

Hysterectomies for benign disease: variability in techniques and outcomes depending on patients, surgeons, and type of hospital

Victoria Sánchez Sánchez¹, Emergui Zrihen Yonit¹, Daniel González García-Cano¹, Lidia González Marrero², Margarita Arozena Abad³, Maria Isabel Arduan Pérez⁴, González Martín Jesus⁵, Acosta Ainara Amaro¹, Jose Angel García Hernández^{1,6}, Alicia Martín Martínez^{1,6}

¹ Department of Obstetrics and Gynecology. Complejo Hospitalario Universitario Insular Materno Infantil de Las Palmas de Gran Canaria. Universidad de Las Palmas de Gran Canaria; ² Department of Obstetrics and Gynecology. Hospital Clínico Universitario de Tenerife. Universidad de La Laguna; ³ Department of Obstetrics and Gynecology. Hospital Universitario Nuestra Señora de la Candelaria. Tenerife. Universidad de La Laguna; ⁴ Department of Obstetrics and Gynecology. Hospital José Molina Orosa. Lanzarote; ⁵ Research Unit. Hospital Universitario de Gran Canaria Dr. Negrín. Universidad de Las Palmas de Gran Canaria; ⁶ Universidad de Las Palmas de Gran Canaria.

ABSTRACT

Most hysterectomies are performed for benign conditions, such as fibroids, endometriosis, abnormal menstrual bleeding, and uterine prolapse. Established approaches are laparotomy and minimally invasive approaches by the vaginal and laparoscopic routes, with or without robotics.

We conducted a study, in our region, of the approaches most commonly used in benign hysterectomies, and examined patient outcomes according to the characteristics of surgeons and hospitals.

We performed a prospective multicenter study involving patients ($n = 506$) who underwent a hysterectomy for benign disease by any approach between February 2019 and February 2020. Overall, 55.3% of procedures were performed by laparotomy, 32.4% vaginally, and 12.2% laparoscopically. Surgeons with the highest surgical volumes performed more minimally invasive surgery (MIS) ($p < .001$), and those with more experience performed more laparoscopic interventions ($p = .002$). Laparotomies were performed more frequently in small hospitals (<500 beds) ($p = .026$). MIS was performed more often in teaching hospitals than in centers without this accreditation ($p = .001$). Sixty-nine (13.6%) patients experienced surgical complications; the laparoscopic approach was associated with a higher incidence of complications overall (24.2%) and with more readmissions ($p < .005$).

Our results confirm that the surgical approach for benign hysterectomies varies depending on the type of hospital and the characteristics of the surgeons.

KEYWORDS

Hysterectomy, gynecological surgery.

Introduction

Most hysterectomies are performed for benign conditions, such as fibroids, endometriosis, abnormal menstrual bleeding, and uterine prolapse^[1]. Established approaches are laparotomy and minimally invasive approaches by the vaginal and laparoscopic routes, with or without robotics. In the 1980s and 1990s, more than 70% of hysterectomies were carried out by laparotomy^[2]. In the last 20 years, numerous studies have been published demonstrating the benefits of less invasive approaches^[3]; as a result, the use of laparotomy has fallen by more than 30% in Western countries^[4].

Each approach has an impact on the patient and on their return to daily activity, and affects the risk of intraoperative injury^[5]. According to several studies, the recovery of patients after hysterectomy for benign disease, performed by minimally invasive approaches, is faster than after laparotomy^[6].

Laparotomy has also been associated with an increased risk of surgical wound infections, venous thromboembolism, and

Article history

Received 26 Jun 2021 - Accepted 9 Aug 2021

Contact

Yonit Emergui Zrihen; yonittata@hotmail.com
Servicio de Obstetricia y Ginecología. Complejo Hospitalario Universitario Insular Materno Infantil de Las Palmas de Gran Canaria, Avenida Marítima del Sur s/n, 35016. Phone number: 679856832

prolonged hospital stay in patients with endometrial carcinoma^[7]. However, the implementation of less invasive approaches varies widely among different countries and healthcare centers, depending on factors such as patient characteristics, surgeons' skill level, and hospital characteristics^[8].

