

A Comparison of Surgical Outcomes between Single-Site Robotic, Multiport Robotic and Conventional Laparoscopic Techniques in Performing Hysterectomy for Benign Indications

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Abstract

Objectives: Minimally invasive gynecologic surgery (MIGS) is the standard of care in performing hysterectomy for benign conditions. However, the choice of laparoscopic modality is largely dependent on surgeon's discretion, experience, and equipment availability. The objective of this study is: To compare outcomes between different minimally invasive approaches available for benign hysterectomies and to evaluate patient factors that influence the use of one approach over another. With this study, we sought to provide some objective criteria while deciding the appropriate MIGS technique.

Materials and Methods: This is a retrospective study comparing perioperative outcomes between three techniques of minimally invasive hysterectomy: laparoscopy (LSC), multiport daVinci (MP-Rob) and single-site daVinci (SS-Rob). Patients undergoing benign hysterectomy (daVinci or conventional LSC) from January 2015 to July 2016 were included. 129 patients were identified and divided into: LSC ($n = 44$), MP-Rob ($n = 36$) and SS-Rob ($n = 49$).

Results: There were statistically significant differences in age (MP-Rob46 \neq LSC39), body mass index (BMI) (MP-Rob33 \neq LSC27 or SS-Rob26.8), uterus weight (MP-Rob144 \neq LSC102 or SS-Rob105) and operative time (LSC192 \neq SS-Rob162.3 or MP-Rob163). Chi-square analyses revealed history of endometriosis and clinical endometriosis was statistically less common while leiomyomas were more common indications of MP-Rob. There was no statistically significant difference noted between length of stay, estimated blood loss, intraoperative, and post-operative complications between different surgical types.

Conclusion: Patients with higher age, BMI, uterus weight and abnormal uterine bleeding were noted to undergo MP-Rob surgery. Patients with history of endometriosis were more likely to undergo LSC or SS-Rob surgery. Operative time was significantly less for daVinci hysterectomies (SS-Rob and MP-Rob) as compared to conventional LSC.

Keywords: Conventional laparoscopy, hysterectomy, laparoendoscopic single site, robotic surgery, single incision

INTRODUCTION

Hysterectomy is the most common major gynecologic surgery performed worldwide with the most common indication being abnormal uterine bleeding caused by leiomyomas (AUB-L).^[1] Traditionally, hysterectomy was performed with an open procedure using midline vertical or Pfannenstiel skin incision. This technique has fallen into disfavor by majority of the

benign gynecologic surgeons due to the advent of minimally invasive options such as laparoscopic single site, laparoscopic multiport, Robot-assisted multiport, and Robot-assisted single-site platform.^[2]

These minimally invasive options provide the well-known benefits of excellent cosmesis, shorter hospital stay,

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faster recovery, faster return to routine activities, significant decline in wound related complications (such as infections, hematoma, and dehiscence) and other major postoperative complications (deep vein thrombosis and respiratory morbidities).^[3] Use of daVinci has also overcome many technical problems seen with conventional laparoscopy (LSC) like avoiding tremors, 3 dimensional vision, depth perception and 360° rotation of the instruments.^[4-6] Single-site daVinci platform further improves the cosmetic benefits of minimally invasive surgery by using only one small incision for the entire procedure, thus further reducing the potential morbidity associated with the multiple incisions (port related complications, pain, cosmesis and recovery time.^[7-9] However, this technique is associated with challenges such as instrument collisions, ergonomic problems and poor visualization due to the use of single port.^[10-12]

The available literature provides inadequate and inconclusive evidence as to the best laparoscopic approach for the patients that need hysterectomy for benign indications.^[6,13] At this juncture, when gynecologic surgeons are pursuing additional training in certifications for daVinci multiport and single-site platforms, it becomes vital that surgeons that are expert in various approaches present their data to the gynecologic fraternity. In this study, we evaluated the perioperative outcomes associated with the 3 modalities available to the modern gynecologists and facilitate them to select the best approach for their patients, based on varied pathologies and patient characteristics.

MATERIALS AND METHODS

This is a retrospective analysis of all the patients that underwent hysterectomy via single-site daVinci platform (SS-Rob), multiport daVinci (MP-Rob) or via conventional LSC for benign indications by a single surgeon between January 2015 and June 2016. This study was conducted at our academic, community based hospital. This is a fellowship program affiliated with American Association of Gynecologic Laparoscopists. All the surgeries were performed by the director of minimally invasive gynecologic surgery (MIGS) fellowship program who has trained extensively with the pioneers of LSC in US and is proficient in all 3 modalities. All computerized data on these patients had been de-identified prior to the collection. The Institutional Review Board at University of Tennessee College of Medicine gave approval (project # 17-009) on January 30, 2018 and verified de-identification and patient privacy protection. Informed consents were not needed as this was a retrospective chart review.

