THE JOURNAL OF OBSTETRICS AND GYNECOLOGY OF INDIA

The Journal of Obstetrics and Gynecology of India (May–June 2019) 69(3):284–291
https://doi.org/10.1007/s13224-018-1170-0

ORIGINAL ARTICLE

A Comparison of the Clinical Outcomes in Uterine Cancer Surgery After the Introduction of Robotic-Assisted Surgery

Reshu Agarwal[1] · Anupama Rajanbabu[1] · Gaurav Goel[1] · U. G. Unnikrishnan[2]

Received: 10 February 2018 / Accepted: 12 August 2018 / Published online: 19 September 2018

About the Author

Dr. Reshu Agarwal is a consultant Gynecologist Oncologist currently practising at Kanpur U P. She finished her MD Obstetrics and Gynecology from KGMC Lucknow and finished her Fellowship in Gynecologic Oncology from Amrita Institute of Medical Sciences Kochi. She has many international and national publications.

Dr. Reshu Agarwal had finished her Fellowship in Department of Gynecologic Oncology at Amrita Institute of Medical Sciences, Amrita University, Kochi, Kerala, India; Dr. Anupama Rajanbabu is a professor in Department of Gynecologic Oncology at Amrita Institute of Medical Sciences, Amrita University, Kochi, Kerala, India; Dr. Gaurav Goel is a Post Graduate Trainee in Department of Gynecologic Oncology at Amrita Institute of Medical Sciences, Amrita University, Kochi, Kerala, India. U. G. Unnikrishnan is a Lecturer in Department of Biostatistics, Amrita University, Kochi, Kerala, India.

✉ Anupama Rajanbabu
anupamashyam@gmail.com

[1] Department of Gynecologic Oncology, Amrita Institute of Medical Sciences, Amrita University, Kochi, Kerala 682041, India

[2] Department of Biostatistics, Amrita Institute of Medical Sciences, Amrita University, Kochi, Kerala, India

Abstract

Objective To compare the rates of intraoperative and postoperative complications of open and robotic-assisted surgery in the treatment of endometrial cancer.

Methods This retrospective study was performed at a single academic institution from January 2014 to February 2017 in the Department of Gynecology Oncology at Amrita Institute of Medical Science, Kerala, India. The study included patients with clinically early stage uterine malignancy undergoing open or robotic-assisted surgery. Data collected included clinicopathological factors, intraoperative data, length of hospital stay and intraoperative and postoperative (early and late and severity according to Clavien–Dindo classification). Morbidity was compared between two groups.

Results The study included 128 patients, of whom 61 underwent open surgery and 67 underwent robotic-assisted surgery. Mean operative time ($P = 0.112$), mean estimated

blood loss ($P < 0.001$), number of patients requiring blood transfusion ($P < 0.001$) and mean length of hospital stay ($P < 0.001$) were significantly lower in robotic group. None of the patients in robotic group experienced intraoperative hemorrhage ($P = 0.010$). The early postoperative complications, SSI ($P < 0.001$), infection ($P = 0.002$), and urinary complications ($P = 0.030$) and late postoperative complications lymphoedema ($P = 0.002$), vault-related complications (1.5% robotic vs. 6.6% open) and incisional hernia (none in robotic vs. 4.9% in open) were significantly lower in robotic group. Grade-II complications (Clavien–Dindo classification) were significantly lower in robotic group ($P < 0.001$).

Conclusion Robotic-assisted surgical staging for uterine cancer is feasible and safe in terms of short-term outcomes and results in fewer complications and shorter hospital stay.

Keywords Uterine malignancy · Open surgery · Robotic surgery · Intraoperative complication · Postoperative complications

Introduction

Uterine cancer is the most common gynecological malignancy affecting women in developed countries. In India, still cervical cancer is the most common gynecological cancer affecting women, but the incidence of uterine cancer is increasing slowly as shown by national cancer registry data from India. There is an annual percentage change of 3.81%, and 33,696 patient cases are projected for the year 2020 [1, 2].

Endometrial cancers constitute the bulk of uterine cancers, most of them present at an early stage, and surgery is often the first major step in their management. GOG LAP2 trial [3] and other studies [4, 5] have showed that minimally invasive surgeries gave same oncological outcome when used for endometrial cancer treatment with lower surgical and postoperative morbidity; however, the steep learning curve of laparoscopy limited its widespread use in endometrial cancer surgery till date. In many parts of the world and in India, majority of the endometrial cancer patients still continue to be treated by open laparotomy.

