

Robot-Assisted Total Laparoscopic Hysterectomy in Different Classes of Obesity: A Cohort Study

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ABSTRACT

Background and Objectives: Robot-assisted laparoscopic hysterectomy is a safe and feasible approach in patients with higher body mass index (BMI). Slightly longer operating time in patients with high BMI did not result in higher complication or conversion rates. The purpose of this study was to evaluate whether robot-assisted total laparoscopic hysterectomy is a feasible and safe surgical approach in different classes of obesity.

Methods: A single center retrospective cohort study was performed in a large secondary teaching hospital in the Netherlands. All patients who underwent robot-assisted total laparoscopic hysterectomy between January 1, 2011 and January 31, 2019 were included.

Results: Data regarding patient characteristics, complication rate, conversion rate, skin-to-skin time, robot console time, and operating room time were collected. Surgery specific data were compared in patients with several classes of obesity. In total 356 cases were included. Median BMI was 29 kg/m² (range 18 – 59). Complication rate and conversion to laparotomy did not differ significantly in different classes of obesity. Robot console time and skin-to-skin time was significantly longer in women with a BMI \geq 40 kg/m² (n = 34) compared to patients with normal BMI.

Conclusion: Robot-assisted laparoscopic hysterectomy is a safe and feasible approach in women in different classes of obesity. The significantly prolonged operating time does not result in higher complication or conversion rates.

Key Words: Hysterectomy, Obesity, Robot-assisted laparoscopy.

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INTRODUCTION

Robot-assisted laparoscopy is increasingly adopted as an alternative strategy for conventional laparoscopic and open procedures after its approval for gynaecological procedures by the Food and Drugs Administration in 2005. Potential benefits include three-dimensional vision, reduction of the surgeons' tremors, lower amount of blood loss, and shorter length of hospital stay.¹ These benefits apply specifically to obese patients, hence robotic surgery is thought to be superior to conventional laparoscopy in this subgroup of patients.²⁻⁴

The prevalence of obesity has been increasing over the years. In 2018 32.5% of Dutch adults had a body mass index (BMI) of 25 kg/m² or higher.⁵ Obesity increases all-cause mortality, prevalence of hypertension, diabetes, heart disease, and perioperative complications.⁴ Furthermore, obesity increases the risk for gynaecological disorders that require surgery, such as endometrial hyperplasia, endometrial cancer, and pelvic organ prolapse.⁶

The purpose of this study was to evaluate feasibility and safety of robot-assisted total laparoscopic hysterectomy in different classes of obesity. We evaluated the perioperative surgical outcomes in a consecutive series of patients.

MATERIALS AND METHODS

A cohort study was conducted among patients undergoing robot-assisted total laparoscopic hysterectomy between January 1, 2011 and January 31, 2019. The study was performed in a large teaching hospital in The Netherlands.

Table 1.
Baseline Characteristics

Age, Median, Years (range)	58	(range 28–90)
Body Mass Index, median, kg/m ² (range)	29	(range 18–59)
Body Mass Index Groups, n (%)		
≤ 25 kg/m ²	72	(20.2%)
25–29,9 kg/m ²	117	(32.8%)
30–34,9 kg/m ²	85	(23.9%)
35–39,9 kg/m ²	48	(13.5%)
≥ 40 kg/m ²	34	(9.6%)
Malignant indication for surgery, n (%)	228	(63.3%)
History of abdominal surgery, n (%) <i>missing 2</i>	147	(41.1%)
Operating room time, (min), median (range)	173	(range 108 – 393)
Skin-to-skin time (min), median, (range) <i>Missing 1</i>	115	(range 59 – 302)
Robot console time (min), median (range) <i>Missing 71</i>	69	(range 22 – 240)
Blood loss (ml), median, (range) <i>Missing 7</i>	50	(range 0 – 3000)
Uterus weight, (grams), median (range) <i>Missing 22</i>	110	(range 25 – 1421)
Complications (intra- and postoperative) n (%)	48	(13.3%)
Conversion, n (%)	10	(2.8%)
Length of hospital stay (days), median (range) <i>Missing 1</i>	3	(range 2 – 25)

All patients undergoing robot-assisted total laparoscopic hysterectomy with or without bilateral salpingo-oophorectomy for benign and malignant indications were included.