A power analysis was performed to determine the minimum size of each group ($n = 35$) based on literature review.

Patient's age, body mass index (BMI), comorbidities (past surgical and medical history), indications for the surgery and intraoperative findings were recorded. Perioperative outcomes were assessed by comparing the estimated blood loss (EBL), operative time, intra-operative complications, immediate and delayed postoperative complications and length of hospital stay. Weight of uterus and pathology of uterus were also compiled. Analysis of data was performed using SPSS v24 (IBM Corp. Released 2016. IBM SPSS Statistics, Version 24.0. Armonk, NY, USA).

Patient factors and perioperative outcomes were compared using descriptive and non-parametric statistics as appropriate. Independent samples Kruskal–Wallis analyses were used to compare continuous outcome variables while Chi-square analyses were used to compare dichotomous/categorical outcome variables. A Kruskal–Wallis H test was conducted to determine if there were differences in age, BMI, length of stay (LOS and EBL between the three surgical groups. Chi-square analyses were conducted to determine whether there were differences between the three surgery groups relative to various patient characteristics. Pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. Statistical significance was accepted at the $P < 0.0167$ level. This *post hoc* analysis was used to note statistically significant differences in age between the 3 groups.

All patients undergo perioperative care utilizing enhanced recovery after surgery guidelines. All patients are offered 23-hour observation status for various reasons including late finish in the day, uncontrolled pain, nausea, inability to void or out of city residence.

RESULTS

A total of 129 patients were identified and divided into 3 groups based on the surgical approach utilized; LSC ($n = 44$), MP-Rob ($n = 36$) and SS-Rob ($n = 49$).

Age and body mass index

Distributions of age and BMI were similar for all three groups, as assessed by visual inspection of a boxplot. Median age increased from LSC (39.5 years), to SS-Rob (41 years), to MP-Rob (46 years) which was significantly different between surgical groups, $\chi^2 (2) = 9.411$, $P = 0.009$. Median BMI increased from SS-Rob (26.8 kg/m²), to LSC (27 kg/m²), to MP-Rob (33.7 kg/m²) which was also significantly different, $\chi^2 (2) = 18.932$, $P = 0.001$.

Statistically significant differences were noted in age between LSC ($Mdn = 39.5$ years) and MP-Rob ($Mdn = 46$ years) ($P = 0.009$), but not between LSC and SS-Rob ($Mdn = 41$ years) or between SS-Rob and MP-Rob. Similarly, statistically significant difference

was noted in BMI between LSC ($Mdn = 27 \text{ kg/m}^2$) and MP-Rob ($Mdn = 33.7 \text{ kg/m}^2$) ($P = 0.000$) and between SS-Rob ($Mdn = 26.8 \text{ kg/m}^2$) and MP-Rob ($P = 0.001$), but not between LSC and SS-Rob [Table 1].

Uterus weight and operative time

Distributions of uterus weight and operative time were not similar as assessed by visual inspection of a boxplot. Median uterus weight increased from LSC (102 g), to SS-Rob (105 g), to MP-Rob (144 g), noted to be statistically significant between surgical groups, $\chi^2 (2) = 10.954$, $P = 0.004$. Median operative time increased from SS-Rob (150 min), to MP-Rob (163 min), to LSC (192 min) which was statistically significantly different between surgical groups, $\chi^2 (2) = 10.184$, $P = 0.006$. Furthermore, statistically significant differences recorded in uterus weight between LSC ($Mdn = 102 \text{ g}$) and MP-Rob ($Mdn = 144 \text{ g}$) ($P = 0.008$) and between SS-Rob ($Mdn = 105 \text{ g}$) and MP-Rob ($P = 0.012$), but not between LSC and SS-Rob. Statistically significant difference noted in operative time between LSC ($Mdn = 192 \text{ min}$) and SS-Rob ($Mdn = 150 \text{ min}$) ($P = 0.007$), but not between LSC and MP-Rob ($Mdn = 163 \text{ min}$) or between SS-Rob and MP-Rob [Table 1].

Length of stay and estimated blood loss

LOS and EBL noted for the three surgical groups were: SS-Rob ($n = 49$), MP-Rob ($n = 36$), and LSC ($n = 44$). Distributions of LOS and EBL were similar for all groups, as assessed by visual inspection of a boxplot. Median LOS increased from LSC (16.4 h), to SS-Rob (17.1 h), to MP-Rob (20.6 h), but the differences were not statistically significantly, $\chi^2 (2) = 2.489$, $P = 0.288$. Median EBL was the same across all three surgical groups (50 mls) and was subsequently not statistically significantly different, $\chi^2 (2) = 2.696$, $P = 0.260$ [Table 1].

