

## Original Research

# Impact of Uterine Size on Outcomes of Total Laparoscopic Hysterectomy for Uterine Leiomyomas

Tomoka Ishibashi<sup>1</sup>, Kentaro Nakayama<sup>1,\*</sup>, Sultana Razia<sup>1</sup>, Hitomi Yamashita<sup>1</sup>,  
Masako Ishikawa<sup>1</sup>, Seiya Sato<sup>1</sup>, Satoru Kyo<sup>1</sup>

<sup>1</sup>Department of Obstetrics and Gynecology, Shimane University School of Medicine, 6938501 Izumo, Japan

\*Correspondence: [kn88@med.shimane-u.ac.jp](mailto:kn88@med.shimane-u.ac.jp) (Kentaro Nakayama)

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## Abstract

**Background:** Given that total laparoscopic hysterectomy (TLH) is less invasive than open surgery, its popularity has increased in Japan. The aim of the present study was to determine the most appropriate uterine size for the safe completion of TLH for the treatment of uterine leiomyomas. **Methods:** This retrospective study included 505 patients who underwent TLH for uterine leiomyomas. Patients were divided into three groups according to the weight of the excised uterus (<500 g, n = 347; 500–1000 g, n = 125; >1000 g, n = 33). TLH procedures were performed by a resident physician under the supervision of an attending physician. Clinical outcomes including blood loss and duration of surgery were collected from patients' electronic medical records and compared according to uterine size. Magnetic resonance imaging (MRI) was performed prior to TLH for detection, localization, and measurement of the myoma. **Results:** Mean operation times were shortest (<500 g: 163 min; 500–1000 g: 190 min; >1000 g: 209 min) and the mean volume of blood lost was lowest (<500 g: 116 mL; 500–1000 g: 208 mL; >1000 g: 402 mL) in patients with a uterus weighing less than 500 g. There were no significant differences in operation time or bleeding between those with a uterine weight of 500–1000 g or >1000 g. MRI revealed that myomas tended to be restricted within the sacral promontory in patients with uterine weights <500 g, whereas those in the other two groups tended to extend beyond this region. **Conclusions:** TLH outcomes are best when the uterine weight is <500 g. The use of MRI prior to TLH may provide insights into uterine size and/or mass and thus allow for improved surgical planning.

**Keywords:** uterus; total laparoscopic hysterectomy; myoma; MRI

## 1. Introduction

Uterine leiomyomas are benign monoclonal tumors affecting the smooth muscle cells of the myometrium, comprising a large amount of extracellular matrix containing collagen, fibronectin, and proteoglycan [1,2]. Leiomyomas grow in 80% of women and can cause exhaustion symptoms such as heavy, irregular, and prolonged uterine bleeding; anemia; bulk symptoms (e.g., pelvic pressure/pain, obstructive symptoms) and fertility issues. Myomas affect different races differently: Myoma-related symptoms are more common in African American women, who often exhibit higher numbers of leiomyomas with larger uteri, which may increase the incidence of complications or blood transfusion requirements when compared with rates observed in Caucasian women [3–5]. Medical management using hormone-based preparations (e.g., oral contraceptives, levonorgestrel containing intrauterine system (IUSs), and gonadotropin releasing hormone (GnRH) agonists) is possible in patients with symptomatic uterine myomas [6]. While these therapies provide varying degrees of control in patients with abnormal uterine bleeding, most do not act directly on the myomas. Thus, surgical intervention remains the mainstay of uterine leiomyoma treatment.

In the United States, more than 250,000 hysterec-

tomies are performed annually for the treatment of myoma only [7]. Medical and surgical treatment of leiomyomas can negatively influence the reproductive system, causing significant morbidity and decreasing quality of life [8,9], and leiomyomas can relapse after non-hysterectomy treatment. The parameters of surgical treatment for these tumors depend on their size and location. When compared with open surgery, total laparoscopic hysterectomies (TLHs) are less invasive, having gradually obtained acceptance as an alternative approach to tumor excision in Japan due to decreased blood loss and shorter hospital stays [10]. TLHs have been the subject of significant controversy, however, especially in patients with a large uterus. Previous reports have considered uterine sizes in patients beyond 12 weeks of gestation or greater than 280 g large [11,12]. These large uteri are frequently associated with an increased risk of complications and morbidities, such as intraoperative bleeding, postoperative complications, and longer hospital stays following TLH [13]. On the other hand, some have also suggested that TLH is preferable to other surgical approaches in patients with enlarged uteri undergoing total abdominal hysterectomy [14,15].

