J Robotic Surg
DOI 10.1007/s11701-010-0195-x

ORIGINAL ARTICLE

Robotic surgical management of endometrial cancer in octogenarians and nonagenarians: analysis of perioperative outcomes and review of the literature

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Received: 30 March 2010 / Accepted: 20 May 2010
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Abstract The primary aim of this article is to report the outcomes of octogenarians and nonagenarians who have undergone robotic surgery for endometrial cancer. A multi-institutional research consortium was created to evaluate the utility of robotics for gynecologic surgery (benign and malignant). IRB approval was obtained at each institution. A multi-institutional HIPPA compliant database was then created and analyzed for all patients that underwent robotic-assisted surgery with staging for endometrial cancer between the April 2003 and January 2009. In total, 395 patients were identified. A subset of patients between the ages of 80 and 95 years were then identified and analyzed for demographic data and perioperative outcomes. Twenty-seven patients in this age group were identified who underwent robotic-assisted hysterectomy and staging. The median age was 84, and median body mass index was 28. Comorbidities such as diabetes mellitus and hypertension were identified in 22 and 74% of patients, respectively. Over one-half (56%) of the patients reported a prior abdominal surgery. Final pathological analysis demonstrated that 88% of all patients had either Stage I or II disease. The median operative time was 192 min. The median estimated blood loss was 50 cc, and the median lymph node count was 16. The median hospital stay was 1.0 day. The overall intraoperative and postoperative complication rate was 7.4 and 33%, respectively. No patient received a blood transfusion. There was one conversion to laparotomy (3.7%). A comparison of the outcomes of the elderly cohort to those of all patients in the database (control group) revealed that there was no statistically significant difference between the groups in terms of operative time, blood loss, hospital stay, nodal yield, or conversion rate. Intraoperative complications were statistically similar between the groups; however, postoperative complications were significantly higher in the elderly cohort. We conclude that robotic surgery is safe, feasible, and expands surgical options for octogenarians and nonagenarians diagnosed with endometrial cancer. Age should not be considered a contraindication for robotic surgical management of patients with endometrial cancer.

Keywords Robotic hysterectomy · Endometrial cancer · Elderly · Minimally invasive surgery · Robotic surgery · Uterine cancer · Octogenarians

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Introduction

According to the most recent census in the year 2000, over 35 million citizens of the USA were >65 years of age, which is a 12% increase from the previous census in 1990.

Published online: 11 June 2010

Among the elderly population (>65 years of age), individuals >80 years showed the highest percentage of growth, with this age group comprising just under 40% of all U.S. citizens who are 65 years and older. This is a 6% increase from just 10 years earlier. It is expected that this trend will persist until 2050 based on census estimates for the elderly population [1].

Endometrial cancer is a disease predominately of older postmenopausal women with a median age at diagnosis of 62 years. It is the most common gynecologic malignancy with approximately 41,000 new cases and 7,300 deaths annually. The vast majority of patients will present with Stage I disease and have very good prospects for long-term survival [2]. While medical comorbidities are more prevalent in an older population, it is relatively uncommon for patients with endometrial cancer to not undergo surgery due to comorbid risks. However, a combination of advanced age and multiple medical comorbidities poses a different set of concerns for the gynecologic oncologist. A limited number of recent reports have demonstrated that age should not be a contraindication to surgery for endometrial cancer and that overall survival for elderly patients with Stage I disease is excellent [3, 4]. The surgical management of endometrial cancer has historically been approached in the elderly via three modalities, namely, traditional open, minimally invasive, and vaginal, with a more recent emphasis on a minimally invasive approach for the general population [5, 6]. However, the optimal surgical approach for the treatment of endometrial cancer in the elderly, specifically those ≥80 years, remains poorly defined [3, 4].

Recent data focusing on robotic surgery for endometrial cancer has demonstrated it as a safe and viable alternative to traditional and laparoscopic surgery. Robotic surgery for gynecologic malignancies has been associated with minimal blood loss, a shortened hospital stay, less pain, quicker recovery, adequate nodal yields, lower rates of conversion, and acceptable operative times [7–15]. Comparisons of robotics to traditional laparotomy and laparoscopy for the management of endometrial cancer have demonstrated an improvement in several perioperative outcomes (operative time, blood loss, less pain, lower rates of conversion, and quicker return to normal activity) in the favor of robotic surgery [10–15]. An improvement in surgical outcomes with a reduction in perioperative complications would be advantageous for an elderly population undergoing surgery. Unfortunately, very little data exist on robotic surgical outcomes in an elderly population (>65 years of age) diagnosed with endometrial cancer.