Introduction of robotically assisted laparoscopic surgery with a shorter learning curve enabled more gynecologic oncologic surgeons worldwide to shift from open surgery to minimally invasive surgery when treating endometrial cancer [6, 7].

There are studies in the literature comparing open surgery with laparoscopy [4, 5, 8] and laparoscopy with robotic-assisted surgery [9, 10], and meta-analysis comparing the three approaches [11, 12]. However, there is scant data on clinical outcomes where the standard of care directly shifted from open to robotic-assisted surgery. Also the published literature had unequal distribution of cases with only a few cases in robotic arm [6, 13]. In our institution, patients with uterine malignancies used to undergo open surgery till the introduction of robotic-assisted surgery in 2015. The aim of our present study is to compare the intraoperative and postoperative outcomes of robotic-assisted surgery for uterine malignancy as compared to open surgery.

Materials and Methods

This is a single institution, retrospective review of patients who were operated for uterine malignancy by open or robotic approach from January 2014 to February 2017 at the department of Gynaecology Oncology at Amrita Institute of Medical Sciences, Kochi, India.

All patients with diagnosed or suspected clinically early stage uterine malignancy who underwent primary surgical treatment were included in the study. Patients with clinically advanced disease undergoing debulking surgery, patients who were operated after receiving neoadjuvant chemotherapy, patients operated for recurrent disease and patients who underwent robotic-assisted or open surgery for other indications were excluded from the study.

Since the introduction of robotic system in 2015, all surgically fit patients with clinically early stage uterine malignancy seeking for care at our department were offered robotic-assisted staging surgery. Decision to do surgery by either approach was dependent on patients' choice except in patients with suspected uterine sarcoma in whom open surgery was preferred.

All robotically assisted procedures were performed with the patient in low dorsolithotomy position, while open surgeries were performed in either supine position or low dorsolitholotomy position. All patients underwent complete staging surgery for uterine malignancy with hysterectomy, salpingo-oophorectomy, lymph node dissection (pelvic with/without para aortic nodes) and omentectomy and peritoneal biopsies when required.

After approval from the hospital ethics committee, data were extracted from hospital electronic medical records. Demographic and clinical characteristics (age, BMI, medical and surgical comorbidities), pathological characteristics (histologic type, subtype, grade and FIGO stage), perioperative characteristics (surgical approach, type of procedures performed, complexity of surgery, duration of surgery defined as time from skin incision to skin closure), blood loss during surgery, duration of hospital stay (defined as from the day of surgery to day of discharge), need for transfusion, occurrence of intraoperative complications and postoperative complications were collected from electronic medical records. Peritoneal adhesion index (PAI) score was

Box 1 Classification of surgical complications

Grades	Definition
Grade I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, and radiological interventions
	Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgetics, diuretics, electrolytes and physiotherapy. This grade also includes wound infections opened at the bedside
Grade II	Requiring pharmacological treatment with drugs other than such allowed for grade-I complications
	Blood transfusions and total parenteral nutrition are also included
Grade III	Requiring surgical, endoscopic or radiological intervention
Grade IIIa	Intervention not under general anesthesia
Grade IIIb	Intervention under general anesthesia
Grade IV	Life-threatening complication (including CNS complications)[a] requiring IC/ICU management
Grade IVa	Single-organ dysfunction (including dialysis)
Grade IVb	Multiorgan dysfunction
Grade V	Death of a patient
Suffix "d"	If the patient suffers from a complication at the time of discharge, the suffix "d" (for "disability") is added to the respective grade of complication. This label indicates the need for a follow-up to fully evaluate the complication

CNS central nervous system, *IC* intermediate care, *ICU* intensive care unit

[a]Brain hemorrhage, ischemic stroke, subarachnoidal bleeding, but excluding transient ischemic attacks

used to standardize the definition of adhesion and subsequent analysis [14]. According to time of onset, postoperative complication was divided into early (occurring within 30 days of surgery) and late (occurring after 30 days of surgery) complications. The severity of intra- and postoperative surgical complications was stratified into 5 grades on the basis of Clavien–Dindo classification (Box 1) [15].