In this setting, we conducted a study in our region of the approaches most commonly used in benign hysterectomies, and of patient outcomes according to the characteristics of surgeons and hospitals.

Materials and methods

This was a prospective observational study performed in 4 participating centers affiliated with the Spanish public health system in the Autonomous Community of the Canary Islands: Complejo Hospitalario Universitario Insular Materno Infantil de Las Palmas, Gran Canaria; Hospital Universitario Nuestra Señora de La Candelaria, Tenerife; Hospital Clínico Universitario, Tenerife; and Hospital José Molina Orosa, Lanzarote.

Participating hospitals were classified according to the number of beds as: large (>800 beds); medium-size (500-800 beds); and small (<500 beds); they were also classified according to the average number of hysterectomies performed annually for benign conditions: hospitals performing >250 hysterectomies per year; hospitals performing >100 and <150 hysterectomies per year; and hospitals performing <100 hysterectomies per year. We also took into account whether or not the hospital had an accredited teaching program for medical residents.

During the study period, from February 2019 to February 2020, all patients who attended the different hospitals for scheduled hysterectomy for benign disease by any approach on an outpatient or in-hospital basis were invited to participate in the study, and those who agreed signed an informed consent document. In this period, 390 hysterectomies were performed in a large hospital (>800 beds), of which 349 (90.4%) were included in this study; 127 hysterectomies were performed in a medium-size hospital (500-800 beds), of which 95 (74.80%) were included in the study; 62 hysterectomies were performed in a hospital with <500 beds, and all were included in the study.

Medical indications for hysterectomies included fibroids, endometriosis, uterine prolapse, and other benign conditions, this latter category mainly including patients undergoing sex change procedures and patients with abnormal menstrual bleeding.

Data from the study patients' records were collected individually from the electronic medical records at each facility. Variables related to patients' epidemiological characteristics were collected: age; body mass index (BMI); American Society of Anesthesiologists (ASA) classification (an index that defines the patient's health status and is used to estimate the risk posed by anesthesia in the surgical procedure – a high ASA index is associated with an increased risk of surgical complications); history of previous abdominal surgery; current surgical indication; type of procedure performed (simple hysterectomy, hysterectomy with uni- or bilateral adnexectomy, hysterectomy with salpingectomy, subtotal hysterectomy); and surgical approach (laparotomy, vaginal, laparoscopy, laparoscopy-assisted vaginal route). Robotic surgery is not performed for benign conditions in any of the participating hospitals.

Minimally invasive surgery (MIS) was defined as a procedure performed by the vaginal route, by laparoscopy, or by the laparoscopy-assisted vaginal route.

For each case, characteristics of the healthcare center and of the principal surgeon were recorded. Specifically, it was recorded whether or not the healthcare center had a resident teaching program, while the following principal surgeon details were recorded: gender, resident physician or not, years of experience, and number of hysterectomies performed in the previous year.

According to the number of hysterectomies performed in the year prior to the study, surgeons were classified as: surgeons with high surgical volume, if they had performed more than 20 hysterectomies; medium-volume surgeons (10-20 hysterectomies); low-volume surgeons (less than 10 hysterectomies), or residents.

The latter two subgroups (low-volume surgeons and residents) were pooled for the purposes of data analysis. Gynecologists were also classified into the following subgroups based on their years of experience in the profession: highly experienced gynecologists (20 or more years of experience); medium experience (10-19 years); low experience (less than 10 years of experience); and residents. The less experienced surgeons and residents were pooled for the purposes of data analysis.