The primary objective of this article is to report our clinical experience with octogenarians and nonagenarians who have undergone robotic surgery for endometrial cancer. Our secondary objective is to present a review of recent literature on the surgical management of endometrial cancer in elderly women with respect to perioperative outcomes.

Materials and methods

A multi-institutional research consortium consisting of five board-certified gynecologic oncologists in distinct geographical regions of the USA was created to evaluate the utility of robotics for gynecologic surgery (benign and malignant). Regions of the USA represented included the Southeast, the Midsouth, and the Midwest. Between April 2003 and January 2009, a total of 959 patients underwent robotic surgery for benign gynecologic disorders and/or gynecologic malignancies by a surgeon in the research consortium. The study received Institutional Review Board (IRB) approval, and data were collected at each institution. For the purposes of the consortium, a multi-institutional HIPPA compliant database was created for all patients that underwent robotic-assisted surgery between the April 2003 and January 2009.

All participating members of the research consortium were among the early adopters of robotic technology for use in gynecologic surgical applications in their respective regions of the country. For credentialing and training purposes, each surgeon completed an on-line training course, a 1- to 2-day porcine surgical lab, case observations, and individual case proctoring (2–5 cases per surgeon) prior to receiving robotic surgical privileges at their respective institutions. The length of robotic surgical experience for all surgeons in the consortium ranged from 4 to 6 years for all surgeons at the time of data analysis. Practice patterns varied among the members from private practice to university-affiliated private practice to university-affiliated academic practice. Resident and/or fellow participation were reported at four of the five institutions. All endometrial cancer staging surgeries for hysterectomies were performed with either the da Vinci S or da Vinci Standard Surgical System. Techniques and instrumentation utilized by each surgeon are listed in Table 1.

Data from all four centers were compiled in a spreadsheet file (Excel 2003; Microsoft Corporation, Redmond, WA) for later computational processing and statistical analysis using Sigma Stat 3.5 (Jandel Scientific, San Rafel, CA). Data were tested for normality and homogeneity of variance to determine find whether our samples were representative of the population and whether parametric or non-parametric analyses would be used for further analysis. Prior to such testing, data were filtered for any outliers and missing data points, a small number of which are expected in large samples as these. Per American Society for Testing and Materials (ASTM) guidelines (E178), the Grubbs test

Table 1 Techniques and instrumentation utilized by each surgeon

Surgical technique/ instrumentation	Surgeon 1	Surgeon 2	Surgeon 3	Surgeon 4	Surgeon 5
Trocars					
Camera-	12 mm applied	12 mm applied	10/12 for camera	(Long) Versa-step	(Long) Versa-step
Robot-	8 mm robot ports × 3	8 mm robot ports	8 mm robot ports	8 mm robot	8 mm robot
Assistant-	12 mm Excel	12 mm Excel	10/12 accessory	11 mm Versa-step	11 mm Versa-step
Vaginal closure	Lapra-Ty, O vicryl CT1 running locked stitch	Lapra-Ty, O vicryl CT1 running locked stitch	Mod Richardson stitch at angles, run and lock to midline and tie	Lapra-Ty at each cuff angle with 2-0 pds running	Lapra-Ty, 2.0 vicryl locked every other
Coagulation device	Hot shears	Hot shears	Monopolar scissors, Fenestrated bipolar	Hot shears-robot	Hot shears-robot
	Gyrus Maryland Prograsp	Gyrus Maryland Prograsp	Prograsp	Maryland-robot	Maryland-robot
				Prograsp	Prograsp
				Liagsure-atlas	Liagsure-atlas
Removing nodes	Hotshears and marylands	Hotshears and marylands	Fenestrated bipolar	Hotshears and marylands	Hotshears and marylands
Blood loss definition	Irrigated—output	Irrigated—output	Irrigated—output	Irrigated—output	Irrigated—output
Op-time definition	Skin incision to skin closure	Skin incision to skin closure	Skin incision to skin closure	Skin incision to skin closure	Skin incision to skin closure
Uterine manipulator	V-care	V-care	Rumi / Koh	First 10 cases KOH then V-care	First 10 cases KOH then V-care

Versa-step® trocar (Covidien, Mansfield, MA), 12 mm Excel® (Ethicon, Cincinnati, OH), 8 mm robotic fascia dilating trocars® (Intuitive Surgical, Sunnyvale, CA), V-care uterine manipulator® (ConMed, Utica, NY), the rumi® device in combination with the Koh-colpotomizer® (Cooper Surgical, Trumbull, CT), Maryland lion jaws® (Gyrus ACMI, Maple Grove, MN), Ligasure atlas® (Covidien, Mansfield, MA), hot shears® (Intuitive Surgical, Sunnyvale, CA), and Maryland graspers® (Intuitive Surgical, Sunnyvale, CA), 2.0 PDS sutures (Ethicon, Cincinnati, OH), LAPRA-TY® sutures (Ethicon, Cincinnati, OH), O-vicryl® suture (Ethicon, Cincinnati, OH)

was used for removing and detecting outliers from the groups if such outliers were detected. A total of 405 patients were identified; however, ten outliers were detected and removed, resulting in 395 patients available for analysis. Our entire cohort of 405 patients has been reported elsewhere without exclusion [8].

