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ORIGINAL RESEARCH ARTICLE

Evaluation of complications, conversion rate, malignancy rate, and, surgeon's experience in laparoscopic assisted supracervical hysterectomy (LASH) of 1274 large uteri: A retrospective study

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Abstract

Introduction: Hysterectomy now belongs to standard gynecological procedures. Moreover, a shift towards laparoscopic techniques is ever more apparent as they provide many advantages such as less traumatization and shorter convalescence. Large uteri are still mentioned as contraindications for laparoscopic hysterectomy even though those patients might benefit from the lower morbidity associated with minimal invasive techniques. In this study, the largest reported so far, we analyzed intraoperative and postoperative complications as well as the surgeon's experience of laparoscopic assisted supracervical hysterectomy (LASH) in patients with a uterus weight over 500 g.

Material and Methods: The present retrospective study, between June 27, 1998 and August 31, 2019, evaluates 1274 patients with a uterus weight over 500 g who were treated with LASH for benign uterine diseases at the Clinic for Minimal Invasive Surgery (Berlin, Germany). All surgeries were performed by one of four in-house surgeons with experience in LASH: they had performed at least 500 LASH procedures before the study. Patients receiving surgical treatment for malignant tumors were not included in the study. Major and minor intraoperative and postoperative complications were recorded and evaluated. Additionally, medical files were evaluated for demographic data, American Society of Anesthesiologists score (I–IV), name of the surgeon, duration and indication for surgery, history of previous gynecological procedures and concomitant surgical interventions, weight of removed uterine tissue, duration of postoperative hospitalization in patients with complications, intraoperative conversion from laparoscopy to laparotomy, and malignancy rate.

Results: The mean age was 47.0 ± 7.3 years and mean body mass index was 25.6 ± 7.1 kg/m^2. Average parity was 1.04 ± 1.57. Average uterus weight was

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; HE, hysterectomy; LASH, laparoscopic assisted supracervical hysterectomy; LH, laparoscopic hysterectomy; TLH, total laparoscopic hysterectomy.

761.8 ± 317.9 g (500–4065 g). The mean duration of surgery was 96.9 ± 49.5 min; 54% of all patients were treated without concomitant intervention, conversion rate was 2.12%. The malignancy rate was 0.4% and the complication rate was 6.81% with 1.36% intraoperative complications and 5.45% postoperative complications.

Conclusions: The overall low complication and malignancy rates observed in this study allow us to present LASH as a safe and efficient alternative laparoscopic approach to remove uteri of any size in the hands of experienced surgeons.

KEYWORDS
benign uterine diseases, hysterectomy, laparoscopic assisted supracervical hysterectomy, laparoscopy, large uteri

1 | INTRODUCTION

In present-day gynecology, hysterectomy belongs to the standard procedures and is one of the most commonly performed surgeries. The surgical removal of the uterus has been performed since ancient times. Soranus of Ephesus first mentioned the procedure in AD 120. Up to the 18th century, however, most patients died postoperatively of hemorrhage, sepsis, or exhaustion.[1] Conrad Langenbeck performed the first vaginal hysterectomy in Germany in 1813.[2] Kurt Semm was the first to combine vaginal hysterectomy with laparoscopic assistance in 1984,[3] followed by the first complete laparoscopic hysterectomy (LH) in 1989.[4] Today, three main types of LH are available: laparoscopically assisted vaginal hysterectomy where vaginal hysterectomy is preceded by laparoscopy, total LH (TLH) where the vaginal vault is sutured laparoscopically, and laparoscopic supracervical hysterectomy (LASH).