The present study aimed to evaluate the association between uterine size and complications in patients with leiomyoma who had undergone TLH between 2014 and



2021 at Shimane Medical University hospital. We sought to determine the uterine size for which the TLH approach is most effective in these patients.

## 2. Materials and Methods

### 2.1 Study Design and Data Collection

This study was conducted in the Department of Obstetrics and Gynecology at Shimane Medical University Hospital in Japan. The study included 505 patients who underwent TLH between July 2014 and December 2021. All patients had benign indications for TLH such as abnormal uterine bleeding, pelvic pain, fibroid uterus, and endometriosis. All operations were performed by a resident physician under the supervision of an attending physician. All patients underwent physical examination including pelvic ultrasonography, blood tests, and a detailed evaluation of clinical history. Patients were hospitalized the day before surgery. All patients provided written informed consent for laparoscopic surgery. This work was authorized by the Institutional Review Board of Shimane University (IRB no. 201912120-1).

Patient groups were defined according to uterine weight following excision on pathological examination: Group A included patients with a uterine weight <500 g ( $n = 347$ ), group B included patients with a uterine weight of 500–1000 g ( $n = 125$ ), and group C included patients with a uterine weight >1000 g ( $n = 33$ ). Data including age, preoperative symptoms, surgical duration, bleeding volume, uterine weight upon pathological examination, and follow-up records were curated from patients' electronic medical records. Magnetic resonance imaging (MRI) was performed prior to TLH in each patient for preoperative detection and localization of myoma, as well as to measure the length of the uterine cavity depending on the size of the myoma.

### 2.2 Statistical Analyses

Student's  $t$ -test was used to compare data among the three groups.  $p$ -values < 0.05 were considered statistically significant. These data were statistically analyzed by using the SPSS 27.0 (IBM Corporation, Armonk, NY, USA) software.

## 3. Results

Data were analyzed for a total of 505 patients who had undergone TLH for benign conditions. The median ages of patients in group A (uterine weight <500 g), group B (uterine weight 500–1000 g), and group C (uterine weight >1000 g) were 47.9 (range: 37–81), 46.3 (range: 37–59), and 47.4 (range: 36–56) years, respectively, and there were no significant differences in age among the groups. The median weights of uterine myoma in groups A, B, and C were 254.9 g (range: 41–499.5), 686.4 g (range: 500–993), and 1278.8 g (range: 1000–2000), and the differences between

groups were significant ( $p = 0.000$ ) (Table 1). Intraoperative parameters such as surgical duration and blood loss are shown in Table 1. No surgery required conversion to laparotomy.

Mean intraoperative blood loss was significantly lower in group A (mean: 116 mL; range: 10–1000 mL) than in group B (mean: 208 mL; range: 10–2060 mL) or C (mean: 402 mL; range: 10–3500 mL). No significant differences in blood loss were observed between groups B and C (Fig. 1, Table 1). Mean surgical duration was significantly shorter in group A (mean: 163 min; range: 231–242 min) than in group B (mean: 190 min; range: 106–408 min) or C (mean: 209 min; range: 106–453 min). No significant differences in surgical duration were observed between groups B and C (Fig. 2, Table 1). MR imaging revealed that enlarged uteri weighing over 500 g extended beyond the sacral promontory. However, in patients with uteri under 500 g, a hypointense area was observed anterior to the sacral promontory (Fig. 3). Representative pathological images of excised uteri for the three groups are presented in Fig. 4.

