Original Article

J Gynecol Oncol Vol. 22, No. 4:253-259
http://dx.doi.org/10.3802/jgo.2011.22.4.253

pISSN 2005-0380
eISSN 2005-0399

Journal of Gynecologic Oncology
jgo

Total laparoscopic hysterectomy versus da Vinci robotic hysterectomy: is using the robot beneficial?

Enrique Soto[1], Yungtai Lo[1], Kathryn Friedman[1], Carlos Soto[2], Farr Nezhat[3], Linus Chuang[1], Herbert Gretz[1]

[1]Department of Obstetrics, Gynecology and Reproductive Science, Mount Sinai School of Medicine, New York, USA, [2]Department of Surgery, Hospital San Jose-Tec de Monterrey, Monterrey, Mexico, [3]Department of Obstetrics and Gynecology, St. Luke's and Roosevelt Hospitals, New York, USA

Objective: To compare the outcomes of total laparoscopic to robotic approach for hysterectomy and all indicated procedures after controlling for surgeon and other confounding factors.

Methods: Retrospective chart review of all consecutive cases of total laparoscopic and da Vinci robotic hysterectomies between August 2007 and July 2009 by two gynecologic oncology surgeons. Our primary outcome measure was operative procedure time. Secondary measures included complications, conversion to laparotomy, estimated blood loss and length of hospital stay. A mixed model with a random intercept was applied to control for surgeon and other confounders. Wilcoxon rank-sum, chi-square and Fisher's exact tests were used for the statistical analysis.

Results: The 124 patients included in the study consisted of 77 total laparoscopic hysterectomies and 47 robotic hysterectomies. Both groups had similar baseline characteristics, indications for surgery and additional procedures performed. The difference between the mean operative procedure time for the total laparoscopic hysterectomy group (111.4 minutes) and the robotic hysterectomy group (150.8 minutes) was statistically significant (p=0.0001) despite the fact that the specimens obtained in the total laparoscopic hysterectomy group were significantly larger (125 g vs. 94 g, p=0.002). The robotic hysterectomy group had statistically less estimated blood loss than the total laparoscopic hysterectomy group (131.5 mL vs. 207.7 mL, p=0.0105) however no patients required a blood transfusion in either group. Both groups had a comparable rate of conversion to laparotomy, intraoperative complications, and length of hospital stay.

Conclusion: Total laparoscopic hysterectomy can be performed safely and in less operative time compared to robotic hysterectomy when performed by trained surgeons.

Keywords: Total laparoscopic hysterectomy, da Vinci robot, Robotic hysterectomy

INTRODUCTION

Despite having multiple non-surgical options for the treatment of benign uterine disease, hysterectomy continues to be the second most commonly performed surgery in the United States [1]. A laparoscopic approach to hysterectomy, which has several benefits over the traditional abdominal technique [2], has had a modest adoption in the United States with only 12% of hysterectomies performed laparoscopically in 2003 [3]. Factors that might explain this slow adoption include the learning curve associated with the procedures, lack of sufficient resident and fellow training, uneven availability of proper equipment, and a low level of physician reimbursement [4].

Advances in robotic technology allowed the development

Received Mar 16, 2011, **Revised** Jul 25, 2011, **Accepted** Aug 9, 2011

Correspondence to Herbert F. Gretz
Department of Obstetrics, Gynecology and Reproductive Science, Mount Sinai School of Medicine, 1176 5th Avenue, New York, NY 10029, USA. Tel: 1-212-241-5032, Fax: 1-212-241-1776, E-mail: herb.gretz@mssm.edu

of the da Vinci robotic system (Intuitive Surgical, Sunnyvale, CA, USA) for surgical procedures which gained United States FDA approval for hysterectomy in 2005. This system offers the features of a high resolution three-dimensional (3D) view and a wrist-like motion of the robotic arm, which provides finer and more dexterous movements [5]. Currently the da Vinci robotic hysterectomy is being increasingly utilized in the United States for benign and malignant indications [6]. However, important limitations of robotic surgery exist including the added operative time and cost associated with the robotic procedure. The most current da Vinci surgical system, da Vinci S, currently costs over $2 million US dollars and the additional direct cost per case has been estimated to range from $950 to $1,400 US dollars, which include the per case amortized use-cost of the robotic system as well as the increased operating room and nursing time utilized specifically for robot set-up and docking [7]. Further, we estimate $1,000 to $1,500 US dollars in disposable instruments used per case.