Statistical Analysis

The characteristics of open and robotic-assisted surgery groups were compared. To obtain the association between study variables and types of surgery, Chi-square test was applied, and then, odds ratio was calculated for postoperative complications. To test the mean significance of operative variables between categorical variables, independent two sample *t*-test was applied for parametric variables and Mann–Whitney *U* test was applied for non-parametric variables. $P < 0.05$ was considered statistically significant, and $P < 0.001$ was considered highly significant. All analyses were performed using IBM SPSS for Windows, version 20.

Results

During the study period, a total of 128 (67 robotic, 61 open) consecutive patients underwent staging surgery for uterine malignancy. Trend of shift of standard of care at our institute from open to robotic is shown in Fig. 1.

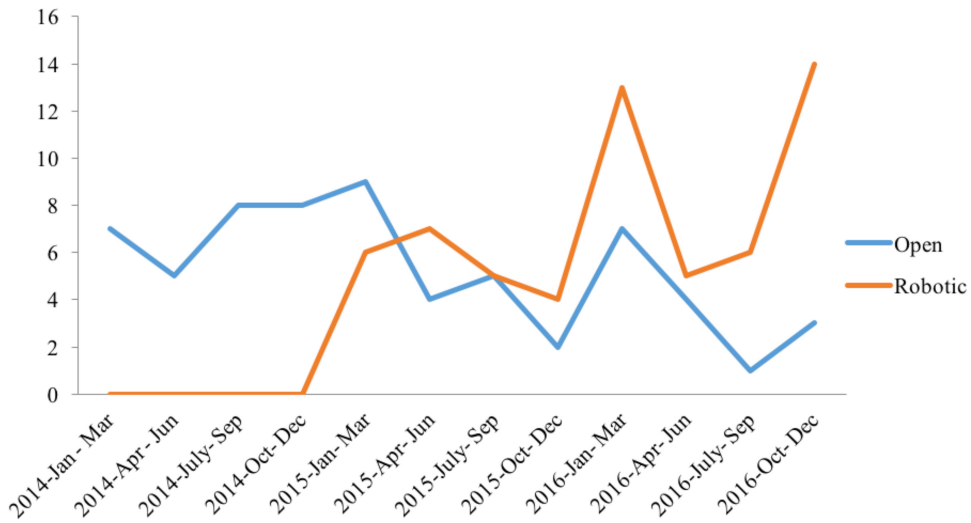

Fig. 1 Trend of shift of standard of care from open to robotic surgery

Table 1 Clinicopathological factors

Variables	Open (n = 61) N (%)	Robotic (n = 67) N (%)	P value
Age in years			0.014
Median	63	58	
Range	44–79	28–82	
BMI in kg/m^2			0.254
Median	26.9	27	
Range	24.4–32.5	17–44	
Medical history			
Past H/O cancer	6 (9.8%)	4 (6.0%)	0.517
DM	30 (49.2%)	22 (32.8%)	0.073
HTN	26 (42.6%)	29 (43.3%)	1.000
BA/pulmonary comorbidity	9 (14.8%)	3 (4.5%)	0.067
CAD/CVA	7 (11.5%)	5 (7.5%)	0.548
Metabolic/endocrine	23 (37.7%)	21 (31.3%)	0.463
H/O previous abdominal surgery			0.724
No	30 (49.2%)	36 (53.7%)	
Yes	31 (50.8%)	31 (46.3%)	
Histologic type			0.115
Carcinoma	49 (80.3%)	57 (85.1%)	
Sarcoma	8 (13.1%)	3 (4.5%)	
Atypical hyperplasia	4 (6.6%)	7 (10.4%)	
Histologic subtype of endometrial carcinoma			
Endometrioid	37 (75.5%)	45 (79%)	0.817
Clear cell	5 (10.2%)	2 (3.5%)	0.245
Serous	5 (10.2%)	5 (8.8%)	1.000
Carcinosarcoma	0 (0%)	5 (8.8%)	0.024
Mixed	2 (4.1%)	0 (0)	0.225
Stage			
IA	26/57 (45.6%)	29/60 (48.3%)	0.853
IB	12/57 (21.1%)	15/60 (25%)	0.665
II	8/57 (14.0%)	5/60 (8.3%)	0.387
IIIA	1/57 (1.8%)	1/60 (1.67%)	1.000
IIIB	1/57 (1.8%)	0/60 (0)	0.487
IIIC	2/57 (3.5%)	8/60 (13.3%)	0.095
IV	5/57 (8.8)	2/60 (3.3%)	0.264