Past surgical and past medical history

Past surgical history of any major abdominal surgery or cesarean section was not significantly different in any group. Similarly, history of diabetes, hypertension and migraines were not significant, whereas history of depression or anxiety was

recorded as less common in SS-Rob (14.3%) as compared to other two groups (MP-Rob 38.9%, LSC 36.4%).

In the LSC surgery group, 22 patients (50.0%) had a history of endometriosis compared to 17 patients (34.7%) in the SS-Rob surgery group and 7 patients (19.4%) in the MP-Rob surgery group; a statistically significant difference in proportions, $\chi^2 (2) = 8.089$, $P = 0.018$. In the SS-Rob surgery group, 32 patients (65.3%) experienced clinical endometriosis compared to 26 patients (59.1%) in the LSC surgery group and 13 patients (36.1%) in the MP-Rob surgery group; a statistically significant difference in proportions, $\chi^2 (2) = 7.591$, $P = 0.022$. In the MP-Rob surgery group, 24 patients (68.6%) experienced leiomyomas compared to 19 patients (38.8%) in the SS-Rob surgery group and 16 patients (36.4%) in the LSC surgery group; a statistically significant difference in proportions, $\chi^2 (2) = 9.850$, $P = 0.007$ [Table 2].

Complications (intraoperative, immediate and delayed)

While analyzing the intraoperative and immediate postoperative complications, number of patients experiencing any complication was low, creating unequal numbers of patients in each surgery type who experienced complications compared to those who did not experience complications. With regards to intraoperative complications, 3 patients (8.3%) experienced a complication in the MP-Rob surgery group compared to 2 patients (4.0%) in the SS-Rob surgery group and 1 patient (2.3%) in the LSC surgery group, a nonstatistically significant difference in proportions, as assessed by Fisher's exact test, $P = 0.319$. Two intra-operative complications noted in SS-Rob group: cystotomy and thermal damage to rectal serosa were both as a result of excision of deep infiltrative fibrotic endometriosis from these areas.

For immediate postoperative complications, 2 patients (4.1%) experienced a complication in the SS-Rob surgery group compared to 1 patient (2.3%) in the LSC surgery group and 0 patients (0.0%) in the MP-Rob surgery group, a non-statistically significant difference in proportions, as assessed by Fisher's exact test, $P = 0.778$ [Table 2].

There were more delayed complications noted in SS-Rob group (6/49), although these could not be analyzed in comparison with MP-Rob and LSC group due to very small size of complications across all surgery types. However, these maybe relevant to the surgeon when studying the clinical significance of each individual complication.

DISCUSSION

We compared the three key approaches utilized by the gynecologic surgeons when performing hysterectomy for benign conditions: Conventional LSC, Robotic multiport and Robotic single site. We sought to assess the perioperative

Table 1: Medians for continuous variables for three surgical groups

	SS-Rob ($n=49$), n (%)	MP-Rob ($n=36$), n (%)	LSC ($n=44$), n (%)	P
Age	41	46	39.5	0.009
BMI	26.8	33.7	27	0.001
Uterus weight (g)	105	144	102	0.004
Operative time (min)	150	163	192	0.288
Length of stay (h)	17.1	20.6	16.4	0.006
Estimated blood loss (ml)	50	50	50	0.260

Kruskal-Wallis H test results. SS-Rob: Single-site daVinci,

MP-Rob: Multiport daVinci, LSC: Laparoscopy, BMI: Body mass index

Table 2: Differences between the three groups relative to patient characteristics

	SS-Rob		MP-Rob		LSC		P
	No, n (%)	Yes, n (%)	No, n (%)	Yes, n (%)	No, n (%)	Yes, n (%)	
History of endometriosis	32 (65.3)	17 (34.7)	29 (80.6)	7 (19.4)	22 (50.0)	22 (50.0)	0.018
Leiomyomas	30 (61.2)	19 (38.8)	11 (31.4)	24 (68.6)	28 (63.6)	16 (36.4)	0.007
Clinical endometriosis	17 (34.7)	32 (65.3)	23 (63.9)	13 (36.1)	18 (40.9)	26 (59.1)	0.022
Intraoperative complications	48 (98.0)	1 (2.0)	33 (91.7)	3 (8.3)	43 (97.7)	1 (2.3)	0.319
Immediate postoperative complications	47 (95.9)	2 (4.1)	36 (100.00)	0 (0.0)	43 (97.7)	1 (2.3)	0.778

SS-Rob: Single-site daVinci, MP-Rob: Multiport daVinci, LSC: Laparoscopy

outcomes between these methods and provide some objective criteria to enable an experienced surgeon while deciding the surgical approach. All of the surgeries in this study were performed by an advanced gynecologic surgeon who is an endometriosis expert and fellowship trained in MIGS.