LASH is indicated for the treatment of various benign gynecological diseases including uterine fibroids, dysfunctional uterine bleeding, menometrorrhagia due to benign endometrial hyperplasia, endometriosis, adenomyosis, diffuse myomatosis, pressure-related bowel or bladder dysfunctions, large uterine fibroids, and excessive menstrual blood loss that does not respond to medical therapy.[5–7] LASH offers many advantages. It reduces morbidity and convalescence, as well as the subsequent socio-economic burden. Furthermore, supracervical hysterectomy partially conserves the patients' cervical anatomy and the surrounding structures. Some studies even point out that the cervix should only be removed if clinically indicated because removal might result in genital descensus, bladder and bowel alterations, or sexual dysfunction.[8–10] The principal disadvantage is that supracervical hysterectomy does not eradicate the potential presence of cervical stump carcinoma. Although the risk of cancer is low (0.11%–1.9%),[11,12] postoperative preventive cancer screening is mandatory and LASH is not suited for women with a suspicious cervical smear result. Even though the conservation of the cervix results in more rapid recovery and fewer short-term complications, it should be mentioned that LASH infrequently causes cyclical bleeding or cervical prolapse.[13–15]

Minimally invasive supracervical hysterectomy could be considered as a gentle surgical alternative to all methods of total hysterectomy. In the present retrospective study, we have analyzed the number and type of intraoperative and postoperative complications as well as conversion and malignancy rate of LASH in patients with a uterus weight of 500 g or higher. Additionally, we have evaluated the importance of the surgeon's experience.

Key message

Laparoscopic assisted supracervical hysterectomy is a safe and efficient alternative laparoscopic approach to remove uteri of any size.

2 | MATERIAL AND METHODS

2.1 | Patient selection

The intraoperative and postoperative complications of LASH in patients with a uterus weight over 500 g were evaluated between June 27, 1998 and August 31, 2019 in a retrospective single-center study. All surgeries were performed at the Clinic for Minimal Invasive Surgery (MIC-Klinik) in Berlin (Germany) by one of the four expert in-house surgeons. All four have elaborate experience in LASH: they have performed at least 500 LASH procedures before the study and perform between 700 and 960 minimally invasive hysterectomy procedures per year. After surgery, the uterus weight was assessed both in the operating room as well as afterwards by the histopathological institute. The latter is deemed more precise, so this is the weight we recorded in our patient records. Of 17 889 women treated with LASH for benign uterine diseases, 1274 patients with a histopathological uterus weight of 500 g or higher were retrospectively included in this study. Indications for LASH were uterine fibroids associated with discomforting symptoms or with tendency towards growth, or dysfunctional bleeding resistant to therapy (menorrhagia, metrorrhagia, dysmenorrhea, or hypermenorrhea). Patients receiving surgical treatment for malignancy (cervical, endometrial, or ovarian tumors) were not

included in the study. To exclude malignant abnormalities, a colposcopic and cytological evaluation of the cervix was conducted, for the purpose of which the Papanicolaou smear was not older than 12 months. In the case of dysfunctional bleeding resistant to therapy or sonographic abnormalities with regard to the endometrium, a diagnostic hysteroscopy with fractionated abrasion was performed to exclude malignancy.

2.2 | Surgical procedure

LASH was performed according to the customary manner.[16] As of 2012, LASH was combined with our in-house established change-over technique.[17,18] This method ensures a better view and access to the uterus, which allows for uteri of almost any size to be safely removed.[19] Morcellation was applied during all LASH procedures. Since 2021, it has been standard to use the More-Cell-Safe in-bag morcellator for all minimally invasive procedures at our clinic.

2.3 | Data collection

Medical files of 1274 patients with a histopathological uterine weight of 500 g or more, undergoing LASH were evaluated in this retrospective study. Patient's age and body mass index (BMI), classification of the patient in accordance with the American Society of Anesthesiologists (ASA) score (I–IV), the name of the surgeon, the duration of surgery, and indication for surgery were recorded. We also documented whether the patient had a history of previous gynecological operations and to what extent additional surgical interventions, such as adhesiolysis or interventions for adnexal pathology, were performed during LASH. The evaluation also included weight of the removed tissue, as well as the number and type of intraoperative complications. Additionally, histological data, parity, duration of postoperative hospitalization for patients with complications, intraoperative and postoperative complications and intraoperative change from laparoscopy to laparotomy were documented. Intraoperative and postoperative inpatient complications were recorded at our clinic. In Germany, it is standard for outpatient care to be followed up by the patient's general practitioner. Our clinic and surgeons are in direct contact with the general practitioners and are alerted immediately if any later complications should occur, even if these appear months or even years later.