Clinicopathological characteristics of the patients in two groups are represented in Table 1. The two groups were similar in most parameters except for slightly younger patients in the robotic surgery group. More than 50% of the patients in both groups had medical comorbidities and around 50% of the patients had undergone previous abdominal surgeries. Most of the patients had endometrial carcinoma or atypical hyperplasia of endometrium (total 117/128, 91.4%; 53, 86.9% in open and 64, 95.5% in robotic). Among endometrial carcinomas, endometrioid was the most common subtype (total 86/106, 81.1%; 37/49, 75.5% in open and 45/57, 79% in robotic). As far as uterine sarcomas are concerned, none of the patients with leiomyosarcoma were operated robotically (5/8 (62.5%) in open vs. 0/3 in robotic). Endometrial stromal sarcoma was equally distributed in both groups with 3 patients in each group. Most of the patients presented in early stages (total 82/117, 70.1%; 38/57, 66.7% in open and 44/60, 73.3% in robotic).

Surgical procedures performed were similar in the two groups (Table 2) except for the rate of lymph node dissection which was significantly higher in robotic surgeries (98.5% robotic vs. 75.4% open, $P < 0.001$). There was no significant difference in the mean PAI score of two groups, but the rate of adhesions and adhesiolysis was significantly higher in robotic group as compared to open group (56.7% robotic vs. 36.1% open. $P = 0.022$). Operative time

Table 2 Intraoperative and hospitalization data

	Open (n = 61) N (%)	Robotic (n = 67) N (%)	P value
Surgical procedures			
Hysterectomy	60 (98.3%)	66 (98.5%)	1.000
Simple	57 (93.4%)	62 (92.5%)	
Radical	3 (4.9%)	4 (6.0%)	
USO/BSO	60 (98.3%)	66 (98.5%)	1.000
Lymph node dissection	46 (75.4%)	66 (98.5%)	**< 0.001**
Omentectomy	11 (18%)	7 (10.4%)	0.309
Excision of extra-uterine disease	7 (11.5%)	3 (4.5%)	0.192
Peritoneal adhesion index (PAI) score			
Mean ± SD	1.95 ± 3.27	2.82 ± 3.83	0.172
0	39 (62.1%)	29 (43.3%)	
1–4	12 (19.7%)	21 (31.3%)	
5–9	6 (10.6%)	13 (19.4%)	
≥ 10	4 (7.6%)	4 (6.0%)	
Duration of surgery (minutes)			
Mean ± SD	208.60 ± 66.43	184.39 ± 58.38	**0.03**
Estimated blood loss (ml)			
Mean ± SD	234.92 ± 331.54	28.43 ± 21.68	**< 0.001**
No of patients with blood transfusion	9 (14.8%)	0 (0)	**< 0.001**
Length of hospital stay			
Mean ± SD	6.00 ± 2.93	1.36 ± 0.62	**< 0.001**

Statistically significant values are represented in bold

(184.39 ± 58.38 min robotic vs. 208.60 ± 66.43 min open, $P = 0.03$), estimated blood loss (28.43 ± 21.68 ml robotic vs. 234.92 ± 331.54 ml open, $P < 0.001$), number of patients requiring blood transfusion for intraoperative blood loss (none in robotic vs. 9 in open, $P < 0.001$) and length of hospital stay (1.36 ± 0.62 days robotic vs. 6.00 ± 2.93 open, $P < 0.001$) were significantly lower in robotic group.

Table 3 shows the intraoperative and postoperative complications. Intraoperatively, none of the patients experienced hemorrhage (defined as blood loss of more than 500 ml) in robotic group (none in robotic vs. 9.8% in open, $P = 0.010$). Bowel serosal injury was experienced by 3 patients in robotic group, but none of them experienced full thickness mucosal injury. However, in open group 1 patient had full thickness bowel injury. One patient in robotic group experienced ureteric injury. There was no case of conversion to open in robotic group (Table 3).

Overall postoperative early and late complications were significantly lower in robotic-assisted surgery (Table 3). The most common early postoperative complications were wound breakdown and SSI (1.5% robotic vs. 27.9% open; OR, 22.9; 95% CI, 2.95–177.94; $P < 0.001$), infection (3% robotic vs. 18% open; OR, 7.97; 95% CI, 1.72–36.90; $P = 0.002$), and urinary complications (3% robotic vs. 14.8% open; OR, 3.37; 95% CI, 0.87–13.05; $P = 0.030$). One patient in robotic group had postoperative hemorrhage which was managed conservatively without the need for blood transfusion (Clavien–Dindo grade I). Gastrointestinal complications in form of paralytic ileus or bowel obstruction were seen in none of the patients in robotic group and 3.3% patients in open group. The most common late postoperative complications were lymphoedema (none in robotic vs. 13.1% in open; OR, 5.13; 95% CI, 1.06–24.74; $P = 0.002$), vault-related complications (1.5% robotic vs. 6.6% open) and incisional hernia (none in robotic vs. 4.9% in open). None of the patients experienced thrombo-embolic complications in robotic group.