Complications were analyzed using the classification used by Dicker *et al.*^[9] and recommended by The Collaborative Review of Sterilization Project (CREST); we built our database based on this classification years ago, and felt that it categorized complications clearly and in detail. Accordingly, complications were classified as:

1. Infection: surgical wound infection, cellulitis or abscess in the vaginal dome, pelvic abscess, and infections in a site other than the surgical site (urinary tract infection, pneumonia, sepsis, others).
2. Bleeding requiring transfusion (intraoperative or postoperative).
3. Major complications: lesions in the intestine, bladder, or ureter that required intraoperative surgical repair (including conversion to laparotomy to complete a vaginal hysterectomy, bladder injury repair, ureter injury repair, vascular injury repair), or postoperative events (re-intervention within 30 days of the original operation for control of bleeding or hematoma drainage; other re-interventions, such as correction of evisceration, pelvic abscess drainage, or wall dehiscence repair).
4. Life-threatening adverse events: pulmonary thromboembolism, acute myocardial infarction, acute pulmonary edema, anaphylactic reaction, disseminated intravascular coagulation.
5. Readmission: unscheduled admission within 30 days of discharge for the treatment of a complication related to the previous surgery.
6. Death: death or a complication that caused death during the surgical procedure or within 42 days.
7. Minor or uncategorized complications: urinary retention, paralytic ileus, nerve injury, deep vein thrombosis, thrombophlebitis.

Mean stay was defined as the average number of days that the patient remained in hospital. The study was approved by the Research Ethics Committee of the province of Las Palmas de Gran Canaria with reference code: 1.007/2018-065-1.

Statistical analysis

Mean, standard deviation, median, and 25th and 75th percentiles were calculated for the quantitative variables. The Kolmogorov-Smirnov test (if the sample size was greater than 50) or Shapiro-Wilk test (if the sample size was equal to or less than 50) were used to check the normality of the data. Frequency and percentage were calculated for qualitative variables, using the Fisher test to compare nominal qualitative variables and the

linear trend test to compare ordinales variables with dichotomous variables.

The Kruskal-Wallis test was used to compare a numerical variable between several groups. Two-by-two comparisons were made with the Bonferroni correction, and dichotomous variables were predicted by logistic regression. A p-value of less than .05 was considered significant. Statistical analyses were performed using R Core Team 2020, version 4.0.0.

Results

The study population consisted of 506 patients who underwent hysterectomy for benign disease at one of the participating centers during the study period. Baseline patient characteristics are shown in Table 1.

Patients who underwent vaginal hysterectomy were older (63.93 years \pm 11.35) than those who underwent laparotomy (46.52 years \pm 5.25) and laparoscopy (42.8 years \pm 12.8) ($p < .001$).

The most common indication for hysterectomy was myomatous uterus. The most common approach was laparotomy (55% of patients), while 45% of patients underwent MIS. Only 5 laparoscopic-assisted vaginal procedures were performed, and these were pooled with the laparoscopic surgeries for the analysis of the results. The most frequent intervention was simple hysterectomy (55.1% of cases).

A total of 70 surgeons participated in the study, each performing at least 1 hysterectomy during the study period. The surgeries were mainly performed by female gynecologists (57.3% of cases), and more than 60% of hysterectomies were performed by medium- and high-volume gynecologists with more than 10 years of experience. By contrast, surgeons with a lower surgical volume performed more laparotomies than the more experienced ones. A third of the procedures were performed by surgeons with less than 10 years of experience, while residents participated as principal surgeon in less than 20% of the interventions (Table 1).

In terms of hospital characteristics and surgical approach, we found that laparotomies were more frequently performed in small hospitals (<500 beds) ($p = .026$) (Table 1).

More than 85% of hysterectomies were performed in teaching hospitals, and more MIS procedures were performed in centers of this type than in centers without this accreditation ($p = .001$) (Table 2).

When the indication (disease) and approach were compared, one approach was seen to prevail over the others ($p < .001$): laparotomy was the approach used for 87.4% ($n=270$) of cases with myomatous uterus as the indication; the vaginal route was most often selected for uterine prolapse (96.8%, $n=150$), and laparoscopy was the approach used in 58.3% ($n=7$) of cases of heavy menstrual bleeding, and in 86.4% ($n=19$) of the other benign indications.