For the purposes of this article, our database ($n = 395$) was analyzed for all patients aged $\geq$80 years. Twenty-seven patients aged $\geq$80 years were identified and available for analysis. These records were then reviewed for demographic data, prior medical conditions, prior abdominal or pelvic surgeries, and follow-up. The data collected on this elderly cohort were compared to the overall database population (control, $n = 395$) to detect any significant differences in perioperative outcomes. The perioperative outcomes analyzed included: operative time (skin incision to skin closure), estimated blood loss (EBL, mm), length of hospital stay (days), total lymph node count, conversion to laparotomy, and perioperative complications. Most data regarding complications were documented in a prospective fashion while the study was ongoing, after approval from the institutional IRB, although prior to that time, data were accessed through hospital databases and chart review. Operative complications were defined as occurring during the period of incision to closure of the abdomen. Post-operative complications were identified either immediately in the post-operative period prior to the patient's discharge from the hospital or identified during office visits at any time up until 6 weeks after the patient's surgery.

Results

A total of 395 patients were identified who underwent a robotic-assisted hysterectomy with staging for endometrial cancer. From these 395 patients, 27 patients were identified who were between the ages of 80 and 95 years. No patient older than 95 was identified. Three-quarters (76%) of this elderly subset of patients were between 80 and 85 years old, and the median age was 84. Octogenarians accounted for 89% (24/27) of this elderly subset of patients, and nonagenarians accounted for the remaining 11% (3/27) of patients. The median body mass index (BMI) was 28, and the largest BMI recorded was 45. The majority of elderly patients were Caucasian. Medical comorbidities such as hypertension (74%), diabetes mellitus (22%), and obesity (26%) were prevalent among the study group. Over one-half (56%) of all 27 patients reported a prior abdominal

Table 2 Operative findings

Operative findings (median)	Elderly subset ($n = 27$)	Control group ($n = 395$)	25%	75%	CI of mean	Range	P value
Operative time	192 min	167 min	138.5	211.3	29.7	313.0	0.239
Blood loss	50 cc	50 cc	25	100	43.4	395	0.844
Node count	16	16	8.3	22	3.2	32	0.982
Hospital stay	1 day	1 day	1.0	2.0	2.6	29	0.01
Conversion rate to open surgery	3.7%	7%					0.792

CI Confidence interval

surgery, all (27, 100%) reported at least one comorbidity, 18 (67%) reported at least two comorbidities, whereas only 7.4% reported all three comorbidities. Final pathological analysis demonstrated that 88% of all patients had either Stage I or II disease, with Stage III disease accounting for 12% of the patients. No patients with Stage IV disease were reported. The histologic grade distribution of the surgical specimens was FIGO I, 42%; FIGO II, 37%; FIGO III, 21% (Table 5).

With regards to operative findings, the median operative time was 192 min for the elderly subset. The median estimated blood loss was 50 cc. The median lymph node count was 16. Eighty-nine percent (24/27) of patients underwent a pelvic lymph node dissection, and fifty-nine percent (16/27) underwent an aortic lymph node dissection. The median hospital stay was 1.0 days. Over three-quarters (81%) of the patients were discharged from the hospital within 2 days of surgery. Robotic surgery was successfully completed in 96% of patients (26/27). A comparison of the perioperative outcomes of the elderly cohort to the control group revealed that there was no statistically significant difference between the groups in terms of operative time, blood loss, hospital stay, nodal yield, or conversion rate was identified (Table 2).