Early and late postoperative complications according to the Clavien–Dindo classification are given in Table 4. None of the patients in robotic group experienced grade-IIIB, IV and V complication. Grade-II (1.5% robotic vs. 37.7% open; $P < 0.001$) complications were significantly lower in robotic group. Grade-IIIA complication was experienced by only one patient in robotic group.

Discussion

The present study compared the intraoperative and postoperative morbidity when there was a shift in standard of care in the surgical management of uterine cancers from

Table 3 Comparison of Intraoperative and postoperative (early and late) complications

Complications	Open (n = 61) N (%)	Robotic (n = 67) N (%)	P Value	OR	CI
Intraoperative complications					
Hemorrhage (≥ 500 ml)	6 (9.8%)	0 (0)	**0.010**		
Bowel injury	1 (1.6%)	3 (4.5%)	0.621		
Serosal	0 (0)	3 (4.5%)			
Mucosal (full thickness)	1 (1.6%)	0 (0)			
Ureteric injury	0 (0)	1 (1.5%)	1.000		
Conversion to open	–	0 (0)			
Other	1 (1.6%)	0 (0)	0.477		
Early postoperative complications					
Wound breakdown/infection	17 (27.9%)	1 (1.5%)	**< 0.001**	22.9	2.95–177.94
Seroma/induration	4 (6.6%)	1 (1.5%)			
Superficial SSI	7 (11.5%)	0 (0)			
Deep SSI	5 (8.2%)	0 (0)			
Organ/space SSI	1 (1.6%)	0 (0)			
Infection	11 (18%)	2 (3%)	**0.006**	7.97	1.72–36.90
Hematoma	1 (1.6%)	1 (1.5%)	1.000		
GI complications	2 (3.3%)	0 (0)	0.225		
Ileus	1 (1.6%)	0 (0)			
Bowel obstruction	1 (1.6%)	0 (0)			
Urinary complications	9 (14.8%)	2 (3.0%)	**0.025**		
Ureteric leak	0 (0)	1 (1.5%)			
Bladder dysfunction	9 (14.8%)	1 (1.5%)			
Lymphatic complications	3 (4.9%)	2 (3.0%)	0.669		
Lymphorrhea	0 (0)	1 (1.5%)		3.37	0.87–13.05
Lymphocyst	3 (4.9%)	1 (1.5%)			
Hemorrhage	0 (0)	1 (1.5%)	1.000		
Readmission within 30 days	1 (1.6%)	1 (1.5%)	1.000		
Coagulation disorders	1 (1.6%)	1 (1.5%)	1.000		
Dyselectrolytemia	3 (4.9%)	0 (0)	0.105		
Late postoperative complications					
Lymphoedema	8 (13.1%)	0 (0)	**0.002**	5.13	1.06–24.74
Incisional hernia	3 (4.9%)	0 (0)	0.105		
Vault complications	4 (6.6%)	1 (1.5%)	0.191		
Recurrent vault infection	3 (4.9%)	1 (1.5%)			
Vault dehiscence	1 (1.6%)	0 (0)			
VTE	1 (1.6%)	0 (0)			

Statistically significant values are represented in bold

open to robotic-assisted staging surgery. We found that robotic-assisted surgery was associated with significantly reduced intra- and postoperative surgical complications.

The current study documents the experience and clinical outcomes in Indian setting where there was a direct switch over of surgical modality from open to robotic-assisted surgery. Our study is consistent with study of Mok et al. [6], who reported the similar experience and outcome; however, our study had equal number of patients in both the groups as opposed to smaller numbers undergoing robotic surgery in the Mok et al., study.