Surgery-specific follow-up took place approximately six weeks after surgery. Additional follow-up visits were planned if complaints or complications arose. In case of malignancy, follow-up was planned according to the national guidelines. The institutional review board approved the present study.

Four gynaecological surgeons performed all procedures. Hysterectomy was performed with the Da Vinci Si™ system with bipolar and monopolar current (Intuitive Surgical Inc, Sunnyvale CA, USA).

One 10-mm port midline port above the umbilicus and two 8-mm and one 12-mm assistant ports were used. Closed and open introduction techniques were used according to the discretion of the surgeon. Gynaecologic surgeons performing robot-assisted laparoscopic hysterectomies were trained according to the guidelines off the Dutch Society of Gynaecological Endoscopic Surgery and completed robotic training provided by Intuitive Surgical.⁷

Demographic data including age, BMI, indication for surgery, and history of previous abdominal surgery were

recorded. Indication for surgery was classified into benign or malignant indications. Benign indications included uterine leiomyomas, abnormal uterine bleeding, and uterine prolapse. Amongst malignant indications were early-stage endometrial carcinoma or endometrial intraepithelial neoplasia (EIN). Incidentally a case of cervical micro-invasive carcinoma was included.

BMI was classified into five categories, based on the classification used by the World Health Organisation: normal weight: BMI < 25 kg/m²; pre-obesity: BMI 25–29 kg/m²; obesity class I: BMI 30 – 35 kg/m²; obesity class II: BMI 35–40 kg/m²; obesity class III: BMI > 40 kg/m².⁸ Surgery-specific data were collected, including operating room time: time from patient arrival in the operating theatre to departure; skin-to-skin time: total operating time between skin incision and closure of skin wounds; robot console time: total time the surgeon spent operating in the robot console.

Complications of surgery were recorded. The number of conversions to laparotomy and estimated blood loss were recorded. The blood loss was subdivided into four categories: less than 100 ml; 100–499 ml; 500–999 ml, and 1000 ml and more.

Complications were categorized as major or minor complications, based on the criteria used by Garry et al.⁹

Analysis was performed using the statistical software package SPSS for Windows (version 23, IBM/SPSS Statistics, Armonk, NY, USA). Multiple linear regression analysis was performed to analyse skin-to-skin time and robot console time, correcting for indication for surgery, estimated blood loss, age, and weight of the uterus. Cases with missing data on skin-to-skin, robot console time were excluded from separate analyses.

RESULTS

In total, 356 cases of robot-assisted total laparoscopic hysterectomies were included for analysis.

Baseline characteristics are shown in **Table 1**. Median BMI was 29 kg/m² (range 18–59). Twenty percent of the included patients had a normal BMI < 25.0 kg/m². Most hysterectomies were performed because of malignant indications. Median operating room time was 173 minutes (range 108–393 minutes; n = 355). Median skin-to-skin time was 116 minutes (range 59–302; n = 355), and median robot console time was 69 minutes (range 22–240 minutes; n = 289). Complications occurred in 48 cases, including six major complications: one dehiscence of the vaginal vault with prolapse of intestine, two cases of major post-operative hemorrhage requiring blood transfusions, one case of bladder injury, and one case in which the ureter was accidentally transected for which reimplantation was needed. One case of postoperative pulmonary embolism was recorded. Other complications included urinary tract infections, local wound infections, and vaginal vault hematomas. Reoperation was necessary in a case of vaginal top dehiscence with prolapse of intestine; another reoperation was needed to reimplant the ureter. Twelve patients were readmitted; mostly because postoperative infections or postoperative hemorrhage not requiring surgery. Cases were subdivided into categories based on classes of obesity; there was no significant difference between the groups in conversion rate and complication rate (**Table 2**). In patients with higher BMI a higher proportion of malignant indications for surgery was observed (*P* = .01) (**Table 2**).

