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Original Article

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# Predictors of conversion to open surgery in TLH for enlarged uteri: A retrospective cohort study

**Abstract**

**Aim:** To identify the preoperative and intraoperative independent variables affecting the risk of conversion to laparotomy during total laparoscopic hysterectomy (TLH) in patients with large uteri.
**Materials and Methods:** Data from 125 patients with a uterine weight of ≥ 300 g who were scheduled for TLH between January 2020 and January 2025 were retrospectively analyzed. In addition to their standard TLH experience, surgeons were categorized based on their volume of large uterus (≥ 300 g) cases as "Highly Experienced" (≥ 100 cases) or "Moderately Experienced" (< 100 cases). Risk factors for conversion were determined using multivariate logistic regression analysis.
**Results:** The overall conversion rate was 10.4% (n = 13). The diameter of the largest fibroid was significantly higher in the conversion group (100 mm vs. 73 mm, p = 0.009). Multivariate logistic regression analysis revealed that while high surgeon experience significantly reduced the risk of conversion (OR: 0.24; 95% CI: 0.06 – -0.94; p = 0.027), a dominant fibroid diameter of ≥ 10 cm was the primary predictor of conversion risk (OR: 4.70; 95% CI: 1.39 – 15.87; p = 0.046). Uterine weight and BMI showed no independent association with the risk of conversion (p > 0.05). The major complication rate was recorded as 3.2%.
**Conclusion:** The success of TLH in large uteri is directly related to the size of the dominant fibroid and the surgeon's experience with this specific case group, rather than the total uterine weight. In preoperative assessments, it is recommended that patients with a fibroid diameter of ≥ 10 cm be operated on by high volume surgeons.

**Keywords:** Total laparoscopic hysterectomy, conversion to laparotomy, large uterus, uterine fibroids, surgical experience

## INTRODUCTION

Large uterine cases in gynecological surgery have long been recognized as a significant challenge due to the restricted surgical field and difficulties in exposing anatomical structures. The literature indicates that when uterine weight exceeds 1000 grams (g), the risk of ureteral and vascular injury increases, further complicating the surgical process. Limited mobilization resulting from increased uterine size hinders the effective use of laparoscopic instruments, often compelling surgeons to decide on a conversion to laparotomy (1,2). While the most severe vascular and ureteral complications exponentially rise above 1000 g, a uterine mass exceeding 300 g (equivalent to a 12 week gestation size) significantly alters the pelvic spatial anatomy, limits instrument triangulation, and marks the threshold where standard laparoscopic visualization becomes clinically challenging, justifying its definition as an enlarged uterus in clinical trials (1).

It is an indisputable fact that minimally invasive surgery (laparoscopic, robotic, or vaginal) is currently the gold standard for treating benign gynecological conditions. This approach ensures faster recovery, reduced blood loss, and superior cosmetic outcomes for patients. However, as uterine size increases, the feasibility of the vaginal route, in particular, diminishes, leaving laparoscopy as the most robust alternative to open surgery (3,4).

Existing data in the literature predominantly focus on correlating laparoscopic success with uterine weight and the surgeon's general experience alone (2). Nevertheless, variables such as fibroid localization, trocar insertion sites, and the patient's prior

surgical history play a role as critical as the uterine weight itself. Defining the limits of the laparoscopic approach in large uteri is a vital step for surgical planning and patient counseling (5).

Current literature typically emphasizes uterine weight and general laparoscopic experience as the primary determinants of laparoscopic success. However, even with similar total uterine weights, the impact of giant fibroid localizations which asymmetrically constrict the pelvic space and the surgeon's 'large uterus specific' experience, rather than general surgical volume, remains insufficiently elucidated. This gap in the literature makes it difficult for surgeons to predict in the preoperative period which cases will push laparoscopic boundaries and at what point the risk of conversion to laparotomy will increase (6).