2.4 | Definition of outcome parameters

Major complications were defined as strong, uncontrollable intraoperative hemorrhage from the uterine artery, blood transfusion, and lesions of the ureter, bladder, or intestines. Other major complications included postoperative pouch of Douglas abscesses with revision, hematoma formation with revision, thromboses and embolisms, blood transfusion, and re-laparoscopies because of unclear postoperative symptoms. Minor postoperative complications were defined as unspecific fever (temperature above 38°C), increased inflammatory parameters (leukocytes more than 10×10^9/L, C-reactive protein >10 mg/L), wound infection, unclear postoperative pain and hematoma formation without revision. Postoperative inflammation included unspecific fever (temperature above 38°C), increased inflammatory parameters (leukocytes $>10\times10^9$/L, CRP >10 mg/L), infected hematoma, and pouch of Douglas abscesses.

2.5 | Statistical analyses

For the parameters age, BMI, hospitalization, duration of surgery, and uterus weight, we calculated mean, standard deviation and 95% confidence interval. We used analysis of variance (ANOVA) for continuous, normally distributed variables, and Kruskal–Walis test for abnormally distributed variables. Data were analyzed using Windows-Excel (Microsoft 2010) and SPSS-version 20.0 (SPSS Inc.).

2.6 | Ethics statement

Based on the retrospective design of this study, the consideration of the protection of patient's rights, and the importance of disseminating results in the gynecological field, managing and medical director Dr. Med. Matthias Albrecht and Head of Gynecology Prof. Dr. Med. Bernd Bojahr of the MIC Klinik Berlin have approved this research from an ethical point of view. In line with the research policies and procedures of Germany, this retrospective study did not require approval from an external ethical committee.

3 | RESULTS

3.1 | Demographics and surgery characteristics

From June 27, 1998 to August 31, 2020, 17 889 women were treated with LASH for benign uterine diseases. The extracted uterine weight was above 500 g in 1274 women of this patient collective (prevalence of large uteri is 7.1%). Twenty-seven of these patients required conversion to abdominal surgery (conversion rate of 2.12%), so only data from the remaining 1247 patients were evaluated. All demographic data can be found in Table 1.

The average uterus weight was 761.8 ± 317.9 g (500–4065 g); 1070 patients (85.8%) had a uterus weight lower than 1000 g, 164 patients (13.2%) had a uterus weight between 1000 g and less than 2000 g, and 13 patients (1.0%) had a uterus weight of 2000 g or more. The mean duration of surgery was 96.9 ± 49.5 minutes. The entire procedure to extract the uterus weighing 4065 g lasted 4 hours and 53 minutes, of which surgery on the uterus took 2 hours and morcellation took 2 hours and 53 minutes.[18]

TABLE 1 Preoperative characteristics of study population with large uteri treated with laparoscopic assisted supracervical hysterectomy (LASH)

Preoperative characteristics of the study population	Study group ($n = 1247$)
Age (years), mean ± SD	47.0 ± 7.3
Parity, *n* (%)	($n = 1111$)
Nullipara	465 (41.9)
Unipara	320 (28.8)
Bipara	252 (22.7)
Tripara	60 (5.4)
More than tripara	14 (1.3)
One cesarean section	99 (8.9)
Two cesarean section	23 (2.1)
Mean ± SD	1.04 ± 1.57
Body mass index (kg/m^2), mean ± SD	25.6 ± 7.1
Previous surgery, *n* (%)	$n = 1137$
Previous abdominal surgery	425 (37.4)
Previous gynecological surgery	445 (39.1)
With laparoscopy	217 (19.1)
With laparotomy	263 (23.1)
ASA, *n* (%)	$n = 1245$
ASA I	442 (35.5)
ASA II	696 (55.9)
ASA III	106 (8.5)
ASA IV	0 (0.0)
Indication for surgery, *n* (%)	$n = 1247$
Uterus myomatosus without symptoms	214 (17.2)
Uterus myomatosus with pain	620 (49.7)
Uterus myomatosus with bleeding and pain	413 (33.1)