Intraoperative complications were few; specifically, there were no major vascular (arterial or venous), gastrointestinal (small or large bowel), or urologic (ureteral) injuries reported. No patient received a blood transfusion. There were two intraoperative complications identified. One patient experienced an incidental cystotomy that was repaired robotically without further incident, and one patient underwent conversion to laparotomy due to dense pelvic adhesions. Thus, the overall intraoperative complication rate for the elderly cohort was 7.4% (Table 3). Comparison of the intraoperative complications in the elderly cohort to the control group revealed no statistically significant difference ($P = 0.719$). With regards to postoperative complications, a total of nine complications were identified from eight patients. Although the postoperative complications identified were mostly minor in nature (vaginal cuff bleed grade, 1 patient; vaginal cuff abscess/infection grade, 3 patients; wound seroma grade, 1 patient; urinary tract infection grade, 2 patients), one patient experienced a prolonged hospitalization secondary to a postoperative infection and small bowel obstruction grade 3 (NCI Common Toxicity Criteria for Adverse Advents). However, compared to the control group, the elderly group of patients had a significantly higher incidence of postoperative complications ($P = 0.022$; Table 4).

Table 3 Intraoperative complication rate

Intraoperative complications	Elderly subset ($n = 27$)	Control group ($n = 395$)
Vascular injury	0	6
Bowel injury	0	4
Cystotomy	1	2
Conversion to laparotomy	1	2
Trocar injury	0	1
Pneumothorax	0	1
Ureteral Injury	0	0
Total*	2 (7.4%)	21 (5.1)%

* P value = 0.719

Discussion

Based on date made available by the National Cancer Institute, individuals aged >65 years account for almost two-thirds of new cancer cases and three-fourths of cancer-related mortality [18]. However, despite the increased incidence of new cancers in this age group, participation in clinical trials has been historically limited. This lack of participation in clinical trials has hampered the development of standardized treatment guidelines for the elderly based on the best available evidence [18–21].

In gynecologic oncology, few specific guidelines exist to guide the surgical management of gynecologic malignancies in the elderly patient. With regards to endometrial cancer, there is no consensus on the optimal surgical approach (minimally invasive, laparotomy, vaginal) for

Table 4 Postoperative complication rate

Postoperative complications	Elderly subset ($n = 27$)	Control group ($n = 395$)
Vaginal cuff bleed	1	2
Urinary tract infection	1	7
Wound seroma	1	6
Abscess	2	5
Pneumonia	1	1
Venous thromboembolism	0	6
Vaginal cuff separation	0	2
Lymphedema/lymphocyst	0	6
Fever	1	7
Ileus	1	2
Vesico-vaginal fistula	0	1
Death	0	2
Vascular injury	0	1
Acute renal failure	0	1
Retroperitoneal bleed	0	1
Superficial thrombosis	0	1
Other	1	3
Total*	9 (33.0%)	54 (13%)

* P value = 0.0022

these patients [3, 4, 16, 17]. Thus, elderly patients may not receive the same surgical standard of care as their younger counterparts. This could be due to concerns of increased morbidity and mortality of therapy and surgeon/patient preference, [3, 4, 16, 17]. Modification of therapy (vaginal hysterectomy, omitting nodal dissection based on age and/or physician preference) due to these concerns has been recently reported in the literature [4, 16]. However, are these concerns well justified and what impact does surgical approach have on morbidity and mortality in the elderly with endometrial cancer? To answer this question, we undertook this study and reviewed the literature from 2000 to 2009 detailing the experience of an elderly population (≥65 years) with endometrial cancer undergoing surgery.

In terms of use in the general population, robotic surgery for the treatment of endometrial cancer has recently been reported to be a safe and feasible alternative to traditional and laparoscopic surgery. Small, single institution comparative studies have reported that robotics is associated with an improvement in several perioperative parameters (blood loss, hospital stay, complications, node count, and recovery time) when compared to open and laparoscopic surgery [10–14]. In the only multi-institutional study reported to date ($n = 405$ patients), a shortened learning curve for robotics was demonstrated that was independent of prior laparoscopic experience (<10 cases). In addition, our study confirmed, but on a much larger scale, that robotics is associated with several improvements in perioperative outcomes (blood loss, shortened hospital stay, few operative complications, and a very low rate of conversion to laparotomy), as noted by earlier studies [8]. Whether these benefits would extend to an elderly population undergoing robotic surgery to treat endometrial cancer has not been previously reported.

Based on the results of our study, we conclude that the benefits of robotic surgery appear to extend to an advanced elderly population of women undergoing surgery for endometrial cancer despite a median age of 84. We identified no statistically significant difference in operative time, blood loss, hospital stay, nodal yield, rate of conversion, and intraoperative complications between the elderly cohort ($n = 27$) and the control group ($n = 395$). Interestingly, robotic surgery in the elderly cohort was successfully completed in 96% of the patients, and 81% of the patients were discharged within 2 days of surgery. This compares very favorably to data from the recently published Lap 2 Trial that reported increasing age as an independent risk factor for conversion to laparotomy, an overall conversion rate of 25.8%, and a median hospital stay of 3 days for the laparoscopy arm. Thus, it would appear based on our data that age is not a contraindication to robotic surgery for the treatment of endometrial cancer, nor is it an independent risk factor to conversion to laparotomy.