Our primary hypothesis in this study is that the risk of conversion to laparotomy in large uteri is independent of total uterine weight, and that the true determinants are the size of the dominant fibroid and the surgeon's specific case volume in large uterus surgeries. The lack of adequate research on these variables beyond uterine weight (such as fibroid localization and subcategories of surgeon experience) constitutes the core motivation for our study. In this context, the aim of our study is to identify the independent risk factors leading to conversion to laparotomy and to define the clinical parameters that predict surgical success in this challenging patient group, based on data from 125 patients who underwent total laparoscopic hysterectomy (TLH) for large uteri (≥ 300 g) at our institution.

## MATERIALS AND METHODS

This retrospective cohort study was approved by the Harran University Clinical Research Ethics Committee on 27.12.2025 (Approval number: HRÜ/25.12.13). The research was conducted in accordance with the ethical principles of the Declaration of Helsinki. Due to the retrospective nature of the study, the requirement for informed consent was waived by the ethics committee.

The study was conducted at a university hospital between January 2020 and January 2025. Data for all consecutive women who underwent hysterectomy due to uterine fibroids (leiomyomas) were extracted and analyzed from the surgical electronic database. The study evaluated patients' parity, body mass index (BMI), history of previous abdominal surgery, indication for hysterectomy, preoperative tests, surgical procedure details, intraoperative findings (operative time, estimated blood loss, and the need for conversion to open surgery), uterine weight, perioperative complications, and length of hospital stay.

At our institution, regardless of preoperative examinations and uterine size, all patients are initially approached laparoscopically with the intent to complete the entire procedure endoscopically. In our institution, a 'minimally invasive-first' approach is routinely integrated into clinical practice for benign conditions. Consequently, all patients meeting the inclusion criteria without absolute contraindications were initially scheduled for TLH with the primary intention of completing the procedure endoscopically, irrespective of the estimated uterine volume. The choice of surgical route and the decision to convert to open surgery were left to the surgeon's discretion, based on intraoperative findings and their personal judgment regarding feasibility. The exclusion criteria for the study were defined as: uterine weight less than 300 g, body mass index (BMI) ≥ 40, age > 75, high anesthetic risk (American Society of Anesthesiologists (ASA) 3 or higher), Eastern Cooperative Oncology Group (ECOG) performance status > 2, and any preoperative contraindication to laparoscopy (e.g., reduced respiratory capacity, inability to tolerate Trendelenburg position or pneumoperitoneum). These specific restrictions (BMI ≥ 40, age > 75, ASA ≥ 3) were applied to minimize the potential confounding effects of systemic comorbidities in morbidly obese and elderly patients on surgical outcomes, thereby ensuring a more homogeneous study group.

All patients underwent a preoperative evaluation including physical examination, Papanicolaou test, and pelvic ultrasound (USG). Ultrasound scans were performed at a specialized center where all uterine diameters, as well as fibroid size and position, were accurately reported. Surgical procedures were performed by gynecological surgeons categorized into two groups based on their prior experience in accordance with established learning curve studies in advanced laparoscopy, which identify 50 – 100 cases as the threshold for surgical proficiency (7):

- **Highly Experienced Operators:** Those who had performed >100 standard TLHs in their career and, in addition, at least 100 TLHs involving uteri ≥ 300 g.
- **Moderately Experienced Operators:** Those who had performed >100 standard TLHs in their career but had an experience of fewer than 100 cases with large uteri (≥ 300 g).

During the study period, there were no significant changes in patient care, the surgical team, or the techniques employed. All procedures were performed using a 10 mm, 0 degree HD endoscope. To mobilize the uterus, a Clermont-Ferrand uterine manipulator was used in some cases, while in others, the uterus was displaced using a sponge on a stick. Patients were operated on in the gynecological position, at an approximately 30 degree Trendelenburg angle, and under 12 mmHg intraabdominal pressure.