In our study, we noted that younger patients and lower BMI patients were likely to undergo a LSC or SS-Rob surgery. Corrado *et al.* conducted a case-control study, comparing perioperative outcomes and costs of SS-Rob ($n = 23$) and MP-Rob ($n = 46$) approaches in early stage endometrial cancer patients and reported no significant difference in terms of age.^[13] Similarly, Lopez *et al.* who compared SS-Rob ($n = 50$) with laparoendoscopic single-site surgeries (LESS) ($n = 50$) also recorded similar mean age in both groups.^[14] They noted lower BMI in robotic group.^[14]

The most common indications for hysterectomy in our study were AUB, pelvic pain and endometriosis. Those with AUB or fibroid uterus underwent MP-rob surgery and were noted to have larger size uteri and leiomyoma on final pathology. Similarly, patients with history of endometriosis and clinical endometriosis underwent LSC or SS-Rob surgeries. SS-Rob platform was chosen for younger patient with stage 1–2 endometriosis, no prior surgeries and concern for cosmesis. LSC was also used more commonly for endometriosis excision due to availability of tactile sensation. However, if more disease (stage 3–4) based on examination, previous LSC, or endometriomas is suspected, then multiport surgery will add more value. SS-Rob platform has been deemed a safe and feasible technique in performing hysterectomy,^[9] while MP-Rob is being widely used to perform lymphadenectomies and radical hysterectomies in addition to benign hysterectomies.^[15]

Operative time was similar in MP-Rob and SS-Rob group whereas higher in LSC patients. Traditionally, robotic surgery is linked to increased operative due to the associated docking and undocking of the robot. We use same team for all Robotic gynecologic cases that are extremely proficient in docking and undocking without adding to the operative time. Robot will otherwise decrease the operative time by allowing faster dissection. Furthermore, our surgeon prefers to use

conventional LSC for endometriosis cases which consists of peritoneal stripping and consumes more time than simple hysterectomy. Corrado *et al.* also reported similar operative times when comparing MP-Rob and SS-Rob groups.^[13] However, they noted decreased EBL, decreased LOS and increase in immediate post-operative complications with SS-Rob surgeries.^[13] Bogliolo *et al.* also reported decreased EBL and LOS in SS-Rob cases but comparable complication rates.^[16] El Hachem *et al.* compared clinical outcomes of LSC and SS-Rob groups and reported longer operative time with SS-Rob cases, whereas no significant difference in EBL, LOS and complication rates.^[17] Our study demonstrated comparable EBL, LOS, intraoperative, and immediate postoperative complications among all 3 approaches.

In our study, we noted more delayed complications in SS-Rob group (6/49), 3 of these patients had port site infections, 1 patient had a pelvic hematoma requiring evacuation, 1 developed cuff dehiscence and 1 developed umbilical hernia requiring surgery. These results were not statistically significant, although they maybe clinically relevant to gynecologic surgeon. The complications could be due to the larger incision required for single-site port (port site infections, umbilical hernia). These can also be attributed to difficult nature of single-site surgery. However, safety and feasibility of single-site daVinci platform has been studied and established widely in gynecologic surgery.^[4,9,12,18-21]

The major limitation of our study is its retrospective nature. As a result, it is dependent on the quality of information contained in the medical records. We did not perform a cost analysis between the three modalities. Two of the studies reported significant cost difference in favor of SS-Rob surgeries, when comparing single-site and multiport platform approach.^[13,16] The cost analysis performed by El Hachem *et al.* between LSC and SS-Rob groups resulted in favor of LSC surgeries.^[17] We did not perform any LESS surgeries. However, many authors have compared outcomes between SS-Rob approach with LESS surgery.^[5,9,14] Paek *et al.* reported less EBL and postoperative complications with SS-Rob group,^[9] while Lopez *et al.* noted decreased LOS and no difference in EBL between 2 groups.^[14] All studies showed

increased operative time in SS-Rob group compared to LESS.^[5,9,14] Our study noted longer operative time with LSC cases, compared to both daVinci groups. We did not have any conversion to laparotomies in any of the groups and no conversions from single-site to multiport daVinci platform.

CONCLUSION

Our data demonstrates that younger and lower BMI patients with history of endometriosis or clinical endometriosis can benefit with conventional LSC or daVinci single-site platform. Older and higher BMI patients, or those with AUB, suspected fibroid uterus can benefit with a multiport daVinci assisted approach and achieve satisfactory clinical outcomes. This approach of objective selection of patients while deciding the appropriate surgical modality can yield suitable perioperative outcomes.

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Conflicts of interest

There are no conflicts of interest.

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