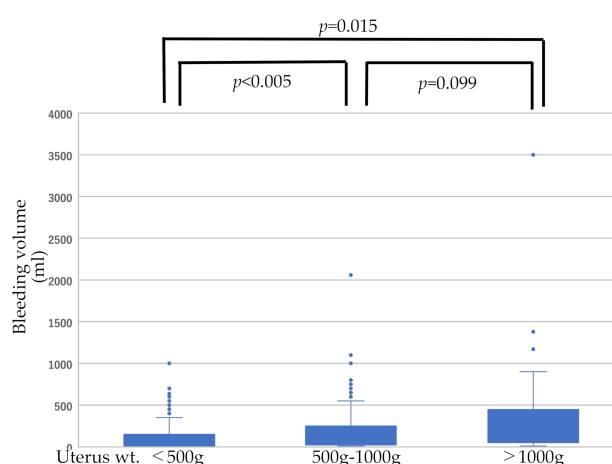


Fig. 1. Blood loss further stratified by uterine weight.

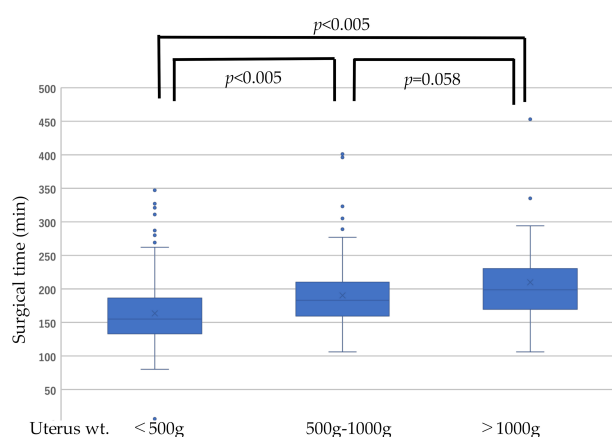
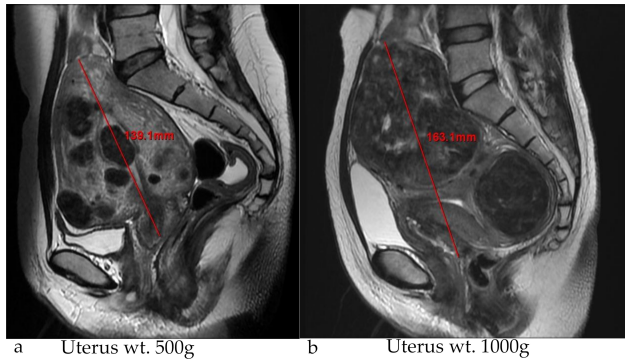


Fig. 2. Surgical duration further stratified by uterine weight.

**Table 1. Clinical characteristics and outcomes of patients undergoing total laparoscopic hysterectomy.**

Variable	Group A (n = 347)	Group B (n = 125)	Group C (n = 33)	<i>p</i> values		
	Uterus <500 g	Uterus 500–1000 g	Uterus >1000 g	A vs. B	A vs. C	B vs. C
Age, years	47.9 (28–82)	46.3 (32–63)	47.4 (34–55)	0.204	0.149	0.473
Total myoma weight, g	254.9 (41–499.5)	686.4 (500–993)	1278.8 (1000–2000)	0.000	0.000	0.000
Bleeding volume, mL	116 (10–1000)	208 (10–2060)	402 (10–3500)	0.005	0.015	0.099
Surgical duration, min	163.3 (231–242)	190.3 (106–408)	209 (106–453)	0.005	0.005	0.058



**Fig. 3. MRI comparison.** (a) MRI image showed that myoma wt more than 500g restricted inside the sacral promontary. (b) more than 500 g extended beyond the sacral promontary .



**Fig. 4. Representative images of uterine myomas weighing.** (a) 440 g, (b) 960 g, and (c) 1960 g following pathological examination.

## 4. Discussion

Uterine leiomyomas are the most common tumors arising from the female reproductive tract. These tumors slowly increase in size, and treatment is considered when their presence is associated with certain symptoms such as hypermenorrhea, abdominal pain, abdominal distension, and infertility.