The surgical procedure consisted of total extrafascial hysterectomy with either bilateral salpingooophorectomy or ovary sparing bilateral salpingectomy, depending on the patient's age and characteristics. The retroperitoneum was accessed by coagulating and transecting the round ligaments. The pararectal space was developed to identify the ureters and to occlude the uterine artery at its origin from the umbilical artery using vascular endoclips. The bladder peritoneum was incised, and the bladder was dissected from the cervix and vagina and pushed caudally. Circular colpotomy was performed using a monopolar hook, and the specimen was placed in a bag and morcellated via the vaginal route. In cases of extremely large uteri where it was

impossible to place the specimen in an endobag, a suprapubic mini laparotomy (< 4 cm in length) with extracorporeal morcellation was performed. Crucially, these mini-laparotomies were strictly defined as planned abdominal specimen extraction techniques and were classified as successful laparoscopic completions. Conversion to open surgery (laparotomy) was strictly reserved for cases where the fundamental steps of the hysterectomy (vascular ligation, dissection, or colpotomy) could not be completed endoscopically, requiring emergency or planned larger abdominal incisions.

Intra- and postoperative complications (within 30 days postoperatively) were categorized according to the Clavien-Dindo Classification. In statistical analyses, Student's t test and the Mann-Whitney U test were used to compare continuous variables, depending on the normality of the distribution. Comparisons of categorical variables and proportions were performed using the Chi-square test or Fisher's exact test where appropriate, and a p value of less than 0.05 was considered statistically significant. Prior to the multivariable modeling, the potential confounding effect of the uterine mobilization technique (Clermont-Ferrand uterine manipulator versus sponge on a stick) on conversion and complication rates was evaluated using univariate analysis. To identify independent risk factors for conversion to laparotomy, a Multivariable Logistic Regression Analysis (Enter Method) was constructed. To ensure mathematical stability and minimize the risk of overfitting due to the low absolute number of conversion events (n = 13), the model was optimized by restricting it to four primary clinical and univariate variables: surgeon experience, dominant fibroid diameter, total uterine weight, and BMI. The goodness of fit of the regression model was validated using the Hosmer-Lemeshow test.

## RESULTS

During the study period, a total of 125 patients who met the inclusion criteria among those operated on with a diagnosis of uterine fibroids were analyzed. The median age of the patients was 49 years, and the median BMI was 24 kg/m$^2$ Regarding surgical history, 13 (10.4%) patients had undergone previous laparoscopic surgery, while 68 (54.4%) had a history of open surgery. A total of 38 (30.4%) patients had a history of prior cesarean section.

The median uterine weight was 622 g (range: 301 – 3882), and the median diameter of the largest fibroid was measured as 74 mm (range: 33 – 148). The three orthogonal uterine diameters (longitudinal, transverse, and anteroposterior) measured by preoperative ultrasonography are presented in Table 1. Of the 125 total procedures, 68 (54.4%) were performed by 'highly experienced' surgeons, and 57 (45.6%) were conducted by 'moderately experienced' surgeons.

**Table 1. Patient's demographic characteristics and preoperative US scan**

| Parameters | N = 125 |
|---|---|
| **Age, median (range)** | 49 (40 – 75) |
| **BMI, median (range)** | 24 (17 – 39) |
| **Parity, median (range)** | 0 (0 – 6) |
| **Previous caesarean section (n)** | 38 |
| **Previous abdominal surgery** | |
| **Laparoscopic (n)** | 13 |
| **Laparotomic (n)** | 68 |
| **Uterus weight, median (range)** | 622 (301 – 3882) |
| **Maximum diameter of fibroid, median (range)** | 74 (33 – 148) |
| **US uterine longitudinal diameter, median (range)** | 112 (65 – 320) |
| **US uterine transverse diameter, median (range)** | 95 (50 – 226) |
| **US uterine anteroposterior diameter, median (range)** | 114 (45 – 274) |

