

# Robotic Versus Abdominal Hysterectomy for Very Large Uteri

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## ABSTRACT

**Background and Objectives:** We sought to examine the outcomes of patients with myomatous uteri weighing >1000 g who underwent hysterectomy by one of two modalities, either with a robotic system or by laparotomy.

**Methods:** All patients who underwent robotic hysterectomy for uteri weighing >1000 g at our institution between May 2007 and January 2011 were identified, and a retrospective chart review was performed. These patients were matched to a laparotomy control group by body mass index and uterine weight, and the postoperative outcomes in both groups were analyzed and compared.

**Results:** Sixty patients with uteri weighing >1000 g underwent hysterectomy, 30 with the robotic system and 30 by laparotomy. The median body mass index was 31.8 kg/m<sup>2</sup> (range, 18.5–56.3 kg/m<sup>2</sup>) and the median uterine weight was 1259 g (range, 1000–3543 g) in the robotic group versus 30.2 kg/m<sup>2</sup> (range, 18–48 kg/m<sup>2</sup>) and 1509 g (range, 1000–3570 g), respectively, in the laparotomy group ( $P = .31$ ). The median operating time was 255 minutes (range, 180–372 minutes) in the robotic group versus 150 minutes (range, 100–285 minutes) in the laparotomy group ( $P < .001$ ). There were no conversions to laparotomy. In both groups the operative time was not increased with increasing specimen weight. The median blood loss was 150 mL in the robotic group versus 425 mL

in the laparotomy group. Of 30 patients in the robotic group, 23 (76.6%) were discharged from the hospital on postoperative day 1. The median hospital stay for the robotic group was 1 day, and for the laparotomy group, it was 2.5 days ( $P < .01$ ).

**Conclusion:** Robotic surgeries for very large myomatous uteri are feasible and have minimal morbidity even in morbidly obese patients. The robotic surgery requires a longer operative time but results in a shorter hospital stay and decreased intraoperative blood loss.

**Key Words:** Robotic Hysterectomy, Fibroids, Leiomyomata, Large Uterus

## INTRODUCTION

Uterine leiomyomata are common benign tumors in women of reproductive age. They can reach significant sizes and cause debilitating symptoms such as menometrorrhagia, dysmenorrhea, pelvic pain, dyspareunia, or urinary and intestinal symptoms.

Hysterectomy is the definitive treatment for leiomyomata, and in the United States leiomyoma represents the leading indication for this operation.<sup>1</sup> Published studies recognize laparoscopy as a surgical approach with better outcomes when compared with laparotomy.<sup>2–5</sup> However, the ability to perform a laparoscopic hysterectomy decreases as the uterine size increases. Traditionally, a uterus greater than 12 weeks' size has been considered an indication for laparotomy over laparoscopy.<sup>6</sup> Other deterrents for a laparoscopic approach are a history of abdominal or pelvic surgeries and morbid obesity.

This study was conducted to summarize our experience with robotic hysterectomy when the operative indication was a very large symptomatic myomatous uterus. The aims of this study were (1) to investigate the operative outcomes in patients who underwent robotic hysterectomy for uteri weighing >1000 g, (2) to investigate whether obesity and morbid obesity impact the surgery or postoperative course, and (3) to evaluate whether differences in outcomes exist between patients in the

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robotic group and matched controls operated on by laparotomy.

## MATERIALS AND METHODS

The institutional review board approved this retrospective study. Inclusion criteria for the robotic cohort were uteri weighing >1000 g, no evidence of malignancy in the surgical specimen, and a minimum follow-up period of 12 months. All patients with very large myomatous uteri were scheduled for a robotic approach regardless of their body habitus or history of abdominopelvic surgeries.

We performed a case log search from the commencement of the robotic program at our institution in September 2006 to January 2011. Before the introduction of the robotic system, our laparoscopic experience with uteri weighing >1000 g was very small.