Technological advances continue to revolutionize the surgical treatment of gynecologic conditions. Innovations in minimally invasive surgery for TLH were first documented by Reich *et al.* [16], since which their application has increased in Japan. However, TLH should be performed by experienced surgeons to avoid complications, such as injury to the bladder and rectum [17–19]. TLH was initiated in our department in 2014 and has been carried out since then as a standardized procedure. The amount of time needed for this surgery has decreased in recent years

as the number of TLH cases has increased. Prior work has demonstrated that TLH reduces the length of hospitalization, the volume of blood loss, surgical duration, and rates of rare complications regardless of uterine weight [10]. Surgeons may experience difficulties and potential risk when handling cases with enlarged uteri, which can limit the operative field and prolong procedure time. No specific guidelines have provided standardized limitations related to TLH based on uterine size. Although hypogastric artery ligation has been found to reduce blood loss in more complex laparoscopic hysterectomy [20] but this technique is still challenging.

In the current study, we investigated the relationship between uterine weight and surgical outcomes including postoperative bleeding and operation time. Median operating time as well as blood loss varied based on uterine weight, and the smallest uteri (<500 g) were associated with the shortest operation time (mean: 163 min; range: 231–242 min) and the least blood loss (mean: 116 mL; range: 10–1000 mL). Operation time and blood loss did not significantly differ between those with uterine weights ranging from 500–1000 g (190 min, 208 mL) and those with uterine weights >1000 g (209 min, 402 mL). These results are similar to those reported by O’Hanlan *et al.* [21], who also observed shorter procedure duration and less blood loss in patients with uterine weights  $\geq 250$ –500 g (120 min, 100 mL). However, neither the duration of surgery or the level of blood loss differed between patients with uterine weights  $\geq 500$ –1000 g (160 min, 200 mL) and  $\geq 1000$ –1500 g (165 min, 200 mL). These results indicate that the total surgical time was longer and estimated blood levels were higher in our study than in previous studies. In the present study, TLH was performed by a resident under the supervision of an attending physician, which may explain these differences.

Taken with previous findings, the current results indicate that uterine weights <500 g are associated with shorter operation times and lower volumes of blood loss than uterine weights over 500 g. Bonilla *et al.* [13] reported uterine weights over 500 g were associated with the duration of hospitalization, risk of blood loss, and other post-operative difficulties in patients undergoing both abdominal and laparoscopic hysterectomies ( $p \leq 0.001$ ). Similarly, Shigemitsu *et al.* [22] reported the limitations of TLH related to uterine volume and observed that operation times increased as uterine weight increased. Uterine enlargement can re-

strict the operative field throughout TLH, increasing the risk of bowel injury, ureter injury, and other complications. Furthermore, several studies have suggested that TLH can be performed successfully by experienced surgeons in patients with enlarged uteri, reporting no differences in complication rates between weights of 700 g and up to 2240 g [23,24]. However, another study reported an increased requirement for blood transfusion in patients with enlarged uteri [25].

These data suggest that TLH is ideal when an individual patient's uterine weight is <500 g whether the procedure is performed by a resident physician or general gynecologist. When the uterus is too large, only experienced surgeons should perform TLH, and preparation for blood loss is essential before surgery in case blood transfusion becomes necessary. Performing MRI prior to TLH can provide some insights into myoma weight and may serve as the best imaging modality for preoperative diagnosis prior to TLH. For instance, when MRI reveals an enlarged myoma restricted to the sacral promontory weighing less than 500 g, TLH may be deemed safe. However, as our study included a limited number of patients, larger studies are required to verify these findings.

## 5. Conclusions

The present study demonstrated that TLH can be performed safely by resident physicians when the uterine size is <500 g. MRI prior to TLH can provide insights into the uterine size and/or mass, which may improve surgical planning.

## Author Contributions

TI, SR, KN drafted the manuscript. HY, MI, and SS collected data; TI performed statistical analysis; KN participated in this study; SK participated in coordinating this study. All authors read and approved the final manuscript.

## Ethics Approval and Consent to Participate

All patients provided written informed consent for laparoscopic surgery. This work was authorized by the Institutional Review Board of Shimane University (IRB no. 201912120-1).

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## Conflict of Interest

The authors declare no conflict of interest. KN is serving as one of the Guest editors of this journal. We declare that KN had no involvement in the peer review of this article and has no access to information regarding its peer review.

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