In the current study, patients in robotic group were younger than patients in open group with wide range of age. This significant difference in age was found because almost eight patients underwent surgery for uterine malignancy in second and third decade of their life, while in open group there was no patient less than 40 years of age. While, if we look at the other end of age spectrum then

Table 4 Grading of complications according to Clavien–Dindo classification

Complications	Open (n = 61) N (%)	Robotic (n = 67) N (%)	P value
Grades			
I	9 (14.8%)	4 (6.0%)	0.143
II	23 (37.7%)	1 (1.5%)	**< 0.001**
III	5 (8.2%)	1 (1.5%)	0.102
IIIA	4 (6.6%)	1 (1.5%)	
IIIB	1 (1.6%)	0 (0)	
IV	0 (0)	0 (0)	–
V	1 (1.6%)	0 (0)	0.477

Statistically significant value is represented in bold

in both groups almost 25% patients were older than 65 years of age. Both the groups were homogenous in rest of the clinicopathological characteristics. Consistent with other studies in the literature in our study, the most common uterine malignancy was the endometrial carcinoma, most common histologic subtype was endometrioid carcinoma and most of the patients presented in early stage [5, 16]. In the current study, mean operative time, mean amount of blood loss and number of patients requiring blood transfusion were significantly lower in robotic-assisted surgery as compared to open surgery. Data regarding operative time vary in the literature. The studies [17] and meta-analysis [11] on endometrial cancer reported a finding of longer operative with robotic-assisted surgery as compared to laparotomy. Our data is in contradiction with the available literature, where operative time was statistically significantly less in robotic group as compared to open group ($P = 0.03$). Our estimated mean blood loss in robotic surgery is 28.4 ml which is significantly lower than the blood loss in open group ($P < 0.001$). Estimated blood loss in the current study is also significantly lower than the range (74.5–231.7 ml) quoted in the literature [11]. Mean length of hospital stay is significantly lower in robotic-assisted surgery 1.36 days as compared to open surgery ($P < 0.001$) and is within the range reported in the literature (1–7.92 days) [11, 17, 18].

Our overall complication rates and severity of complications were significantly lower in the robotic-assisted surgery as compared to open surgeries. The most common early postoperative surgical complication encountered in open surgery group was wound breakdown and surgical site infection followed in order by infection and urinary complications (bladder dysfunction). Similarly, the most common postoperative late surgical classification encountered in open surgery was lymphedema followed by vault-related complication (recurrent vault infection and vault dehiscence) and incisional hernia. As far as vault dehiscence rate in robotic-assisted surgery which is nil in the current study is in discordance with the available data in the literature. Fuchs Weizman et al. [19] have reported the vault dehiscence rate as high as 3.2% in patients with robotic-assisted laparoscopic hysterectomies.

Our present study is in concordance with the review by Bush and Apte [20] where they reported a decreased risk of complications with robotic-assisted surgery compared to laparotomy. Study by Seror et al. [16] was the first related to robotic surgery in endometrial cancer that analyzed complications and severity according to Clavien–Dindo classification. However, in their study the comparison groups were laparoscopy and robotic-assisted surgery. Study by Mok et al. [6] compared the clinical outcome and complication rates between robotic-assisted and open surgery and showed fewer complication rates in robotic group. But the limitation of that study as mentioned earlier also were fewer patients in robotic arm compared to open surgery arm and also severity of complications was not taken into account. Lindfors et al. [17] compared the outcome in elderly patients undergoing robotic or open surgical staging for endometrial cancer. In their study, they concluded that there were no significant differences in the intraoperative complications, but robotic-assisted surgery resulted in fewer postoperative Clavien–Dindo grade-II complications.

Our current study is thus in concordance with the various studies in the literature comparing the occurrence of complications and their severity in patients undergoing surgery with open or robotic-assisted approach for endometrial cancer. Detailed classification of complications (as per time and severity according to Clavien–Dindo classification) and comparative analysis were performed. Odds ratio calculated for the complications found to be significantly different in two groups.

The present study is limited by the fact that it is a retrospective study and the groups were not randomized.

In conclusion, in the present study the operative time, intraoperative blood loss, intraoperative hemorrhage and need for blood transfusion were significantly lower in

robotic-assisted group compared to open group. Also, intraoperative and postoperative (early and late) complications were significantly lower in robotic-assisted surgery group as compared to open, not only in terms of rate but also in terms of severity. The conversion to open surgery in robotic-assisted group was zero.

With our experience, we can conclude that direct shift of standard of care from open to robotic-assisted staging surgery for uterine corpus malignancy can be incorporated by surgeons in their surgical repertoire. Through the use of robotic assistance, inherent benefits of minimally invasive surgery can be offered to more women with uterine cancers.