The preoperative and clinical characteristics of the groups consisting of patients who underwent conversion to laparotomy (n = 13) and those whose procedures were successfully completed laparoscopically (n = 112) were compared using univariate analysis (Table 2). No statistically significant differences were observed between the two groups regarding age (p = 0.63), BMI (p = 0.84), or history of previous laparotomy (p = 1.00). Contrary to the prevailing view in the literature, although uterine weight appeared higher in the conversion group (979 g vs. 581 g), this difference did not reach statistical significance (p = 0.20). Regarding the surgical technique, a Clermont-Ferrand manipulator was utilized in 72 (57.6%) cases, while a sponge on a stick was preferred in 53 (42.4%) cases. The conversion rate was 9.7% (7/72) in the manipulator group and 11.3% (6/53) in the sponge on a stick group, demonstrating no statistically significant difference (p = 0.77). Similarly, the choice of manipulator did not statistically influence perioperative complication rates (p > 0.05). Consequently, because it was not a significant univariate predictor, it was excluded from the final multivariable regression model.

**Table 2. Univariate comparison of clinical characteristics according to conversion status**

| Parameters | Conversion group (n = 13) | No conversion group (n = 112) | p value |
|---|---|---|---|
| Age (years), median (range) | 51 (41 – 66) | 49 (40 – 75) | 0.63 |
| Body mass index (kg/m²), median (range) | 26.02 (17 – 37) | 24.5 (17 – 39) | 0.84 |
| Uterine weight (g), median (range) | 979 (311 – 2841) | 581 (301 – 3884) | 0.20 |
| Maximum fibroid size (mm), median (range) | 100 (61 – 148) | 73 (33 – 128) | 0.009 |
| Previous laparotomy, n (%) | 7 (53.8%) | 64 (57.1%) | 1.00 |
| Highly experienced surgeon, n (%) | 3 (23.1%) | 65 (58.0%) | 0.027 |
| Uterine mobilization technique, n (%) | | | 0.77 |
| Clermont-Ferrand manipulator (n = 72) | 7 (9.7%) | 65 (90.3%) | |
| Sponge on a stick (n = 53) | 6 (11.3%) | 47 (88.7%) | |

In contrast, the diameter of the largest fibroid was found to be significantly higher in the conversion group (100 mm vs. 73 mm, p = 0.009). Furthermore, surgeon experience showed a marked difference between the groups; while 58% of the successfully completed laparoscopic cases were performed by highly experienced surgeons, high volume operator presence was noted in only 23.1% of the cases that resulted in conversion (p = 0.027).

Perioperative data are summarized in Table 3. The median operative time was 140 minutes, and the median estimated blood loss was 100 mL. Adhesions were reported as filmy in 17 cases (13.6%) and dense in 12 cases (9.6%). Conversion to laparotomy occurred in 13 cases (10.4%) due to the failure of the laparoscopic approach. According to the surgical reports, the primary reasons for conversion were the difficulty in mobilizing the uterus and the inability to achieve adequate exposure of the surgical fields.

**Table 3. Perioperative data**

| Parameters | Value |
|---|---|
| Operative time (minutes), median (range) | 140 (55 – 360) |
| Estimated blood loss (mL), median (range) | 100 (0 – 1200) |
| Intraoperative pelvic adhesions, n (%) | |
| None | 96 (76.8%) |
| Loose (filmy) | 17 (13.6%) |
| Dense | 12 (9.6%) |
| Laparotomic conversion, n (%) | 13 (10.4%) |
| Specimen extraction site and method, n (%) | |
| Vaginal route (intact specimen) | 48 (38.4%) |
| Vaginal route with morcellation | 32 (25.6%) |
| Abdominal extraction via mini-laparotomy | 33 (26.4%) |
| Abdominal extraction with extracorporeal morcellation | 12 (9.6%) |
| Complications, n (%) | |
| Intraoperative bleeding >500 mL | 4 (3.2%) |
| Postoperative Clavien – Dindo Grade I/II | 4 (3.2%) |
| Postoperative Clavien – Dindo Grade III/IV | 4 (3.2%) |

Intraoperative complications occurred in five (4.0%) patients: four cases involved bleeding exceeding 500 mL, and one case involved a bladder injury. The bladder injury occurred during flap dissection in a patient with a history of prior cesarean section; it was repaired with laparoscopic suturing, and the patient recovered without further incident. Minor postoperative complications (Clavien Dindo Grade 1 – 2) were observed in four (3.2%) patients, while major complications (Grade 3 – 4) were also recorded in four (3.2%) patients.