For endometriosis ($n=8$), 50% of hysterectomies were performed by laparotomy and 50% by laparoscopy.

Sixty-nine patients (13.6%) experienced some complication related to the surgery; the laparoscopy approach was associated with the highest incidence of complications (24.2%,

Table 1 Patient characteristics, types of procedure, and principal surgeon characteristics.

Patient characteristics	Mean (\pm SD)	
Age	51.71 \pm 12.24 years	
BMI	27.56 \pm 5.11 Kg/m ²	
Total	506	
	n	%
ASA I	113	22.5%
ASA II	360	71.7%
ASA III	29	5.7%
TOTAL SURGERIES	502	
Previous surgery YES	168	33.2%
Previous surgery NO	338	66.8%
TOTAL SURGERIES	506	
Indication for surgery	n	%
Fibroids	309	61%
Heavy menstrual bleeding	12	2.3%
Prolapse	155	30.6%
Other benign disease	22	4.3%
TOTAL SURGERIES	506	
Procedure type	n	%
Simple hysterectomy	279	55.1%
Subtotal hysterectomy	10	1.9%
Hysterectomy + uni- or bilateral annexectomy	80	15.8%
Hysterectomy + uni- or bilateral salpingectomy	137	27%
TOTAL SURGERIES	506	
Laparotomy	280	55.3%
Vaginal surgery	164	32.4%
Laparoscopic surgery	62	12.2%
TOTAL SURGERIES	506	
Experienced, male	180	42.6%
Resident physician (male or female)	84	16.6%
TOTAL SURGERIES	506	
Surgeon case volume	n	%
High-volume surgeons	170	33.6%
Medium-volume surgeons	161	31.8%
Low-volume surgeons + residents	175	34.5%
Total surgeries	506	
Years of surgical experience	n	%
Surgeons with \geq 20 years experience	210	33.6%
Surgeons with 10-19 years experience	109	31.8%
Surgeons <10 years experience/residents	187	34.5%
Total surgeries	506	
<i>SD, standard deviation; BMI, body mass index; ASA, American Society of Anesthesiologists classification</i>		

n=15) ($p=0.005$). The incidence of complications with the laparotomy approach was 14.6% (n=41), and with the vaginal approach it was 7.9% (n=13).

Twenty-three (4.5%) patients experienced a major adverse event, with no significant differences between the different approaches (Table 3).

Infections occurred in 25 patients (4.9%), with no significant difference between the different approaches. Blood transfusion was required as a result of the intervention in 20 patients (3.9%), almost all of whom had undergone laparotomy. The prevalence of minor complications was 2.1% (n = 11) (Table 4).

The incidence of readmissions was 2.5% (n = 13), and was higher among patients undergoing laparoscopy. The mean length of stay was significantly higher for laparotomies (Table 4).

Surgeons with the highest surgical volumes performed more MIS procedures than the other surgeons ($p < .001$), particularly laparoscopies; and those with more years of experience performed more laparoscopic procedures than the less expert surgeons ($p = .002$) (Table 5).

For the univariate and multivariate analysis, the vaginal and laparoscopic surgery groups were pooled in the MIS group. The univariate analysis showed the following risk factors for the selection of less invasive approaches: patient age (OR: 1.11; 95% CI: 1.09 -1.14), ASA classification III (OR: 2.79; 95% CI: 1.22-6.67), intervention in a hospital with 500 beds or more (OR: 1.69; 95% CI: 1.07-2.69), and intervention in a teaching hospital (OR: 2.81; 95% CI: 1.55-5.34). The risk factors for MIS that emerged in the multivariate analysis were patient age (OR:

Table 2 Characteristics of hospital and surgical approach. The data in each cell is displayed as n (%).