This series was compared with patients who were operated on by laparotomy matched, in decreasing order of importance, by specimen weight, body mass index (BMI), and age. The abdominal procedures were performed by non-robotically trained surgeons in the same hospital setting. All cases in both groups involved a resident or fellow as a first assistant.

The preoperative data collected included age, BMI, and a history of abdominopelvic surgeries. Intraoperative data recorded were the type of procedure, estimated blood loss, time spent to complete the procedure, and weight of the surgical specimen. Operating times were counted from skin incision to skin closure, including cystoscopy. The type of anesthesia used was general endotracheal for all patients. There were no special preoperative evaluations for patients with BMI >35 kg/m<sup>2</sup>. For the patients in the robotic group, in addition to standard monitoring, the intraocular pressure was also monitored, first at baseline with patients in the horizontal position and then every 30 minutes while in the Trendelenburg position. If the pressure exceeded 40 mm Hg, a solution of timolol and dorzolamide was administered.

The postoperative outcomes analyzed were the duration of hospital stay and complications requiring readmission or reintervention. The discharge protocols for both groups were the same and included the following criteria: ambulatory, afebrile with stable vital signs; pain controlled with oral medication; and ability to eat and drink. The patients were followed up for a minimum of 6 months postoperatively.

Statistical analysis was performed by use of online statistical software through the Virginia Commonwealth University. The Shapiro-Wilk test showed a non-Gaussian distribution in the data. Therefore the Mann-Whitney test was used for group comparisons. Differences were considered significant if the *P* value was < .05.

All robotic operations were performed with the 4-arm da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA), models S and Si, with a 5-port technique.

In 14 patients a Koh Colpotomizer System (CooperSurgical, Trumbull, CT, USA) in conjunction with a RUMI Uterine Manipulator (CooperSurgical) and a Colpo-Pneumo Occluder balloon (CooperSurgical) was inserted before port placement. In 16 patients a sponge stick wrapped with the Colpo-Pneumo Occluder balloon was inserted in the vagina. The camera port was placed high in the epigastrium. If the uterine fundus extended to the xiphoid, the initial port was placed in the left upper quadrant or left flank to achieve pneumoperitoneum and visualization. For this study, the sunrise port configuration was used in all patients. The assistant trocar was used for insufflation, and one of the robotic ports was used to attach a smoke evacuator. In obese and very obese patients, the width of the abdomen allows for a variety of port placement configurations. For example, we have achieved excellent arm and instrument maneuverability placing all instrument and assistant port(s) in a straight line with the camera port midline and in or above the umbilicus. In patients with previous scars from abdominoplasty, cholecystectomy, and so on, we have inserted the ports through the existing scars, if feasible.

In morbidly obese patients, with the table in the horizontal position, we place the initial port at a 60° angle, aiming cephalad, to compensate for the upward shift of the abdominal wall when moving to a steep Trendelenburg position. Under direct visualization, the instrument and assistant ports are inserted perpendicular to the fascia after the Trendelenburg position is achieved.

In cases in which a very large pendulous pannus is present, we secure the pannus to the anterior thighs with a wide 3M Ioban 2 Antimicrobial Incise Drape (3M, St Paul, MN, USA) or with Medfix Montgomery Straps (Medline Industries, Mundelein, IL, USA). This stabilizes the pannus and prevents it from shifting cephalad when the patient is placed in the Trendelenburg position.

After complete devascularization and separation of the uterus, the large specimens were removed by two methods: (1) morcellation performed through the assistant's

port site or (2) piecemeal delivery of the uterus through the vagina.