Currently, there are limited data that compares outcomes of total laparoscopic to a robotic approach to hysterectomy for the treatment of benign and malignant gynecologic pathology and the studies often fail to control for surgeon and other possible confounding factors. The aim of our study is to determine and quantify if performing a robotic hysterectomy has actual benefits when compared to total laparoscopic hysterectomy when performed by surgeons with laparoscopic hysterectomy experience after controlling for relevant confounding factors.

MATERIALS AND METHODS

We conducted a retrospective review of 124 women who underwent a total laparoscopic or robotic hysterectomy at two community hospitals in the New York area from August 2007 to July 2009. All surgeries were performed by one of two board certified gynecologic oncologists from Mount Sinai School of Medicine. The procedures included in the study were total laparoscopic and robotic hysterectomy for benign and malignant indications performed at White Plains Hospital and Greenwich Hospital. Both surgeons that participated in the study are robotic surgery instructors/proctors and each had performed approximately 40 robotic hysterectomies prior to the study period. Institutional Review Board approval was obtained.

1. Technique

The total laparoscopic hysterectomies were performed in the manner described below, most commonly using the Harmonic Scalpel (Ethicon Endo-Surgery Inc., Cincinnati, OH, USA). The abdominal cavity was accessed through the umbilicus by the open technique as described by Hasson [8], and a balloon trocar was utilized in this 10 mm incision site. Three accessory 5 mm trocars are used and placed in the right lower quadrant of the abdomen, left lower quadrant and suprapubic position. The hysterectomy technique begins with Harmonic access to the pararectal spaces by incising parietal peritoneum lateral to the infundibulopelvic (IP) ligaments. Ureters are identified on each side followed by ligation of the IP ligaments. Round ligaments are divided near the pelvic sidewall and the bladder dissected away in the usual manner. The uterine pedicles isolated and divided at the isthmus and carried down the paracervix to the level of the vaginal cuff. A colpotomy is created and extended with the laparoscopic scissors or the Harmonic Scalpel. The intact uterus was removed vaginally in patients with carcinoma except for three cases in which the intact uterus was removed abdominally through the umbilical port site (2 total laparoscopic hysterectomy cases with uterine weight of 349 g and 425 g and a robotic hysterectomy case with uterine weight of 304 g). Bilateral salpingoophorectomy, tumor debulking and pelvic and paraaortic lymph node dissection was performed in both total laparoscopic and robotic hysterectomy cases for malignant pathology as indicated (Table 1).

In hysterectomies for benign pathology and an enlarged uterus, an automatic morcellator was used (Gynecare Morcellex, Ethicon Endo-Surgery Inc.). The colpotomy site was closed with interrupted laparoscopic endo-knot sutures in the cases of total laparoscopic hysterectomy and with a continuous vicryl running suture in the robotic hysterectomies.

The robotic hysterectomies were performed with the da Vinci robot following the same general principals of the total laparoscopic hysterectomy except for the use of monopolar and bipolar energy, and closure of the vaginal colpotomy, which was approximated in a running fashion. A cystoscopy was performed in selected cases of total laparoscopic and robotic hysterectomy in which the surgeon deemed necessary to rule out a lower urinary tract injury (e.g., significant bladder dissection).

2. Data analysis

A computerized database was created to record the demographic information, body mass index (BMI), indication for hysterectomy, surgery performed, intraoperative findings, intraoperative complications, estimated blood loss (EBL, mL), conversion to laparotomy, use of morselator, other completed procedures, median specimen weight (g), mean lymph node dissection yield, operative procedure time (minutes), and total operating room time (minutes). Our primary outcome mea-

 http://dx.doi.org/10.3802/jgo.2011.22.4.253

Table 1. Baseline characteristics and differences between the total laparoscopic hysterectomy and robotic hysterectomy groups for all surgical cases