Table 3 shows the results of the multiple linear regression analysis; the model includes age, BMI, estimated blood loss, uterine weight, and indication for surgery. In patients with obesity class III (BMI ≥ 40 kg/m²), skin-to-skin time is 29.9 minutes (95% confidence interval [CI] 15.2 – 44.5) longer compared with patients with a normal BMI (**Figure 1**,

Table 2.
Body Mass Index Categories, n = 356

	BMI < 25 kg/m ² n = 72, n (%)	BMI 25.0-29.9 kg/m ² , n = 117, n (%)	BMI 30.0-34.9 kg/m ² , n = 85, n (%)	BMI 35.0-39.9 kg/m ² , n = 48, n (%)	BMI ≥ 40.0 kg/m ² , n = 34, n (%)	Linear-by-linear association: asymptote Sign (2-sided) <i>p</i> = 0.01
Total n, (%)	43 (59.7%)	65 (55.6%)	56 (65.9%)	35 (72.9%)	26 (76.5%)	<i>p</i> = 0.59
Malignant indication	1 (1.4%)	2 (1.7%)	6 (7.1%)	0 (0.0%)	1 (2.9%)	<i>p</i> = 0.91
Conversion to laparotomy	8 (11.1%)	18 (15.4%)	12 (14.1%)	4 (8.3%)	5 (14.7%)	
Complications						
BMI, body mass index.						

Table 3.
Multiple Linear Regression, Dependent Variable Skin-to-skin Time, n = 328

	B (Minutes)	Standard Error	t	Sign	95% Confidence Interval
Intercept	91.7	12.92	7.09	< 0.001	66.24–117.10
Benign	0†	–	–	–	–
Malignant	0.78	5.63	0.14	0.89	–10.31–11.86
BMI ≤ 25.0 kg/m ²	0†	–	–	–	–
BMI 25.0 – 29.9 kg/m ²	3.70	5.27	0.70	0.48	–6.67–14.06
BMI 30.0 – 34.9 kg/m ²	8.70	5.71	1.52	0.13	–2.53–19.94
BMI 35.0 – 39.9 kg/m ²	7.50	6.59	1.14	0.26	–5.46–20.47
BMI ≥ 40.0 kg/m ²	29.88	7.45	4.01	< 0.001	15.22–44.54
Bloodloss ≤ 100 ml	0†	–	–	–	–
Bloodloss 100 – 500 ml	24.53	4.69	5.24	< 0.001	15.31–33.74
Bloodloss 500 – 1000 ml	68.30	14.60	4.68	< 0.001	39.57–97.02
Bloodloss ≥ 1000 ml	60.16	34.22	1.76	0.08	–7.15–127.50
Age (per year)	0.05	0.19	0.26	0.79	–0.32–0.42
Weight uterus (per 100 gram)	11.18	1.24	9.01	< 0.001	8.74–13.62

†Reference
BMI, body mass index.

Table 3). More blood loss is associated with a significantly longer skin-to-skin time, up to an additional 68 minutes (95% CI 39.6 – 97.0 minutes). Linear regression analysis of robot console time gives comparable results: more blood loss is associated with longer robot console time and only for patients with class III obesity (BMI ≥ 40 kg/m²) the console time is significantly prolonged compared to patients with a normal BMI: 20.5 minutes (95% CI 6.4 – 34.6) (**Table 4**).

Every additional 100 grams of uterus weight results in longer skin-to-skin time and robot console time. (Tables 3 and 4).