Abbreviation: ASA, American Society of Anesthesiologists.

TABLE 2 Number and type of concomitant interventions required next to laparoscopic assisted supracervical hysterectomy

Concomitant interventions	$n = 572$ (45.9%)
Number of concomitant interventions, *n* (%)	
One concomitant intervention	415 (33.3)
Two concomitant interventions	126 (10.1)
Three concomitant interventions	29 (2.3)
Four concomitant interventions	2 (0.2)
Type of concomitant interventions, *n* (%)	
Laparoscopic McCall culdoplasty	87 (7.0)
Adnexal surgery	452 (36.2)
Adhesiolysis	174 (14.0)
Sacropexy	5 (0.4)
Endometrial surgery	31 (2.5)
Others	32 (2.5)

3.2 | Concomitant interventions

In 573 cases (46.0%) concomitant interventions were performed. These included suture suspensions (or laparoscopic McCall culdoplasty, 87 patients, 7.0%), adnexal surgeries (including salpingectomies and cyst enucleations; 452 patients, 36.2%), adhesiolysis (174 patients, 14.0%), sacropexy (5 patients; 0.4%) and extirpation or coagulation of endometriosis lesions (31 patients; 2.5%).

Table 2 shows the number and type of interventions performed concomitant to LASH operations.

3.3 | Histology

Table 3 shows an overview of primary and secondary histological findings. The histopathological analysis of the uterine tissue of our patients who were treated with LASH revealed uterus myomatosus in 940 women (75.4%), in 129 (10.3%) patients adenomyosis only was found, and the uterine specimens of 173 women (13.9%) showed a combination of both.

The uterine samples of five women (0.4%) showed a malignancy and included one low-grade endometrial stromal sarcoma, three leiomyosarcomas (grade 1 and grade 2), and one uterine tumor with unclear malignant potential. These patients were referred to a certified cancer center where further treatment or surgery was performed.

Additional histological findings included 270 benign ovarian cysts (21.7%), four benign ovarian carcinoma (serous borderline tumor, 0.32%), and 116 hydrosalpinx follicularis (9.3%). Endometriosis was found in 30 cases (2.4%) and 34 women (2.7%) had endometrial hyperplasia.

A fallopian tube carcinoma was detected in two women (0.16%). "Others" included endometrial and cervical polyps; lipomas; nevi; corpus luteum, omentum and peritoneal cysts; and dystrophic calcifications.

3.4 | Complications

Table 4 shows the intraoperative and postoperative complications. In total, 85 complications in 77 patients were reported, resulting in a complication rate of 6.81%. Of these 85 complications, 17 were intraoperative (1.36%) and 68 were postoperative (5.45%). All intraoperative complications were major whereas postoperative complications included 10 major and 58 minor complications. One patient died postoperatively on the day of surgery with lung embolism being the cause of death.