Size of hospital and approach	Laparotomy	Vaginal	Laparoscopy	TOTAL
> 800 beds	193 (55.3%)	107 (30.7%)	49 (14%)	349 (69%)
500-800 beds	40 (42.1%)	44 (46.3%)	11 (11.6%)	95 (18.8%)
< 500 beds	47 (75.8%)	13 (21%)	2 (3.2%)	62 (12.3%)
Teaching hospital YES/NO	Laparotomy	Vaginal	Laparoscopy	TOTAL
Hospital with resident teaching program	233 (52.5%)	151 (34%)	60 (13.5%)	444 (87.7%)
Hospital without resident teaching program	47 (75.8%)	13 (21%)	2 (3.2%)	62 (12.3%)

Table 3 Major adverse events (n = 23) by surgical approach.

Major adverse event	Laparotomy	Vaginal	Laparoscopy	TOTAL
Bladder injury	6	1	2	9
Ureter injury	3	0	3	6
Reintervention for pelvic abscess drainage		1		1
Reintervention for control of bleeding	3	3	1	7

Table 4 Incidence of different types of complications by surgical approach. The data in each cell is displayed as n (%).

Type of complication and approach	Laparotomy	Vaginal	Laparoscopy	TOTAL
Bleeding with transfusion	19 (6.8%)**	1 (0.6%)	0	20 (3.9%)
Infection	14 (5%)	6 (3.7%)	5 (8.1%)	25 (4.9%)
Major adverse event	12 (4.3%)	5 (3%)	6 (9.7%)	23 (4.5%)
Death	0	0	0	0
Readmission within 30 days	4 (1.4%)	3 (1.8%)	6 (9.7%)*	13 (2.5%)
Minor complications	5 (1.8%)	3 (1.8%)	3 (4.8%)	11 (2.1%)
Mean stay	3.1**	1.8	2.1	-

* $p < .005$; ** $p < .001$

1.14; 95% CI: 1.11-1.17) and surgery performed in a teaching hospital. The variable number of beds could not be included in the multivariate analysis because of the small number of procedures performed in the <500 bed group (Table 6).

Risk factors for perioperative complications were analyzed. ASA classification III was identified in the multivariate analysis as the only variable associated with an increased risk of perioperative complications, while age was not. The variable number of beds could not be included in the multivariate analysis because of the small number of procedures performed in the <500 bed group (Table 7).

Discussion

Choice of surgical approach

Despite the advantages of MIS in the treatment of benign gynecological conditions, its use in practice is variable and dependent on several factors^[10]. In our study, as in other centers^[11], the most widely used approach was laparotomy (55% of cases), selected in 87% of surgeries indicated for myomatous uterus. This approach is generally used when uteri are larger and in cases that are refractory to more conservative treatments. If we had determined the uterine weight in each patient, we could have analyzed

Table 5 Approach according to surgeon case volume and experience. The data in each cell is displayed as n (%).

Surgeon case volume	Laparotomy	Vaginal	Laparoscopy	TOTAL
High	64 (37.6%)	67 (39.4%)	39 (22.9%)	170 (33.6%)
Medium	93 (57.8%)	54 (33.5%)	14 (8.7%)	161 (31.8%)
Low + residents	123 (70.3%)	43 (24.6%)	9 (5.1%)	175 (34.6%)
TOTAL	280 (55.3%)	164 (32.4%)	62 (12.3%)	506
Surgeons' experience	Laparotomy	Vaginal	Laparoscopy	TOTAL
>20 years experience	115 (54.8%)	47 (22.4%)	48 (22.9%)	210 (41.5%)
10-19 years experience	59 (54.1%)	41 (37.6%)	9 (8.3%)	109 (21.5%)
<10 years experience + residents	106 (56.7%)	76 (40.6%)	5 (2.7%)	187 (37%)
TOTAL	280 (55.3%)	164 (32.4%)	62 (12.3%)	506

Table 6 Multivariate analysis of risk factors for minimally invasive surgery.