To compare the perioperative outcomes of our study to other surgical approaches in the literature, we reviewed the literature from 2000 to 2009. Four articles (>50 patients) were identified detailing the experience of an elderly population (≥65 years) with endometrial cancer undergoing surgery. The majority of these referenced studies were collected over 10–20 years and represent single-institution experience. No prior multi-institutional or prospective trials on this topic were identified. Surgical management varied from article to article, but the majority of the elderly patients were managed with traditional open surgery and a smaller percentage with vaginal or laparoscopic surgery. The demographics and perioperative outcomes (operative time, estimated blood loss, hospital stay, nodal yield, and overall major complications) from these published articles were reviewed and are shown in Table 5. The data from this manuscript are included in these tables for reference and comparison.

This review of the literature on elderly patients (age ≥65 years) undergoing surgery for endometrial cancer ($n = 430$ patients) is the most comprehensive study on this patient group to date. Data are available for all surgical approaches, and some conclusions can be drawn from these data. It is clear that a minimally invasive surgical approach would be beneficial to the elderly patient due to its association with less blood loss, shorter hospital stay, and fewer complications. Based on the data available, both

Table 5 Review of demographics and perioperative outcomes in reviewed articles and present study

Study	Age of patient (years)	Surgical approach	Body mass index	Diabetes mellitus (%)	Hypertension (%)	Prior abdominal surgery (%)	Stage I/II disease (%)
Demographics							
Current study (n= 27)	84	Robotic	28	22	74	56	64/24
Moore et al. 2007 [4] (n = 41) (staged patients)	84	Open or laparoscopic	27	4	50	NR	65/15
Scribner et al. 2001 [3] (n = 67)	67	Laparoscopic	29.4	NR	NR	NR	NR
Susini et al. 2005 [16] (n = 171)	75	Vaginal	NR	16.4	24.2	NR	74.2/NR
	74.4	Open	NR	4.6	11.6	NR	81.4/NR
Lachance et al. 2006 [17] (n = 151)	>65	Open	31	25	56	NR	64/11

Study	Number of patients	Surgical approach	Operative time (min)	Blood loss (cc)	Nodal yield (n)	Hospital stay (days)	Transfusion rate (%)	Overall major complications (%)
Surgical outcomes								
Current study	27	Robotic	192	50	16	1	None	None
Moore et al. (staged patients)	41	Open or Laparoscopic	NR	NR	NR	6.7	14	21[a]
Scribner et al.	67	Laparoscopic	236	298	29	3.0	19	18[b]
Susini et al.	171	Vaginal	46	210	0	6.0	5.4	5.4
		Open	115	400	NR	10	11.6	7.0
Lachance et al.	151	Open	176	384	NR	8	NR	40.3

NR, Not reported

[a] Only reported transfusion and readmission rates

[b] Includes 2 perioperative deaths

laparoscopy and robotics provide this advantage. However, robotics appears equivalent if not superior to laparoscopy in terms of blood loss, hospital stay, complication rate, conversion to laparotomy, and the ability to perform a complete staging procedure for this patient population, and similar outcomes have been reported in the general population [7–10, 12]. Although a traditional surgical approach was utilized for the majority of the patients in our literature review, one could clearly argue that abdominal surgery and its association with the most morbidity should be avoided in the elderly patient in favor of a less invasive surgical approach (Table 5). In addition, robotics has shown superiority to traditional surgery with respect to several perioperative outcomes in the general population [8–14]. Our data suggest that this benefit extends to an elderly population undergoing robotic surgery. Although, no direct comparison between robotics and vaginal surgery has been performed in the elderly, robotics also allows the patient to undergo a complete staging procedure with comparable outcomes as a vaginal approach.

Although the information presented here supports robotics as an alternative surgical approach for elderly patients undergoing surgery for endometrial cancer, the authors recognize the limitations of our data. It is retrospective in nature, with small numbers, and has no comparison group. In addition, the literature is limited with respect to this patient population, and most studies (including this one) are likely confounded by selection bias.

In conclusion, it appears that the benefits of robotic technology can be extended to an elderly population with improvements in perioperative outcomes as compared to other surgical modalities reported in the literature. Thus, if the goal in the surgical management of the elderly is to minimize complications and improve perioperative outcomes, robotics should be considered as a viable alternative for such patients.

Conflicts of interest Dr. Lowe and Dr. Tillmanns: consultants for Intuitive Surgical.

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