest report to date, Boggess et al. reported on a case-control series of robotic versus open type III radical hysterectomy. They reported statistically significant differences in operative time, blood loss, and node retrieval all in favor of a robotic approach compared with a traditional approach. Although this paper represents the experience of a single surgeon only, the data are compelling and suggest that a robotic approach may be preferable to an open approach [23]. On the basis of current literature it seems that robot-assisted radical hysterectomy is safe and feasible for the management of early-stage cervical cancer. What is unclear at this point in time is whether robotics will be shown to be superior to a traditional approach for radical hysterectomy or whether the experience of the above referenced authors will translate amongst all gynecologic oncologists. In addition, comparison of robotics to traditional radical hysterectomy

thus far has been limited to two manuscripts only (excluding this report) [22, 23].

In conclusion, our data in this manuscript add to the growing literature on robot-assisted radical hysterectomy compared with a traditional approach. A review of the currently available literature suggests that robotic technology may be associated with improved operative outcomes compared with a traditional approach for radical hysterectomy. While it is the authors' opinion that robotics represents a technological leap in the field of surgery, further study in a prospective multi-institutional fashion will be required to fully define its role.

Acknowledgement The authors would like to thank Alfred Rade-maker PhD for his contributions to the statistical analysis included in this manuscript.

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