Morcellation accounted for a considerable amount of time during the operation, but the times were not recorded or analyzed separately. The mechanized morcellator used was the Storz Rotocut G1 (Karl Storz Endoscopy-America, El Segundo, CA, USA). Our approach was to undock the robotic system during morcellation. Undocking provides a great range of motion for the operator and assistant and allows the return of the patient to a horizontal or minimal Trendelenburg position. Morcellation was performed by the resident or fellow with the attending as the assistant. When the specimen has abundant adenomyosis, it can be malleable enough to be brought with a tenaculum at the introitus and cut piecemeal with scissors and/or a scalpel while Breisky-Navratil vaginal retractors help with exposure. The “paper-roll” technique can also be used.<sup>7</sup>

Special consideration should be given to large infarcted myomata that are completely calcified and the morcellator is unable to cut through. Without undocking, traction and countertraction were applied by use of two robotic tenacula, and the uterus was cut with the monopolar scissors on high power (100 W). This approach generates large amounts of smoke. An easier alternative, not available for this study, is the use of the Endowrist Snap-t Scalpel (Intuitive Surgical, Sunnyvale, CA, USA). When the specimen reaches a size suitable for delivery, a tenaculum is inserted through the Colpo-Pneumo Occluder and grasps the specimen. We have experienced no difficulties in maintaining the pneumoperitoneum during specimen morcellation and removal.

The main laparoscopic instruments used were Hot Shears (Intuitive Surgical, Sunnyvale, CA, USA) (monopolar curved scissors) with a tip cover accessory and power setting of 50 W for arm 1, fenestrated bipolar forceps with a power setting of 50 W for arm 2, and Cadiere or Pro-Grasp (Intuitive Surgical, Sunnyvale, CA, USA) forceps for arm 3. Vascular pedicles were coagulated and transected by the scrubbed assistant with a LigaSure Atlas sealer/divider (Valleylab, Boulder, CO, USA).

**RESULTS**

The robotic group and laparotomy group each included 30 patients with uteri weighing >1000 g between May 2007 and January 2011. None of the patients in either group were treated with gonadotropin-releasing hormone agonists in the preoperative period. Eight of 30 patients in the robotic group (26.6%) and 5 of 30 laparotomy patients (16.6%) had a history of cesarean delivery and/or abdominal myomectomy.

The median age was 48 years (range, 39–65 years) for the patients in the robotic group and 45.5 years (range, 39–59 years) in the laparotomy patients. The median BMI was 31.8 kg/m<sup>2</sup> (range, 18.5–56.3 kg/m<sup>2</sup>) in the robotic group and 30.2 kg/m<sup>2</sup> (range, 18–48 kg/m<sup>2</sup>) in the laparotomy group. These differences were not statistically significant (**Table 1**).

In the robotic group, 17 of 30 patients (56.6%) were obese (BMI > 30 kg/m<sup>2</sup>) and 3 of 30 patients (10%) presented with malignant obesity (BMI > 50 kg/m<sup>2</sup>). In the laparot-

**Table 1.**  
Patient Characteristics and Surgical Outcomes

Patient Characteristics	Robotic Group (n = 30)	Laparotomy Group (n = 30)	P Value
Age [median (range)] (y)	48 (39–65)	45.5 (39–59)	.07
BMI [median (range)] (kg/m <sup>2</sup> )	31.8 (18.5–56.3)	30.2 (18–48)	.31
Operating time [median (range)] (min)	255 (180–372)	150 (100–285)	<.001
Estimated blood loss [median (range)] (mL)	150 (50–700)	425 (50–1000)	<.001
Uterine weight [median (range)] (g)	1259 (1000–3543)	1509 (1000–3570)	.26
Hospital stay [median (range)] (d)	1 (1–2)	2.5 (2–9)	<.001
Complications			
Transfusion	1	4	
Urinary	1	1	
Infection	0	0	
Hernia	0	1	

omy group, 16 of 30 patients (53.3%) were obese and 1 patient (3%) had malignant obesity.

In the robotic group, 26 patients underwent a total hysterectomy and 4 patients underwent a supracervical hysterectomy at their request. Fourteen of 30 patients (47%) had adnexectomy, and in 11 of 30 patients (37%), cystoscopy was performed at the end of the case. The cystoscopies were performed for teaching purposes.