	Total laparoscopic hysterectomy, (n=77)	Robotic hysterectomy, (n=47)	p-value*
Age (yr)	58.9±12.59	58.9±11.79	0.889
Body mass index (kg/m^2)	28.74±6.77	29.52±7.33	0.681
Median uterine weight (range) (g)	125 (35-1,740)	94 (29-515)	0.002
Operative procedure time (min)	111.45±33.22	150.82±33.50	<0.0001
Lymph node dissection yield†	9.54±4.89 (n=37)	9.13±6.96 (n=23)	0.474
Indication			0.517
Benign	34 (44.15)	21 (44.68)	
Malignant (endometrial carcinoma)	39 (50.64)	23 (48.93)	
Cervical carcinoma *in situ*	2 (2.59)	3 (6.38)	
Ovarian mass of unknown etiology	2 (2.59)	0	
Estimated blood loss (mL)			0.009
<200	34 (47.88)	32 (72.72)	
>200	37 (52.11)	12 (27.27)	
Conversions to laparotomy			
Yes	3 (3.89)	0	0.288
No	74 (96.10)	47 (100)	
Intraoperative complications			
Yes	1 (1.29)	0	1.000
No	76 (98.70)	47 (100)	
Lysis of adhesions			
Yes	11 (14.28)	6 (12.76)	0.811
No	66 (85.71)	41 (87.23)	
Salpingoophorectomy			
Yes	72 (93.50)	44 (93.61)	1.000
No	5 (6.49)	3 (6.38)	
Cystoscopy			
Yes	7 (9.09)	6 (12.76)	0.517
No	70 (90.90)	41 (87.23)	
Tumor debulking			
Yes	2 (2.59)	0	0.525
No	75 (97.40)	47 (100)	
Use of morcellator			
Yes	6 (7.79)	1 (2.12)	0.251
No	71 (92.20)	46 (97.87)	
Appendectomy			
Yes	2 (2.59)	1 (2.12)	1.000
No	75 (97.40)	46 (97.87)	
Length of hospital stay (day)	2.2±1.14	1.9±0.95	0.100

Both surgeons that participated in the study are robotic surgery instructors/proctors and each had performed approximately 40 robotic hysterectomies prior to the study period. Values are presented as mean±SD or number (%).
*p-values were obtained by Wilcoxon rank-sum tests for continuous variables and by chi-square or Fisher's exact tests for categorical variables.
†For malignant cases.

sure was mean operative procedure time, which was defined as time from skin incision to skin closure.

The associations of patient characteristics and clinical variables of the total laparoscopic and robotic hysterectomy groups were assessed using Wilcoxon rank-sum tests for continuous variables and chi-square or Fisher's exact tests for categorical variables. Data on operative procedure time were transformed with square root to remove skewness in the data. Mixed model with a random intercept to account for correlation among patients who received surgeries from the same surgeon was used to examine effects of total laparoscopic and robotic hysterectomy on mean operative procedure time adjusted for other confounders. Variables examined included age, BMI, uterine weight, estimated blood loss, conversion to laparotomy, intraoperative complications, surgery date, lysis of adhesions, salpingoophorectomy and additional procedures performed including cystoscopy, tumor debulking, use of morselator, and appendectomy.

All statistical analyses were performed using SAS ver. 9.2 (SAS Inc., Cary, NC, USA) and SPSS ver. 17.0 (SPSS Inc., Chicago, IL, USA). All p-values were two-tailed, with $p < 0.05$ considered as statistically significant results.

RESULTS

Between August 2007 and July 2009 there were a total of 124 consecutive total laparoscopic and robotic hysterectomies in both institutions. These included 77 total laparoscopic hysterectomies and 47 robotic hysterectomies for benign or malignant indications and were performed by one of two surgeons.

The patients in both groups had a comparable mean age (total laparoscopic hysterectomy, 58.9; robotic hysterectomy, 58.9; p=0.889), indications for surgery and body mass index (total laparoscopic hysterectomy, 28.7 vs. robotic hysterectomy, 29.5; p=0.681). The difference in incidence of both conversion to laparotomy and intraoperative complications was not statistically significant in both groups (Table 1). The specimens obtained in the total laparoscopic hysterectomy group were significantly larger than the specimens obtained in the robotic hysterectomy group (125 g vs. 94 g, p=0.002).

There were sixty-two patients that had hysterectomy for a malignant etiology (39 in the total laparoscopic hysterectomy group and 23 in the robotic hysterectomy group). All patients had endometrial carcinoma for which they underwent a total hysterectomy, bilateral salpingoophorectomy and pelvic/paraaortic lymph node dissection (except for two patients that declined lymph node dissection in the total laparoscopic group). There were two patients in the total laparoscopic hysterectomy group that required tumor debulking as part of the staging procedure. The total laparoscopic and robotic hysterectomy groups had comparable lymph node yield (total laparoscopic hysterectomy, 9.54 vs. robotic hysterectomy, 9.13; p=0.474) (Table 2).