DISCUSSION

Results of this retrospective cohort study show that robot-assisted total laparoscopic hysterectomy is a feasible surgical procedure in various classes of obesity. Conversion and complication rates do not significantly change with increasing BMI.

In our cohort, only 20% of the patients had a normal body mass index (BMI < 25 kg/m²). Obesity is an increasing healthcare problem. A recent report of Statistics Netherlands (CBS) shows that in 2018, 47.2% of the Dutch female adult population had an BMI > 25 kg/m², with 16.9% having a BMI ≥ 30 kg/m².⁵

The large percentage of obese women in this cohort, compared to the regular population, may be explained by the fact this is a selected group of females. Considering that obesity increases risk for various gynaecological disorders for which hysterectomy is part of the standard treatment.

In our cohort, most surgical procedures were performed for malignant disease, predominantly early-stage endometrial carcinoma or endometrial intraepithelial neoplasia (EIN). The association between the incidence of endometrial cancer and increasing BMI has been well established.^{10,11} For

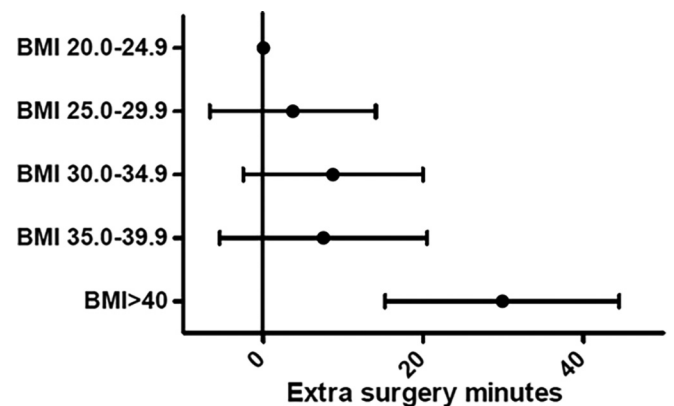


Figure 1. Skin-to-skin time and body mass index.

Table 4.
Multiple Linear Regression, Dependent Variable Robot Console Time, n = 289

	B (Minutes)	Standard Error	t	Sign	95% Confidence Interval
Intercept	59.74	12.76	4.68	< 0.001	34.63–84.85
Benign	0†	–	–	–	–
Malignant	-0.82	5.51	-0.15	0.88	-11.66–10.02
BMI ≤ 25.0 kg/m ²	0†	–	–	–	–
BMI 25.0–29.9 kg/m ²	-0.14	5.13	-0.03	0.98	-10.24–9.97
BMI 30.0–34.9 kg/m ²	4.37	5.76	0.76	0.45	-6.96–15.70
BMI 35.0–39.9 kg/m ²	-0.50	6.50	-0.08	0.94	-13.31–12.30
BMI ≥ 40.0 kg/m ²	20.48	7.17	2.86	0.01	6.37–34.59
Bloodloss ≤ 100 ml	0†	–	–	–	–
Bloodloss 100–500 ml	21.84	4.60	4.75	< 0.001	12.78–30.90
Bloodloss 500–1000 ml	45.53	15.79	2.88	0.004	14.45–76.61
Age (per year)	0.02	0.18	0.09	0.93	-0.34–0.37
Weight uterus (per 100 gram)	5.15	1.40	3.68	< 0.001	2.40–7.91

†Reference

BMI, body mass index.

endometrial carcinoma, total hysterectomy with bilateral salpingo-oophorectomy with or without lymph node sampling or lymphadenectomy is standard care. For this indication, robot- assisted laparoscopy has been shown to be superior to laparotomic approach.^{12,13} Robot-assisted laparoscopy shows comparable or slightly beneficial results in terms of shorter length of stay, less conversions, and possibly more lymph node retrieval compared to conventional laparoscopic approaches. Regarding blood loss and operating time there are conflicting results.^{2,3}

In our cohort, skin-to-skin operating time and robot console time were significantly longer in patients with a BMI ≥ 40 kg/m² compared with patients with normal weight, after correction for relevant covariates. Blood loss, weight of the uterus, indication for surgery, and age of the patient; considering these variables could influence operating time and anaesthetic challenges. Operating time was in line with previous reports on robot hysterectomies in endometrial carcinoma.^{2,3} It did not result in higher conversion or complication rates in this subgroup of patients. We hypothesise that because of poor visibility and a larger amount of intra-abdominal fat, surgery is more challenging with increasing BMI, causing it to take longer, without significant effect on intra- or postoperative complications.