All operations were completed laparoscopically with no conversions to laparotomy.

In the laparotomy group, no supracervical hysterectomies were recorded. Of 30 patients, 19 (63%) underwent adnexectomy, and no cystoscopies were performed.

The median uterine weight was 1259 g (range, 1000–3543 g) in the robotic group and 1509 g (range, 1000–3570 g) in the laparotomy group ( $P = .26$ ). The median operating time was 255 minutes (range, 180–372 minutes) in the robotic surgery group versus 150 minutes (range, 100–285 minutes) in the laparotomy group ( $P < .001$ ).

In both comparison groups, increasing uterine size did not proportionally influence the operative times. As shown in **Table 2**, operative times did not increase linearly when 500-g increments of the specimen weight were considered. Moreover, as shown in **Table 3**, we found no direct correlation between the patients' body habitus and duration of the procedure.

The median blood loss recorded was 150 mL (range, 50–700 mL) for robotic surgery versus 425 mL (range, 50–1000 mL) for open surgery ( $P < .001$ ). Blood loss >500 mL occurred in 2 of 30 patients in the robotic group (6.6%) and in 13 of 30 laparotomy patients (43.3%) ( $P < .001$ ).

In the robotic group, 23 of 30 patients (76.6%) were discharged from the hospital on postoperative day (POD)

1 and 7 of 30 patients (23.4%) on POD 2. The median length of hospital stay for the laparotomy patients was 2.5 days (range, 2–9 days) versus 1 day (range, 1–2 days) for the patients in the robotic group ( $P < .001$ ). In both groups no association was found between the weight of the surgical specimen or the length of surgery and the duration of hospitalization. In addition, in the laparotomy group, no correlation was found between BMI and length of hospital stay. In the robotic group, the patients with a BMI <25 kg/m<sup>2</sup> had longer hospitalizations than overweight and obese patients (1.5 days vs 1.1 days).

No incisional cellulitis was recorded for any of the 60 patients. In the laparotomy group, an incisional hernia developed in one patient.

In the robotic group, one patient was readmitted on POD 4 with abdominal pain and findings of a hydroureter. The ureter was elongated by the enlarged uterus and developed a hanging belly after hysterectomy. The initial conservative management consisted of placement of a double-J stent. Although no direct ureteral injury was identified, 1 year later, stenosis developed at the dissection site, and this was repaired by laparotomy and reimplantation.

In the laparotomy group a cystotomy was recognized and repaired intraoperatively. No readmissions or reinterventions were recorded in the laparotomy group.

## DISCUSSION

In this study we report the outcomes of patients who underwent hysterectomy for myomatous uteri weighing >1000 g by two modalities: with the robotic system or by laparotomy. We found that resection of very large uteri using the robotic system is a feasible alternative to laparotomy, regardless of the patients' body habitus. However, it is a more time-consuming approach, but it appears

**Table 2.**  
Specimen Weight and Operative Times

Uterine Weight (g)	Robotic Group (n)	Laparotomy Group (n)	Operative Time [Median (Range)] (min)	
			Robotic Group	Laparotomy Group
1000–1500	19	15	224 (180–360)	147.5 (120–285)
1501–2000	7	8	258 (230–372)	147 (100–180)
2001–2500	2	4	241 (197–285)	150 (110–202)
2501–3000	1	1	237	190
>3000	1	2	365 (365–365)	178.5 (160–197)

**Table 3.**  
Patient BMI and Operative Times

BMI (kg/m <sup>2</sup> )	Robotic Group (n)	Laparotomy Group (n)	Operative Time [Median (Range)] (min)	
			Robotic Group	Laparotomy Group
<25	8	7	237 (180–360)	135 (100–190)
25.1–30	5	8	240 (213–338)	145 (110–190)
30.1–35	7	5	212.5 (180–300)	186.5 (135–285)
35.1–40	5	7	285 (197–372)	148.5 (120–240)
40.1–45	2	2	274.5 (264–285)	214.5 (167–262)
45.1–50	0	1	NA	160
>50	3	0	330 (255–365)	NA = Not applicable

that there are benefits to the patients that may surpass the longer operative times and the higher costs associated with the amortization of the robotic system. Nawfal et al.<sup>8</sup> showed no association of BMI with blood loss, duration of surgery, length of stay, or complication rates for patients undergoing robotic hysterectomy despite operative times of up to 625 minutes.