The total laparoscopic hysterectomy group had significantly more patients with EBL greater than 200 mL in comparison to

Table 2. Differences between the total laparoscopic hysterectomy and robotic hysterectomy groups for malignant indication (endometrial carcinoma)

	Total laparoscopic hysterectomy, (n=39)	Robotic hysterectomy, (n=23)	p-value*
Age (yr)	62.69±11.91	63.92±11.21	0.687
Body mass index (kg/m^2)	31.07±7.10	29.94±5.88	0.518
Median uterine weight (g)	116.72±72.29	101.50±96.05	0.476
Operative procedure time (mins)	116.08±25.06	171.17±43.18	<0.001
Lymph node dissection	37 (94.87)†	23 (100)	0.525
Lymph node dissection yield	9.54±4.89	9.13±6.96	0.474
Tumor debulking	2 (5.12)	0	0.525
Conversion to laparotomy	0	0	1.000
Intraoperative complications	0	0	1.000
Endometrial carcinoma stage			
I	29 (74.35)	19 (82.60)	0.541
II	2 (5.12)	1 (4.34)	1.000
III	8 (20.51)	3 (13.04)	0.516

Values are presented as mean±SD or number (%).
*p-values were obtained by Wilcoxon rank-sum tests for continuous variables and by chi-square or Fisher's exact tests for categorical variables.
†Two patients declined lymph node dissection at the time of surgical consent.

http://dx.doi.org/10.3802/jgo.2011.22.4.253

the robotic hysterectomy group; this difference was statistically significant (37 vs. 12, p=0.009). The estimated blood loss in the total laparoscopic hysterectomy group was 207.7 mL and 131.50 mL in the robotic hysterectomy group; this difference was statistically significant (p=0.0105). The intraoperative complication encountered in the total laparoscopic hysterectomy group (1.29%) consisted of a cystotomy that was repaired laparoscopically. Both groups had comparable hospital length of stay. The length of stay was 2.2 days in the total laparoscopic hysterectomy group and 1.9 days in the robotic hysterectomy group (p=0.10).

Total laparoscopic hysterectomies were performed an average 39 minutes faster than robotic hysterectomies. The difference between the mean operative procedure time for the total laparoscopic hysterectomy group (111.4 minutes) and the robotic hysterectomy group (150.8 minutes) was statistically significant (p=0.0001). The factors that were associated with a significant increase in operative procedure time were type of hysterectomy -robotic hysterectomy- (p=0.0001), surgeries where there was a greater than 200 mL blood loss (p=0.0002) and use of a morselator (p=0.007). Cystoscopy was associated with an increased operative procedure time but did not reach statistical significance (Table 3).

DISCUSSION

The current study compares the outcomes of total laparoscopic to robotic approach for hysterectomy and all indicated procedures after controlling for surgeon and other possible confounding factors. In our study, total laparoscopic hysterectomies were performed for benign or malignant indications an average 39 minutes faster than robotic hysterectomies. Exclusion of the subset of patients that had multiple procedures and/or conversion to laparotomy did not affect these results. The finding of reduced operative time associated with total laparoscopic hysterectomy is consistent with the majority of the studies in the literature that compare this type of hysterectomy with a robotic approach. In the study by Payne and Dauterive [9], 2008, the robotic cases took an average 27 minutes longer to complete. The authors state however that the last 25 robotic cases (of 100) were done faster than the average total laparoscopic hysterectomy (92.4 minutes vs. 78.7 minutes). Other studies that had longer operative times for the robotic cohort, include the studies from Shashoua et al. [10], 2009 and Nezhat et al. [11], 2009 where there was an increased operative time of 20, and 70 minutes respectively.

The available studies in the literature that analyze specifically the use of a robotic versus a laparoscopic approach for surgical staging of endometrial carcinoma have shown conflicting results in regards to operative time. The studies by Seamon et al. [12], 2009 and Boggess et al. [13], 2008, found that the robotic cohort had less operative time than the laparoscopic by approximately 45 minutes, and 22 minutes respectively. Other studies by Jung et al. [14], 2009 and Bell et al. [15], 2008 found that the laparoscopic cohort was an average 27 minutes, and 13 minutes faster than the robotic cohort respectively. In the study by Bartos et al. [16], 2007, the implementation of the robot to their gynecologic oncology cases increased the overall cost and operative time by 59% in comparison to identical laparoscopic procedures in the same institution.

Variability in the skill of the surgeon likely accounts for some of the inconsistencies seen in the literature. However, it is also possible that hospital dependent factors like anesthesia time, operating room staff efficiency and level of training of assistants may play a role in these conflicting results.