Surgeon case volume	Multivariate analysis		
	OR	95% CI	p-value
Age	1.14	1.11 - 1.17	<.001
ASA: I	1 (ref)		
ASA: II	0.64	0.36 - 1.16	0.14
ASA: III	0.24	0.06 - 0.93	0.03
Previous surgery: No	1 (ref)		
Previous surgery: Yes	0.97	0.57 - 1.62	0.90
BMI	1.00	0.96 - 1.05	0.74
Surgeon with <20 years' experience	1 (ref)		
Surgeon with ≥20 years' experience	1.23	0.70 - 2.17	0.46
High-volume surgeon	1 (ref)		
Medium-volume surgeon	0.17	0.09 - 0.32	<.001
Low-volume surgeons or resident	0.03	0.01 - 0.07	<.001
Teaching hospital: No	1 (ref)		
Teaching hospital: Yes	4.56	1.91 - 11.54	<.001

95% CI, 95% confidence interval; ASA, American Society of Anesthesiologists Classification; BMI, body mass index; OR, odds ratio

Table 7 Multivariate analysis of risk factors for perioperative complications.

Variables	Multivariate analysis		
	OR	95% CI	p-value
Surgery by laparotomy	1 (ref)		
Minimally invasive surgery	0.94	0.48 - 1.82	0.87
Age	0.97	0.94 - 0.99	0.03
ASA: I	1 (ref)	0.06 - 0.93	0.03
ASA: II	1.21	0.62 - 2.50	0.57
ASA: III	4.18	1.26 - 13.4	0.01
Previous surgery: No	1 (ref)		
Previous surgery: Yes	1.33	0.75 - 2.32	0.30
BMI	0.99	0.94 - 1.05	0.98
Surgeon with <20 years experience	1 (ref)		
Surgeon with ≥20 years experience	1.30	0.69 - 2.45	0.41
High-volume surgeon	1 (ref)		
Medium-volume surgeon	0.93	0.46 - 1.85	0.84
Low-volume surgeons or resident	0.99	0.40 - 2.43	0.98
Teaching hospital: No	1 (ref)		
Teaching hospital: Yes	2.57	0.88 - 9.40	0.10

95% CI, 95% confidence interval; ASA, American Society of Anesthesiologists Classification; BMI, body mass index; OR, odds ratio

this variable in greater depth. Recent studies suggest a rate of abdominal hysterectomies of less than 40%^[12], and clinical practice guidelines recommend increasing the number of less invasive approaches^[13], especially through use of the vaginal route^[6]. In our study, 32% of surgeries were vaginal procedures, almost all undertaken for prolapsed uterus. This proportion could have been greater, had more procedures been performed on non-prolapsed uteri, for which experienced surgeons are required. Most hysterectomies can be completed by vaginal or laparoscopic procedures when performed by high-volume surgeons^[14]. The volume of surgeries performed by residents as principal surgeon must be analyzed in more depth, since the proportion was found to be low (17%). The progressive increase in the number of residents and the emergence of more conservative treatments for benign uterine disease are likely to have contributed to this. The increased use of surgical simulation programs or training in specific techniques could change this situation^[15]. The type of hospital also influenced the choice of approach, as previously reported^[16]. We found that laparotomy was more common in smaller hospitals that do not have a teaching program for residents, characteristics that usually go hand in hand. This may be because professionals in these centers are predominantly medium- and low-volume surgeons who opt for laparotomy because this technique is the one that they are most familiar with. In our study, the age of the patient appeared to be a determining factor in the choice of less invasive approaches; this is explained by the higher mean age of the subgroup of patients undergoing vaginal hysterectomies, indicated mainly for uterine prolapse.

Perioperative complications

In our study, the laparoscopic approach was associated with a greater number of complications. We found a 9.7% incidence of major adverse events associated with this approach, mainly urinary tract injury (8%). The latest Cochrane database review describes a higher percentage of major complications for laparoscopic versus abdominal hysterectomies^[6].