Limiting factors when performing laparoscopic hysterectomy for large uteri include limited access to vascular pedicles, decreased uterine maneuverability, and increased risks for hemorrhage and bowel/urinary tract injuries. Longer operative times and difficulty with uterine extraction are other concerns.<sup>4,5</sup> Safety of the robotic procedures was also questioned. Liu et al.<sup>9</sup> published a Cochrane review of 35 patients who underwent robotic sacrocolpopexy and incomplete data from 40 patients who underwent robotic hysterectomy. They concluded that robotic surgery did not benefit women with benign gynecologic disease in terms of effectiveness or safety.

The American Association of Gynecologic Laparoscopists recommends that efforts should be focused to use robotic surgical systems as a means to minimize cases otherwise performed by laparotomy.<sup>10</sup>

Few studies have been published that address the laparoscopic management of uteri weighing >1000 g. To our knowledge, this is the first study that compares the outcomes of robotic versus abdominal hysterectomy for uteri weighing >1000 g and the largest series of robotic hysterectomy for uteri this size.

Wattiez et al.,<sup>4</sup> in a case-control study, described “very enlarged uteri” as those weighing >500 g. In their study 34 consecutive women underwent total laparoscopic hysterectomy, and the mean uterine weight was 617 g (±

177.8 g). Two intraoperative complications were recorded: one ureteral injury was repaired laparoscopically, and in one patient the estimated blood loss was >500 mL.

Fiaccavento et al.<sup>5</sup> published a retrospective study of 100 patients who underwent laparoscopic hysterectomy in which the mean weight of the specimen was 728 g (± 205 g). Two operations were completed by laparotomy.

Kivnick and Yera<sup>11</sup> presented their experience at the 2009 American Association of Gynecologic Laparoscopists conference and described 70 laparoscopic total or supracervical hysterectomies for uteri weighing >1000 g. The mean uterine weight was 1238 g. There were two conversions to laparotomy. Of 70 patients, 59 (84%) were discharged the same day. Alperin et al.<sup>12</sup> published their experience with laparoscopic total or supracervical hysterectomy for uteri weighing >500 g in 446 consecutive patients. They reported conversions to laparotomy in 3.4% of cases, and 92.8% of patients were discharged on POD 0.

Payne et al.<sup>13</sup> discussed the outcomes of robotic hysterectomy for large uteri. In this study 28 of 256 patients had uteri weighing >1000 g. Of these 28 patients, 3 required conversion to laparotomy, and no urinary tract injuries or transfusions were recorded. The authors’ results showed low blood loss and morbidity for women with large uteri undergoing robotic hysterectomy.

Kondo et al.<sup>14</sup> evaluated the feasibility of laparoscopic hysterectomy for uteri weighing >1000 g in 23 patients and reported a 17.4% conversion rate to laparotomy because of problems with initial pelvic access, technical difficulties during surgery, or intraoperative bleeding.