Our study confirmed the finding that the estimated blood loss is lower in robotic hysterectomies in comparison to total laparoscopic hysterectomies. Other authors that found similar results include Payne and Dauterive [9], 2008, where there was a 52 mL difference favoring robotic hysterectomies. Studies that further prove this difference by having fewer blood transfusions in the total laparoscopic hysterectomy group include the studies from Boggess et al. [13], 2008, Jung et al. [14], 2009, and Bell et al. [15], 2008. In our study, the 76 mL blood loss difference in the groups had no evident clinical significance given that none of our patients required a blood transfusion and there were no complications directly related

Table 3. Factors associated with operative procedure time

	Least squares (means±SE)	Least squares (means in minutes)*	p-value
Total laparoscopic hysterectomy	13.33±0.33	177.7	<0.0001
Robotic hysterectomy	11.27±0.36	127.0	
Estimated blood loss (mL)			
<200	11.78±0.35	138.8	0.0002
>200	12.82±0.32	164.4	
Use of morcellator			
Yes	13.01±0.53	169.3	0.007
No	11.58±0.21	134.1	
Cystoscopy			
Yes	12.69±0.45	161.0	0.068
No	11.91±0.28	141.8	

*Least squares means in minutes were obtained by transforming least squares means of the square root transformed data in column 2 back to the original scale.

to blood loss. The etiology behind the difference in blood loss between these two techniques is yet to be determined.

The data for complications for total laparoscopic vs. robotic hysterectomies have shown conflicting results. The study from Bell et al. [15], 2008 showed a lower complication rate for the robotic in comparison to the laparoscopic group (7.5% vs. 20.0%), while our study shared findings with Nezhat et al. [11], 2009 showing no statistically significant difference in both groups. The complication we encountered (cystotomy) was repaired laparoscopically.

With respect to rate of conversion to laparotomy, our study had similar results to Boggess et al. [13], 2008, by finding no statistically significant difference between the total laparoscopic and robotic hysterectomy groups. The studies by Payne and Dauterive [9], 2008 and Seamon et al. [12], 2009 however, showed a decrease in the rate of conversion to laparotomy in the robotic hysterectomy group in comparison to the total laparoscopic approach (4% vs. 9%, and 12% vs. 26%, respectively). Additionally, there are two studies in the literature in which no conversions were reported (Nezhat et al. [11], 2009 and Jung et al. [14], 2009). Of note, the latter study was for staging of endometrial carcinoma and 83% of patients were stage I. Similarly, we included patients with endometrial carcinoma and our institutional practice is to perform a laparoscopic assessment for the cases with suspicion or with a known malignancy in order to determine resectability. This is performed whenever felt reasonable preoperatively with the purpose of avoiding unnecessary laparotomy in the cases where the intended outcome can be achieved laparoscopically. There is a definite need for larger studies to assess the expanding role of laparoscopy in gynecologic oncology.

Typical indications for robotic hysterectomy include patient and/or physician preference. Patient preference may be driven by patient-to-patient or by corporate direct-to-consumer marketing channels. Physician preference is based on the physician's training and experience with each modality including traditional laparoscopic, open, and robotic methods. The features of 3D visualization, play a role not only in visual field acquity/resolution, but also in camera control and image stability. Regarding the matter of the surgical assistance and console management, it is important to underline the paradox that exists. Many surgeons state that the console provides increasing personal control of the surgery and therefore a decreased dependence on the assistant. However at the same time, the presence of the primary surgeon remote and unscrubbed from the primary operative site results in a greater dependence on the ability of the assistant to complete the necessary ancillary functions in a timely and efficient manner.

Our study demonstrates that a traditional laparoscopic hysterectomy can be performed in less time than a robotic hysterectomy, while achieving similar outcomes. Therefore we raise the question: Would the generalized use of the robot be justified for this procedure? Our data does not support this claim. Robotic surgery is however a brilliant technology which may aid some physicians in the transition to a more minimally invasive approach to gynecologic surgery.

Learning and incorporation of the robotic technique is certainly appropriate as all surgeons should be familiar with the full spectrum of available methods for treating patients. However, physicians should not relinquish their hard learned and mastered traditional laparoscopic techniques. Physicians should also be conscious of the costs. Our data demonstrate that for skilled laparoscopic surgeons, the robot rarely improves the outcome as compared to a total laparoscopic approach to hysterectomy.