The mean age of the patients with complications was 46.6 ± 7.3 years (range 34–61 years). Mean BMI of the patients with complications was 25.1 ± 6.3 kg/m^2 (range 17.4–39.44 kg/m^2). The patient with the lowest BMI showed a lesion of the intestines and the patient with the highest BMI showed unclear pain. One patient with a BMI of 21.5 kg/m^2 developed incisional hernias at the

TABLE 3 Histopathological analysis of the uterine specimen of our study collective

Histopathological findings results	*n* = 1247
Primary findings, *n* (%)	
Uterine myomatosus	940 (75.4)
Adenomyosis	129 (10.3)
Uterine myomatosus + adenomyosis	173 (13.9)
Malignancy + uterus myomatosus	5 (0.4)
Secondary findings, *n* (%)	
Benign ovarian cysts	270 (21.7)
Benign ovarian carcinoma	4 (0.32)
Hydrosalpinx follicularis	116 (9.3)
Endometriosis	30 (2.4)
Endometrial hyperplasia	34 (2.7)
Fallopian tube carcinoma	2 (0.16)
Others	75 (6.01)

TABLE 4 Intraoperative and postoperative complications in patients with large uteri treated with laparoscopic assisted supracervical hysterectomy

Complications, *n* (%)	Complication level	*n* = 1247
Intraoperative		17 (1.4)
Arterial bleeding	Major	8 (0.64)
Bladder lesion	Major	7 (0.56)
Intestinal lesion	Major	2 (0.16)
Ureteral lesion	Major	0 (0.0)
Anesthesiological complications	Major	0 (0.0)
Blood transfusion	Major	0 (0.0)
Others		0 (0.0)
Postoperative		68 (5.5)
Adhesions	Major	5 (0.40)
Incisional hernia	Major	1 (0.08)
Wound healing disorder in the abdominal wall	Minor	2 (0.16)
Wound healing disorder outside abdominal wall	Minor	4 (0.32)
Inflammation	Minor	25 (2.00)
Vaginal bleeding	Minor	7 (0.56)
Unclear pain	Minor	16 (1.28)
Embolism/ thrombosis	Major	2 (0.16)
Blood transfusion	Major	0 (0.0)
Hematoma without revision	Minor	3 (0.24)
Others		3 (0.24)

morcellator access site. Of patients with complications, 29 were classified as ASA-I patients, 44 as ASA-II, and 4 as ASA-III.

The average uterus weight of the 77 patients with complications was 858.6 ±493.5 g (range 500–2200 g). Fifty-five patients with complications had a uterus weight less than 1000 g; in 20 patients, the uterus weight was between 1000 g and less than 2000 g; and two patients had a removed uterus weight of 2000 g or more.

Complications occurred in 47 patients with uterus myomatosus with symptoms of pain (61.0%), in 16 patients with uterus myomatosus with symptoms of pain and bleeding (20.8%), and, in 14 patients with asymptomatic uterus myomatosus (18.2%). Patients with asymptomatic, uterus myomatosus showed no symptoms of bleeding or pain. However, because of the large size of the uteri, these patients did express other discomforts such as bladder or bowel dysfunctions, and explicitly desired a hysterectomy.

Only seven patients (0.56%) reported disturbing postoperative bleeding. They were treated by cervix curettage and vaginal coagulation of the endocervical epithelium. Two patients were diagnosed with portio dysplasia postoperatively. The Papanicolaou smear test revealed a PAP IIID in one case and a PAP IVa in the other; hence, the extirpation of the column stump was carried out in both cases.

The mean duration of surgery of patients with complications was 112.2 ± 52.5 minutes (range 51–167 min) whereas the mean duration of hospitalization was 3.3 ± 2.6 days (range 1–10 days). The patient staying for 10 days in hospital had two intraoperative complications (intestinal lesion, bleeding). The bleeding made a conversion to laparotomy necessary.

3.5 | Learning curve

All surgeries were performed by four experienced surgeons (>500 LASH surgeries before this study). Surgeon 1 performed 540 operations (43.3%); surgeon 2, 375 operations (30.1%); surgeon 3, 281 operations (22.5%); and surgeon 4, 51 operations (4.1%).

During the first 2 years of the present study there were no complications, and in 2016 the highest number of complications (12 cases) occurred. In all other years, one to eight complications occurred per year. There was no obvious connection between the year of operation and the number of complications.