No consensus exists regarding what the cutoff should be for the laparoscopic approach. The most important limiting factor for laparoscopy in these cases is the bulk of the uterus that impairs visualization and access to the vascular pedicles. Known modifications to overcome these limiting factors include high epigastric port placement, the insertion of a uterine manipulator, the use of a 30° up/down Laparoscope, and/or extra port placement to assist with manipulation and exposure.<sup>15</sup> The key elements of improved visualization and precise dissection<sup>16</sup> are essential to maintain a hemostatic operative field because suction can be significantly impaired by the uterine bulk. The use of the 30° down laparoscope is helpful when one is developing the bladder flap and sometimes in visualizing the uterine vessels from above and lateral, depending on how much the uterine bulk obstructs the view. The 30° up Laparoscope aids in visualization when transecting the uterosacral ligaments and performing the posterior culdotomy.

A key factor to success is securing the uterine vessels. Although visualization from above is often difficult to achieve, the location of the 4 uterine pedicles is quite predictable and following the lateral uterine contour into the pelvis after dissection of the avascular space of Graves will always lead to the uterine vessels. For better visualization of the vessels, a 0° or 30° down camera may need to be rotated clockwise on the right and counterclockwise on the left. In the robotic cases with excessive blood loss, the sealing device was inadequate to achieve complete hemostasis for some of the uterine vessels when the diameter was in excess of the recommended 7 mm. In addition, the retroperitoneal tissues and the vessel walls can be quite edematous from impaired venous return, and although collagen denaturation occurs, tissue desiccation can be suboptimal after firing the sealing device. When the diameters exceed 10 mm for arteries or 12 to 15 mm for veins, we recommend dissection of the pedicle and sealing of the vessels individually.

If hemostasis is not complete, titanium clip application by the assistant while the operator holds and exposes the bleeding vessel can correct the problem. Despite the fact that placement of suture ligatures are facilitated by the robotic system, this is usually not possible because of the limited space.

If the uterus is too large (especially in the lower uterine segment) to access both uterine arteries from the same port with the sealing device, the placement of a sixth port in a convenient location can provide required access. In

morbidly obese patients this additional port can be used for a second bowel retractor to improve exposure.

We believe that the identification of the ureteral trajectory is imperative before applying an energy source to seal the uterine vessels. The uterine vessels are pushed laterally by the expanding lower uterine segment and are in closer proximity than usual to the ureters. In addition, the anatomy can be significantly distorted and the ureter(s) pushed cephalad by the uterus as it grows out of the pelvis. Sometimes it is easier to seal the uterine vessels at their origin from the anterior division of the hypogastric artery.

Some authors have advocated the practice of universal cystoscopy during major gynecologic cases to improve injury detection. The results of a systematic review suggest that higher injury detection rates are seen when intraoperative cystoscopy is used. It has also been suggested that intraoperative markers such as peristalsis and visualization of ureteral caliber may be unreliable to detect injury.<sup>17,18</sup>

The prophylactic placement of ureteral stents was used in select cases to facilitate intraoperative ureter identification. Lighted ureteral stents have also been used, especially in laparoscopy, in which the haptic feedback is lacking.<sup>19</sup> Results from one large randomized trial have not documented any difference in ureteral injury rates during major gynecologic surgery with the use of prophylactic stenting.<sup>20</sup>

In some cases the uterine size precludes the access of the dissecting instrument used by the dominant hand all the way to the contralateral side across the uterine bulk. Switching the instruments and operating with the non-dominant hand while grasping with the dominant hand can overcome this situation.

We recognize that this study has limitations, which include the retrospective design and the small number of patients. In addition, the times spent for extraction of the surgical specimen were not recorded separately. We also recognize the inherent bias generated by the fact that the robotic cases were performed by experienced laparoscopic surgeons.

Laparoscopic hysterectomy for very large uteri is a challenging procedure, and obesity and morbid obesity and/or previous surgeries compound the difficulty.<sup>21–24</sup> Despite the challenges, patients who are obese experience some of the greatest differential benefit from laparoscopy.<sup>25</sup> Morbid obesity or previous procedures appear not to be an impediment for completing these procedures by a minimally invasive approach. In this series the mean

additional 96 minutes spent on the procedure were offset by a 1.7-day shorter hospitalization and decreased intraoperative blood loss.

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