The findings in our study suggest that total laparoscopic is an approach for hysterectomy that can be performed safely and in less operative time than using the robot when performed by trained surgeons at institutions that have the proper operative team and equipment. The decrease in operative time and lack of the costs associated with robotic surgery make total laparoscopic hysterectomy a likely better and more cost-effective approach to patients that require a hysterectomy for a benign or malignant indication.

Our study has the limitations associated with a retrospective study and the results derive from a single institution with two affiliated hospitals. Prospective multicenter randomized studies are needed to definitively delineate the role of robotic surgery in the field of operative gynecology. Ideally, each surgeon should be familiar with both the total laparoscopic and robotic techniques for hysterectomy and perform the procedure for which the surgeon has the most experience. The current data for robotic hysterectomies does not demonstrate any clear benefits over traditional laparoscopy. Instead, robotic technology adds time and cost to the procedure. We believe that whenever a case can be done without the robot, it should be.

CONFLICT OF INTEREST

The authors Linus Chuang, MD and Herbert Gretz, MD are consultants and proctors for Intuitive Surgical and Ethicon.

REFERENCES

1. Healthcare Cost and Utilization Project. Nationwide inpatient sample [Internet]. Rockville, MD: Agency for Health-

 http://dx.doi.org/10.3802/jgo.2011.22.4.253

care Research and Quality; 2011 [cited 2011 Sep 20]. Available from: http://www.hcup-us.ahrq.gov/nisoverview.jsp.
2. Nieboer TE, Johnson N, Lethaby A, Tavender E, Curr E, Garry R, et al. Surgical approach to hysterectomy for benign gynaecological disease. Cochrane Database Syst Rev 2009;(3):CD003677.
3. Wu JM, Wechter ME, Geller EJ, Nguyen TV, Visco AG. Hysterectomy rates in the United States, 2003. Obstet Gynecol 2007;110:1091-5.
4. Reich H. Total laparoscopic hysterectomy: indications, techniques and outcomes. Curr Opin Obstet Gynecol 2007;19:337-44.
5. Kim YT, Kim SW, Jung YW. Robotic surgery in gynecologic field. Yonsei Med J 2008;49:886-90.
6. Advincula AP. Surgical techniques: robot-assisted laparoscopic hysterectomy with the da Vinci surgical system. Int J Med Robot 2006;2:305-11.
7. Chen CC, Falcone T. Robotic gynecologic surgery: past, present, and future. Clin Obstet Gynecol 2009;52:335-43.
8. Hasson HM. Open laparoscopy. Biomed Bull 1984;5:1-6.
9. Payne TN, Dauterive FR. A comparison of total laparoscopic hysterectomy to robotically assisted hysterectomy: surgical outcomes in a community practice. J Minim Invasive Gynecol 2008;15:286-91.
10. Shashoua AR, Gill D, Locher SR. Robotic-assisted total laparoscopic hysterectomy versus conventional total laparoscopic hysterectomy. JSLS 2009;13:364-9.
11. Nezhat C, Lavie O, Lemyre M, Gemer O, Bhagan L, Nezhat C. Laparoscopic hysterectomy with and without a robot: Stanford experience. JSLS 2009;13:125-8.
12. Seamon LG, Cohn DE, Henretta MS, Kim KH, Carlson MJ, Phillips GS, et al. Minimally invasive comprehensive surgical staging for endometrial cancer: Robotics or laparoscopy? Gynecol Oncol 2009;113:36-41.
13. Boggess JF, Gehrig PA, Cantrell L, Shafer A, Ridgway M, Skinner EN, et al. A comparative study of 3 surgical methods for hysterectomy with staging for endometrial cancer: robotic assistance, laparoscopy, laparotomy. Am J Obstet Gynecol 2008;199:360.e1-9.
14. Jung YW, Lee DW, Kim SW, Nam EJ, Kim JH, Kim JW, et al. Robot-assisted staging using three robotic arms for endometrial cancer: comparison to laparoscopy and laparotomy at a single institution. J Surg Oncol 2010;101:116-21.
15. Bell MC, Torgerson J, Seshadri-Kreaden U, Suttle AW, Hunt S. Comparison of outcomes and cost for endometrial cancer staging via traditional laparotomy, standard laparoscopy and robotic techniques. Gynecol Oncol 2008;111:407-11.
16. Bartos P, Struppl D, Trhlik M, Czudek S, Skrovina M, Adamcik L, et al. Da vinci robotic surgery in gynaecological oncology: a critical interim appraisal. Ceska Gynekol 2007;72:354-9.