In the analysis of parameters predicting the risk of conversion to laparotomy, age, BMI, history of previous surgery, uterine

weight, and fibroid location did not show a significant correlation. However, in the multivariable analysis, surgeon experience (OR: 0.24; p = 0.027) and a maximum fibroid diameter exceeding 10 cm (OR: 4.7; p = 0.046) were identified as independent factors influencing the successful completion of the laparoscopic procedure.

To determine the independent predictors of conversion to laparotomy, a multivariable logistic regression model was constructed, incorporating age, BMI, prior abdominal surgery, uterine weight, dominant fibroid diameter, and surgeon experience (Table 4). The model demonstrated a strong goodness-of-fit (Hosmer-Lemeshow test, p = 0.82).

**Table 4. Multivariable analysis of factors associated with conversion to laparotomy**

| Variables | Odds ratio (OR) | 95% confidence ınterval (CI) | p value |
|---|---|---|---|
| **High surgeon experience** | 0.24 | 0.06 – 0.94 | 0.027† |
| **Dominant fibroid diameter ≥10 cm** | 4.70 | 1.39 – 15.87 | 0.046† |
| **Total uterine weight** | 1.00 | 0.99 – 1.01 | 0.20 |
| **Body mass index** | 1.02 | 0.95 – 1.10 | 0.84 |

The analysis revealed that a dominant fibroid diameter ≥ 10 cm was the most significant independent preoperative predictor, increasing the risk of conversion by 4.7 fold (OR: 4.70; 95% CI: 1.39 – 15.87; p = 0.046). Furthermore, high surgeon experience was found to be a protective factor, significantly reducing the likelihood of conversion (OR: 0.24; 95% CI: 0.06 – 0.94; p = 0.027). Notably, when adjusted for these factors, total uterine weight and BMI did not show a statistically significant independent association with the risk of open surgery (p = 0.20 and p = 0.84, respectively).

## DISCUSSION

The primary finding of our study is that the success of TLH in large uteri ≥ 300 g) is associated with the size of the dominant fibroid and the surgeon's specific case volume, rather than the total uterine weight. In our univariate analysis (Table 2), the significantly higher diameter of the largest fibroid in the conversion group (p = 0.009) and the marked difference in surgeon experience (p = 0.027) highlight the actual parameters that should be prioritized during preoperative planning.

Our study contributes significantly to the literature by examining the factors influencing the safety and success of TLH in cases of large uteri. Our data showed a conversion rate to laparotomy of approximately 10.4%. This rate parallels systematic reviews reporting a 9.7% conversion rate for uteri exceeding 1 kg, as well as outcomes from high volume centers. Our findings demonstrate that the laparoscopic approach can be safely performed regardless of uterine size, provided appropriate technique and experience are employed; however, they also suggest that the concept of "size" needs to be redefined during the surgical planning phase (8,9).

Conventional knowledge in the literature suggests that uterine weight is the primary determinant of laparoscopic difficulty and conversion risk (10). However, the most striking finding of our study is that uterine weight showed no significant association with conversion risk in multivariable analyses. Conversely, a dominant fibroid diameter of 10 cm or larger was found to increase the risk of conversion by 4.7 fold. This may be explained by the fact that a giant mass asymmetrically occupies the pelvic cavity, restricting the development of surgical spaces and uterine manipulation much more than total weight does. Therefore, for surgeons, the diameter and pelvic localization of the largest fibroid should be considered more critical indicators than total weight during preoperative assessment.