Operating time was significantly longer when estimated blood loss was higher, possibly due to poorer visibility.

Other studies provide inconclusive evidence considering operating times in robotic surgery compared to conventional laparoscopic surgery.¹ A previous study by Cunningham et al. described longer operating room time, but no prolonged surgical time in patients with BMI > 40 kg/m² undergoing robotic surgery for endometrial carcinoma.¹⁴

A systematic review and meta-analysis comparing laparoscopic and robot- assisted hysterectomy in obese patients with endometrial cancer showed comparable conversion rates in patient with a BMI ≥ 30 kg/m². However, in patients with a BMI ≥ 40 kg/m² the proportion of conversions was lower in the robot laparoscopic surgery group (3.8% [95% CI 1.4–9.9]), compared to a conventional laparoscopic approach (7.0% [95% CI 3.2–14.2]). Poor visibility was most frequently named as reason for conversion. However, intolerance of Trendelenburg position was the reason for conversion in 31% of laparoscopic conversions and only in 6% of the robotic conversions. This suggests that robot-assisted approaches for patients with class III obesity may be superior considering the amount of Trendelenburg required.¹⁵ The results of the study by Cosin et al. on the other hand showed increasing conversion rates with increasing BMI, though 93% of the patients could still undergo hysterectomy through a minimally invasive approach.¹⁶

The overall complication rate in our cohort was 13.3%, including major and minor intra- and postoperative complications, this is in line with previous reports.^{3,16} There

was no difference in complication rate with increasing BMI. Conversion rate in our cohort was relatively low and did not significantly change with increasing BMI. This is in line with previous literature.^{4,14,15}

Considering large uteri, Ito et al. published a single center cohort experience with uteri >1kg and concluded that minimally invasive surgery for removal of those uteri was feasible through conventional and robot-assisted laparoscopy.¹⁷ Their results were compared to those of Uccella et al., who compared laparoscopic hysterectomies to abdominal and vaginal hysterectomies in large size uteri. It was deduced that with greater uterine size operative times would be longer.^{17,18}

Our data show that skin-to-skin operating times and robot console time increase with increasing uterus weights, when corrected for blood loss, BMI, age, and indication for surgery. This is probably due to morcellation in benign indications and increasing difficulty extracting the large uteri.

For malignant indications the superiority of robot-assisted laparoscopic surgery in both obese and nonobese patients is established in multiple publications.^{2,4,19,20} For benign disease, the beneficial effect and cost-effectiveness of robotic surgery has not yet been established and literature is heterogenic. In different systematic reviews and meta-analyses, no difference in complication rate or conversion rates was found. Some studies report a lower estimated blood loss and shorter length of stay for robotic surgery, but this is not deemed clinically relevant.^{21–23} Future research with data collected by experienced surgeons after their initial learning curve (usually after approximately 50 cases^{24,25}), may show beneficial results favouring robotic laparoscopic surgery for both benign and malignant indications.

CONCLUSIONS

The analysis of this cohort of robot-assisted total laparoscopic hysterectomies for benign and malignant indications showed that complication and conversion rates did not significantly change with increasing BMI. In patients with BMI $\geq 40.0 \text{ kg/m}^2$ skin-to-skin and robot console time were significantly longer compared to patients with a normal BMI, which may be caused by poorer intra-abdominal visibility and more difficult removal of the specimen.

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