Our figure is striking because these procedures were mostly performed by surgeons with greater experience and higher surgical volumes, and, as has been demonstrated in different surgical disciplines, the risk of complications falls as the experience of the surgeon grows^[17].

According to several authors, the definition of a high-volume surgeon varies and the learning curve is different for each of the approaches^[18-20]. Although we cannot draw definitive conclusions, given the small number of laparoscopic procedures included in our series, this is an indicator that must be taken into account and monitored prospectively.

The published incidence of intraoperative bleeding complications varies: 2.1% in abdominal hysterectomy, 3.1% in vaginal hysterectomy, and 2.7% in laparoscopic hysterectomy^[19]. In our series, the percentage of bleeding complications during and after surgery was 3.9%. The abdominal route was most frequently associated with this type of complication, a finding also described by other authors^[21].

Infections are more prevalent in abdominal hysterectomy^[21,22]. In our series, the infection rate, irrespective of the surgical approach, was 4.9%.

The risk of surgical complications is higher in elderly patients due to their greater comorbidity burden^[23]. This is reflected in our study by the identification of ASA III as a risk factor for perioperative complications, but we did not find that age per se was associated with an increased risk of perioperative complications. However, these data should be interpreted with caution since older patients were mainly operated for uterine prolapse by the vaginal route, an approach that is associated with a reduced number of complications.

In our series, hospital stay, an important variable that impacts on hospital costs, quality of life and patient satisfaction^[24], was significantly lower in patients who underwent MIS.

The development of perioperative complications is an important risk factor for readmission within the first 30 days after surgery^[1]. This finding clearly emerged from our study too: the number of readmissions was significantly higher for laparoscopic hysterectomies, and this procedure was also associated with a greater number of perioperative complications.

Conclusions

The data from our study show the impact of variations in clinical practice on outcomes in gynecological surgery that depend on factors such as the type of hospital and the characteristics of surgeons, and lead to inequitable access to healthcare for patients and an increase in health costs resulting from the treatment of complications, readmissions and longer average stays.

Our results highlight the need to reduce the practice of abdominal hysterectomy, especially in small hospitals, and to promote less invasive approaches, mainly by the vaginal route. To this end, the implementation of specific training programs supervised by expert surgeons, surgical teams consisting of an expert surgeon and a more inexperienced professional, training courses in endoscopic and vaginal surgery, and the appointment of expert surgeons to provide support in smaller hospitals may be of interest.

Complications associated with laparoscopic approaches should be monitored and the surgical experience of surgeons in these techniques should be improved in order to reduce the incidence of these events. Another very important objective is to monitor the surgical volume of residents to ensure that they achieve adequate surgical competence.

References

- Dessources K, Hou JY, Tergas AI, et al. Factors associated with 30-day hospital readmission after hysterectomy. *Obstet Gynecol.* 2015;125:461-70.
- Varol N, Healey M, Tang P, Sheehan P, Maher P, Hill D. Ten-year review of hysterectomy morbidity and mortality: can we change direction? *Aust N Z J Obstet Gynaecol.* 2001;41:295-302.
- Kovac SR. Route of hysterectomy: an evidence-based approach. *Clin Obstet Gynecol.* 2014;57:58-71.
- Gimbel H, Settnes A, Tabor A. Hysterectomy on benign indication in Denmark 1988-1998. A register based trend analysis. *Acta Obstet Gynecol Scand.* 2001;80:267-72.
- Scalici J, Laughlin BB, Finan MA, Wang B, Rocconi RP. The trend towards minimally invasive surgery (MIS) for endometrial cancer:

- an ACS-NSQIP evaluation of surgical outcomes. *Gynecol Oncol.* 2015;136:512-5.
- Aarts JW, Nieboer TE, Johnson N, et al. Surgical approach to hysterectomy for benign gynaecological disease. *Cochrane Database Syst Rev.* 2015;2015:CD003677.
- Fader AN, Weise RM, Sinno AK, et al. Utilization of minimally invasive surgery in endometrial cancer care: a quality and cost disparity. *Obstet Gynecol.* 2016;127:91-100.
- Jorgensen EM, Modest AM, Hur HC, Hacker MR, Awtrey CS. Hysterectomy practice patterns in the postmorcellation era. *Obstet Gynecol.* 2019;133:643-9.
- Dicker RC, Greenspan JR, Strauss LT, et al. Complications of abdominal and vaginal hysterectomy among women of reproductive age in the United States. *The Collaborative Review of Sterilization. Am J Obstet Gynecol.* 1982;144:841-8.
- Cooper MA, Hutfless S, Segev DL, Ibrahim A, Lyu H, Makary MA. Hospital level under-utilization of minimally invasive surgery in the United States: retrospective review. *BMJ.* 2014;349:g4198.
- Loring M, Morris SN, Isaacson KB. Minimally invasive specialists and rates of laparoscopic hysterectomy. *JLS.* 2015;19:e2014.00221.
- Uccella S, Morosi C, Marconi N, et al. Laparoscopic versus open hysterectomy for benign disease in uteri weighing >1 kg: a retrospective analysis on 258 patients. *J Minim Invasive Gynecol.* 2018;25:62-9.
- AAGL Advancing Minimally Invasive Gynecology Worldwide. AAGL position statement: route of hysterectomy to treat benign uterine disease. *J Minim Invasive Gynecol.* 2011;18:1-3.
- Cohen SL, Vitonis AF, Einarsson JI. Updated hysterectomy surveillance and factors associated with minimally invasive hysterectomy. *JLS.* 2014;18:e2014.00096.
- Gressel GM, Potts JR 3rd, Cha S, Valea FA, Banks E. Hysterectomy route and numbers reported by graduating residents in obstetrics and gynecology training programs. *Obstet Gynecol.* 2020;135:268-73.
- Mehta A, Xu T, Hutfless S, et al. Patient, surgeon, and hospital disparities associated with benign hysterectomy approach and perioperative complications. *Am J Obstet Gynecol.* 2017;216:497.e1-497.e10.
- Doll KM, Milad MP, Gossett DR. Surgeon volume and outcomes in benign hysterectomy. *J Minim Invasive Gynecol.* 2013;20:554-61.
- Driessen SR, Wallwiener M, Taran FA, et al. Hospital versus individual surgeon's performance in laparoscopic hysterectomy. *Arch Gynecol Obstet.* 2017;295:111-7.
- Mäkinen J, Johansson J, Tomás C, et al. Morbidity of 10 110 hysterectomies by type of approach. *Hum Reprod.* 2001;16:1473-8.
- Terzi H, Biler A, Demirtas O, Guler OT, Peker N, Kale A. Total laparoscopic hysterectomy: analysis of the surgical learning curve in benign conditions. *Int J Surg.* 2016;35:51-7.
- Osler M, Daugbjerg S, Frederiksen BL, Ottesen B. Body mass and risk of complications after hysterectomy on benign indications. *Hum Reprod.* 2011;26:1512-8.
- Colling KP, Glover JK, Statz CA, Geller MA, Beilman GJ. Abdominal hysterectomy: reduced risk of surgical site infection associated with robotic and laparoscopic technique. *Surg Infect (Larchmt).* 2015;16:498-503.
- Inokuchi M, Kato K, Sugita H, Otsuki S, Kojima K. Impact of comorbidities on postoperative complications in patients undergoing laparoscopy-assisted gastrectomy for gastric cancer. *BMC Surg.* 2014;14:97.
- Wright KN, Jonsdottir GM, Jorgensen S, Shah N, Einarsson JI. Costs and outcomes of abdominal, vaginal, laparoscopic and robotic hysterectomies. *JLS.* 2012;16:519-24.

Acknowledgements: The Authors would like to thank MSC for editorial and translation services. All authors have read and approved the final version of the manuscript.