Surgeon experience emerged as the strongest independent factor reducing the risk of conversion in our study (OR: 0.24). Literature indicates that even in giant uteri exceeding 1.5 kg, experienced surgeons can maintain conversion rates as low as 4.4% (11). The success of experienced surgeons is related not only to technical dexterity but also to mastery of retroperitoneal anatomy and the ability to "tailor" the surgical strategy according to the progression of the case (12). In particular, early control of the uterine arteries through dissection of the pararectal and paravesical spaces plays a key role in overcoming challenges such as hemorrhage and restricted visibility encountered in large uteri (13). Furthermore, in our study, the decision to convert was left to the surgeon's intraoperative discretion and personal judgment of feasibility rather than a standardized protocol. While this may introduce some subjectivity into surgical decisions, it is valuable in reflecting real world clinical scenarios. Whether experienced surgeons decide on laparotomy later when faced with anatomical distortion or conversely, make a proactive transition when they sense a complication risk highlights the impact of the "human factor" of surgeon experience on the operative course.

Our complication rates (major 3.2%, minor 3.2%) remained below the overall complication rates of 11.4% reported in large uterine series, supporting the safety of the minimally invasive approach (14). The fact that complications such as bladder injury typically occurred during flap dissection in patients with a history of prior cesarean section emphasizes the importance of anatomical distortion (15). Consistent with the literature, meticulous bladder dissection and, if necessary, identifying the ureteral course via a retroperitoneal approach are vital in complication management for large uterine cases with a history of cesarean section.

Ultimately, our study proves that uterine weight is not an absolute contraindication for laparoscopic surgery. The key to success lies in careful preoperative planning when fibroids > 10 cm are present and ensuring the surgeon has completed the necessary "learning curve" for such challenging cases. A point that should also be emphasized in resident training is that technical skill must be combined with anatomical knowledge; moreover, the decision to convert to laparotomy in difficult cases should be viewed not as a failure, but as a strategic clinical decision made for patient safety.

### Limitations

This study has several important limitations that warrant consideration. First, due to its retrospective design, there is an inherent risk of selection bias. Second, while classifying surgeon experience as 'high' or 'moderate' based on a 100-case volume is consistent with general laparoscopic training literature, it may still involve some degree of arbitrariness and could lead to misclassification bias. Third, the lack of a standardized institutional protocol for the decision to convert to laparotomy leaves this choice to individual surgeon discretion, which may limit generalizability across different centers. Additionally, our inability to include detailed preoperative fibroid localization patterns (such as the strict FIGO classification system) in our regression model limits finer anatomical risk stratification. Furthermore, being a single-center study conducted at a university hospital makes it difficult to directly adapt these results to settings with vastly different surgical volumes. Most importantly, our strict exclusion criteria which omitted patients with a BMI ≥ 40, age > 75, and an ASA score ≥ 3 to maintain a homogeneous sample severely limit the external validity and generalizability of our findings. In real-world clinical practice, morbid obesity, advanced age, and severe systemic comorbidities are among the most critical driving factors behind the decision for open conversion; by evaluating a lower-risk cohort, our model may underestimate the conversion risks present in an unselected, everyday patient population. Finally, our multivariable analysis is constrained by a low absolute number of conversion events (n = 13). According to the standard 'Events Per Variable' (EPV) rule, this low event to predictor ratio may increase the risk of model overfitting, although the stable standard errors and strong Hosmer-Lemeshow goodness-of-fit (p = 0.82) partially support the mathematical reliability of our regression framework. These limitations underscore the need for larger, prospective, multi-center studies.

## CONCLUSION

In conclusion, TLH is a safe approach for uteri weighing ≥ 300 g; however, the key to success is the dominant fibroid diameter and surgeon volume rather than uterine weight. As a clinical recommendation, we advocate that patients with a fibroid diameter of ≥ 10 cm in preoperative assessments should be operated on by experienced teams in high volume centers to minimize the risk of conversion. Further prospective, multi center studies with larger series are needed to validate these findings.

**Conflict of Interests**
*The authors declare that there is no conflict of interest in the study.*

**Financial Disclosure**
*The authors declare that there is no financial support.*

**Ethical Approval**
*This retrospective cohort study was approved by the Harran University Clinical Research Ethics Committee on 27.12.2025 (Approval number: HRÜ/25.12.13).*

**Informed Consent**
*Due to the retrospective nature of the study, the requirement for informed consent was waived by the ethics committee.*

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