Compliance with Ethical Standards

Conflict of interest Authors have no financial conflict of interest to declare.

Ethical Statement Ethical committee permission was obtained.

References

1. National Cancer Registry Programme. Three year report of population based cancer registries: 2012–2014. Bangalore: National Cancer Registry Programme; 2016. p. 114.
2. National Cancer Registry Programme. Time trends in cancer incidence rates 1982–2010. Bangalore: National Cancer Registry Programme; 2013. p. 132.
3. Walker JL, Piedmonte MR, Spirtos NM, et al. Recurrence and survival after random assignment to laparoscopy versus laparotomy for comprehensive surgical Staging for uterine cancer: gynecologic oncology group LAP2 study. J Clin Oncol. 2012;30(7):695–700.
4. Chu L-H, Chang W-C, Sheu B-C. Comparison of laparoscopic versus conventional open method for surgical staging of endometrial carcinoma. Taiwan J Obstet Gynecol. 2016; 55:188–92.
5. Lee C-L, Huang K-G, Wu PJ, et al. Long term survival outcome of laparoscopic staging surgery for endometrial cancer in Taiwanese experience. Taiwan J Obstet Gynecol. 2014;53:57–61.
6. Mok ZW, Yong EL, Hui Low JJ, et al. Clinical outcomes in endometrial cancer care when the standard of care shifts from open surgery to robotics. Int J Gynecol Cancer. 2012; 22(5):819–25.
7. Lau S, Vankin Z, Ramana-Kumar AV, et al. Outcomes and cost comparison after introducing a robotic program for endometrial carcinoma. Obstet Gynecol. 2012;119(4):717–24.
8. Api M, Kayatas S, Boza AT, et al. Surgical staging of early stage endometrial cancer: comparison between laparotomy and laparoscopy. World J Oncol. 2013;4(6):235–40.
9. Nezhat F, Apostol R, Vega M, et al. Perioperative outcomes in robotic-assisted versus conventional laparoscopic treatment of endometrial cancer. J Adenocarcinoma. 2016;1:1–7.
10. Maenpaa MM, Nieminen K, Tomas EI, et al. Robotic-assisted versus traditional laparoscopic surgery for endometrial cancer: a randomized controlled trial. Am J Obstet Gynecol. 2016;215:588.e1-7.
11. Ran L, Jin J, Xu Y, et al. Comparison of robotic surgery with laparoscopy and laparotomy for treatment of endometrial cancer: a meta-analysis. PLoS ONE. 2014;9(9):e108361.
12. Chen S-H, Li Z-A, Huang R, et al. Robotic-assisted versus conventional laparoscopic surgery for endometrial cancer staging: a meta-analysis. Taiwan J Obstet Gynecol. 2016;55:488–94.
13. Guy MS, Sheeder J, Behbakht K, et al. Comparative outcomes in older and younger women undergoing laparotomy or robotic surgical staging for endometrial cancer. Am J Obstet Gynecol. 2016;214:350.e1-10.
14. Coccolini F, Ansaloni L, Manfredi R, et al. Peritoneal adhesion index (PAI): proposal of a score for the "ignored iceberg" of medicine and surgery. World J Emerg Surg. 2013;8:6.
15. Dindo D, Demartines N, Clavien PLA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004;240:205–13.
16. Seror J, Bats AS, Huchon C, et al. Laparoscopy versus robotics in surgical management of endometrial cancer: comparison of intraoperative and postoperative complications. J Minim Invasive Gynecol. 2014;21:120–5.
17. Lindfors A, Akesson A, Staf C, et al. Robotic versus open surgery for endometrial cancer in elderly patients: surgical outcome, survival and cost analysis. Int J Gynecol Cancer. 2018;28(4):692–9.
18. Ulm MA, Gin DN, ElNaggar AC, et al. A comparison of outcomes following robotic-assisted staging laparotomy in patients with early stage endometrioid adenocarcinoma of uterus with uterine weight under 480 g. Gynecol Minim Invasive Ther. 2016;5:25–9.
19. Fuch Weizman N, Einarsson JI, Wang KC, et al. Vaginal cuff dehiscence: risk factor and associated morbidities. J Soc Laparoendosc Surg. 2015;19(2):e2013.00351.
20. Bush SH, Apte SM. Robotic-assisted surgery in gynaecological oncology. Cancer Control. 2015;22(3):307–13.