Thirty-nine complications (7.2%) were reported by surgeon 1; 19 complications (5.1%) by surgeon 2; 25 complications (8.9%) by surgeon 3; and 2 complications (3.9%) by surgeon 4.

4 | DISCUSSION

Nowadays, hysterectomy is one of the most commonly performed surgeries worldwide. Since August 2010, the German Society of Gynecology and Obstetrics has recommended the LASH procedure as an alternative to abdominal and vaginal hysterectomy.[20] In case of contraindications, an abdominal hysterectomy should be considered.[21,22] Whether large uteri are a contraindication for the minimally invasive techniques has long been and still is under controversial debate.[23–25] Traditionally, in women with large uteri, an abdominal hysterectomy with eventually a large midline incision has

been recommended, which bears a higher risk for wound healing disturbance, dehiscence, and herniation.[19]

The conversion rate in this study, with a relatively large number of study participants (1247 patients) was 2.12% and the complication rate was 6.81% with an intraoperative complication rate of 1.36% and a postoperative complication rate of 5.45%. This is in accordance with previously published rates in LASH patients with increased uterine weights. As an example, our complication rate is much lower than 24.7% (intraoperative complication rate: 17.4%; postoperative complication rate: 7.3%) as reported by Kondo et al,[26,27] but it is higher than the complication rates reported by Schöller et al (intraoperative complication rate: 2.2% and postoperative complication rate: 1.4%).[28] Both evaluated laparoscopic hysterectomy for patients with enlarged uteri over 500 g. In a study group of 29 patients undergoing LASH for large uteri by Shahid et al, only one intraoperative complication (bladder injury) occurred and no conversion to abdominal hysterectomy was required.[29] Uccella et al did not record any intraoperative complications and only two postoperative complications in a study group of 71 women treated with LASH and with a uterus weight of 1000 g or more.[30] Four patients of their cohort needed conversion to laparotomy (conversion rate of 5.6%). Similarly, Macciò et al reported only one major complication and a conversion rate of 5.5% (four patients) when assessing the feasibility of TLH in their patient group of 78 patients with uteri heavier than 1.5 kg.[31] Overall, many studies have evaluated the feasibility and safety of laparoscopic hysterectomy for patients with large uteri. The overwhelming majority of reports demonstrate a minimally invasive approach to be safe and efficient for the removal of large uteri, as shown by acceptably low complication and conversion to laparotomy rates.[24,28–30,32–44]

Even though enlarged uteri were shown to be an independent risk factor for post-hysterectomy morbidity in Louie et al's cohort study,[45] which assessed hysterectomy patient data from more than 500 hospitals (27 167 women in total), abdominal hysterectomy had an overall higher complication rate compared with minimal invasive approaches, even in cases with markedly large uteri.[45] Similar results were observed by Uccella et al when comparing abdominal hysterectomy with TLH, they identified the laparoscopic approach as the only independent predictor of a lower incidence of overall complications.[46] In general, complication rates for LASH are between 1% and 2%.[16,47,48] Complication rates for abdominal hysterectomy, which has been traditionally indicated in the case of a very large uterus, presumed difficult-case-uterus and/or vaginal nulliparity,[49] are between 13.1% and 45%.[50–52]

Urinary tract damage, in particular bladder and ureter injuries, remain the major concern of the laparoscopic approach.[53] Bladder lesions occurred in seven of our patients (0.56%). Ureter lesions did not occur in our study. Lesions of the intestines occurred in two patients (0.16%), which is a low prevalence when compared with the literature. Intraoperative excessive bleeding was detected in eight of our patients (0.64%). It is imperative to mention that no bleeding volumes were recorded which limits the interpretation of these results. No other intraoperative complications (including transfusions) occurred in our study.

The possibility of cervical stump carcinoma and postoperative bleeding is seen as a disadvantage of LASH. Ghomi et al report 19.0% postoperative cyclic bleeding after LASH.[54] In our study, only seven patients (0.56%) reported disturbing postoperative bleeding.

Macciò et al evaluated the impact of uterine weight on the safety and feasibility of TLH in 461 patients with large uteri, all operations performed by a single surgeon.[38] They found that not only uterine weight but also previous abdominal surgery were predictors of a higher risk for complications. Higher BMI, previous abdominal surgery, and endometriosis were predictors for longer operative time. In our study, of the nine patients with major intraoperative complications of bladder and intestinal lesions, only two had no previous abdominal surgeries.

It should be mentioned that morcellation carries a potential risk for dissemination of occult uterine malignant cells which can worsen the prognosis.[55,56] Based on recent studies however, the risk for occult malignancy is low.[57] In line with these findings, the malignancy rate in the present study of a large group of patients with large uteri was very low (0.4%), affirming the safety of morcellation in this setting. Nevertheless, it is imperative to inform patients preoperatively about the rare possibility of an occult malignancy and the associated potential risks of morcellation.

Logically, a surgeon's learning curve affects the risk for complications. As such, Wallenstein et al reported a decrease of complication rate from 6.2% to 4.2% for low-volume vs experienced surgeons, respectively.[58] Moreover, they found that risk associated with LH was reduced, with 25% when the operation was performed by a high-volume surgeon and 18% when the patient was treated at a high-volume center, and that, because of the lower morbidity and recovery time, costs were shown to be significantly decreased as well.[58] Wattiez et al compared complications and outcome of TLH between two consecutive periods of 3 years which showed no differences in patient characteristics.[59] Complications rates decreased from 5.6% to 1.3% and conversion to laparotomy decreased from 4.7% to 1.4%. Furthermore, average uterine weight increased but operation time decreased. Ito et al evaluated LASH for patients with uteri heavier than 1000 g between 2009 and mid-2015 and reported conversion to laparotomy in five patients of their 95-patient group (5.2%).[35] Interestingly, no conversions happened after 2011 and the need for intraoperative and postoperative transfusion decreased from 6.3% to 1% and from 6.3% to 2.1% after 2013, respectively; both findings underscoring the impact of the surgeon's learning curve. Schöller et al showed a relatively high conversion to laparotomy rate of 17.4% (24 of 138 patients with uteri >500 g treated with LH), which they explained to be the result of the fact that the entire laparoscopic experience of surgeons is reflected in their cohort, starting with each of their first patients treated with LH and complying with inclusion criteria.[28] After an initial learning curve, they noticed the conversion rate decreasing from 56.5% to 9.56%.

The learning curve is estimated to be 50 to 60 previous LH procedures and can be achieved by any experienced surgeon regardless of the complicating factors.[34,43] This can explain why no significant learning curve period was detected among our four surgeons in the present study; all four had performed at least 500 LASH procedures

before the study and perform between 700 and 960 minimally invasive procedures per year.

An increased uterine size requires greater surgical skills and experience, but also adequate technical equipment and in some cases a modification of the technique.[60,61] Since 2012, all our LASH procedures have been performed with the "change-over technique", which is an in-house-developed technical procedure to complete the surgery laparoscopically, in a safe way and with few potential complications because of easier access.[17,62] The uniquely high number of procedures with "change-over technique" carried out in this study illustrates the acceptance and popularity of the technique.

5 | CONCLUSION

In accordance with many studies published in the last decade, our results assessed from one of the largest groups of patients ever published (1247 patients) show low complication and malignancy rates and confirm that LASH is a suitable procedure for patients with large uteri. It could be preferred over abdominal hysterectomy taking into account the lower post-hysterectomy morbidity (with added known advantages) and the surgeon's experience, and provided that morcellation is assessed as safe.

AUTHOR CONTRIBUTIONS

GT contributed to concept and design of the study, data collection, data analysis and interpretation, and manuscript preparation. BB and HK contributed to concept and design of the study, and data collection. RW contributed to concept and design of the study, data interpretation, and manuscript preparation.

CONFLICT OF INTEREST

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

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