

Original Research

Identifying Risk Factors for Complications in Gynecologic Laparoscopic Surgery: A Retrospective Study

Aiwen Le^{1,*}, Yahong Xu¹, Jinyuan Cui¹

¹Department of Gynaecology, Huazhong University of Science and Technology Union Shenzhen Hospital/Shenzhen Nanshan People's Hospital/the Sixth Affiliated Hospital of Shenzhen University Health Science Center, 518052 Shenzhen, Guangdong, China

*Correspondence: Leaiwen362531@126.com (Aiwen Le)

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Abstract

Background: This study aimed to investigate the risk factors associated with complications following gynecologic laparoscopic surgery. **Methods:** A retrospective analysis was conducted on patients who underwent gynecologic laparoscopic surgery at Huazhong University of Science and Technology Union Shenzhen Hospital between January 2005 and October 2021. The study population was divided into four groups based on the type of surgery: adnexal surgery, myomectomy/other uterine lesions, laparoscopically assisted vaginal hysterectomy (LAVH)/total laparoscopic hysterectomy (TLH), and surgery for malignancy. The rates of major and minor complications were compared and factors influencing the occurrence of complications were analyzed. **Results:** A total of 15,308 patients were included in this study. The rates of major and minor complications were 0.51% (78/15,308) and 4.64% (711/15,308), respectively. Multivariate logistic regression analysis revealed that older age (31–60 years-old vs. 18–30 years-old: adjusted odds ratio (aOR): 2.88, 95% confidence interval (CI): 1.89–7.88; >60 years-old vs. 18–30 years-old: aOR: 2.92, 95% CI: 1.67–5.65), prior abdominal surgery (aOR: 3.58, 95% CI: 1.38–6.54), obesity (aOR: 2.52, 95% CI: 1.39–7.28) and surgical complexity (myomectomy/surgery for other uterine lesions vs. adnexal surgery: aOR: 1.56, 95% CI: 1.23–3.45; LAVH/TLH vs. adnexal surgery: aOR: 3.87, 95% CI: 1.39–8.23; surgery for malignancy vs. adnexal surgery: aOR: 7.62, 95% CI: 3.61–13.63) were associated with major complications. **Conclusion:** The rates of major and minor complications following gynecologic laparoscopic surgery were found to be low. Age, surgical complexity, previous abdominal surgery, and obesity are identified as risk factors for major complications.

Keywords: gynecologic surgical procedures; iatrogenic disease; laparoscopic surgery; risk factors

1. Introduction

Laparoscopic surgery is commonly employed for the treatment of various benign and malignant gynecologic diseases. This approach offers several advantages over open surgery, including reduced trauma, faster postoperative recovery, and fewer complications than open surgery [1]. However, there are potential complications associated with gynecologic laparoscopic surgery, such as injuries to major blood vessels, bowel and genitourinary structures; incisional hernias; port-site metastases; and gas embolism [2,3]. The overall complication rate of gynecologic laparoscopic surgery ranges from 0.69% to 6.22% [3,4], with major complications occurring in approximately 2.84% of cases [2,3]. Notably, many of these major complications arise during the entry stage of the procedure [5].

Factors known to increase the risk of major complications in patients undergoing gynecologic laparoscopic surgery include advanced age, higher body mass index (BMI), smoking, use of carbon dioxide, previous abdominal surgery, preoperative diseases, American Society of Anesthesiologist score of III or higher, higher predicted preoperative uterine weight (in cases of hysterectomy), and a postoperative increase in fibrinogen level of ≥ 20 [3,6–9]. Understanding the factors associated with major com-

plications after gynecologic laparoscopic surgery is crucial for surgeons to identify patients at higher risk and implement appropriate management strategies to mitigate these risk factors.

However, there is a lack of comprehensive data on the risk factors for major complications of gynecologic laparoscopic surgery in Chinese patients. Therefore, the objective of this study was to assess the incidence of complications in Chinese patients who underwent gynecologic laparoscopic surgery and identify the risk factors associated with both major and minor complications.

2. Materials and Methods

2.1 Study Design and Population

This retrospective study enrolled all patients who had undergone gynecologic laparoscopic surgery at Huazhong University of Science and Technology Union Shenzhen Hospital (Shenzhen, China) between January 2005 and October 2021. The inclusion criteria were as follows: (1) age above 18 years; (2) underwent gynecologic laparoscopic surgery; (3) having been initially assessed in other departments through laparoscopy but later diagnosed with a gynecological disease, and transferred to the gynecological department for surgery. The exclusion criteria were: (1) com-



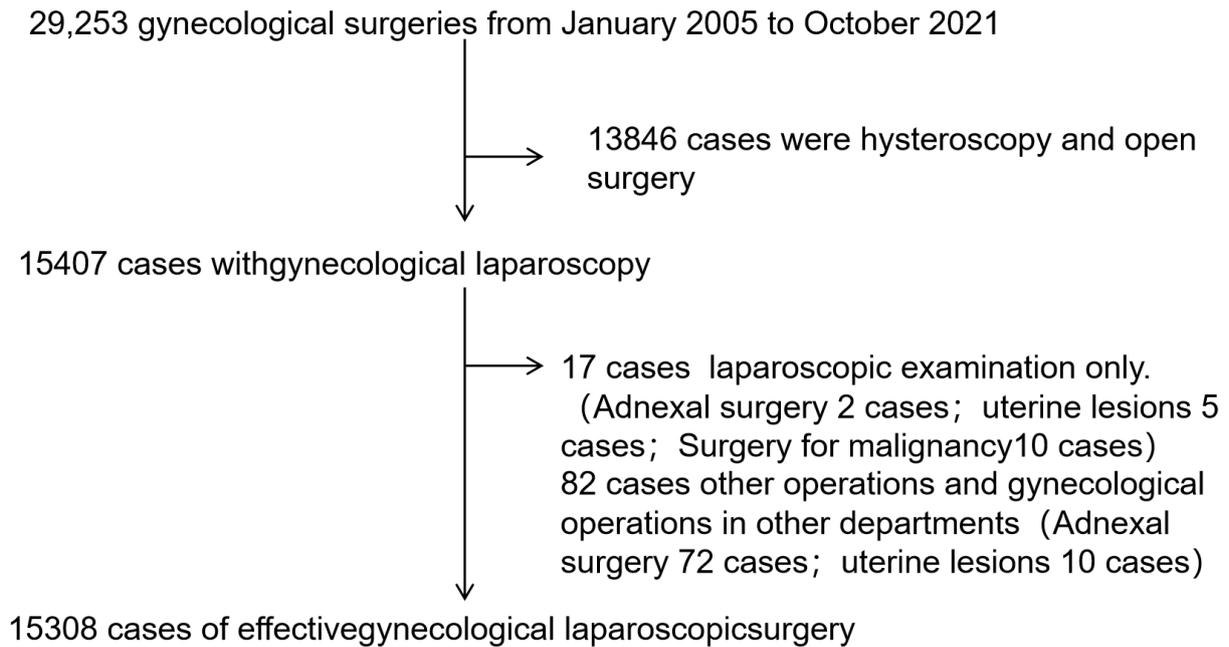


Fig. 1. Flow charts of patients.

bined with other surgeries; (2) open surgery; (3) incomplete data; (4) cases involving only laparoscopy or biopsy subsequent surgery, primarily for advanced ovarian cancer that was deemed inoperable; (5) simultaneous performance of other non-gynecological surgeries in different departments. This study was approved by the Medical Ethics Committee of Huazhong University of Science and Technology Union Shenzhen Hospital (No. LW-2023-005) and informed consent were obtained. In adherence to the guidelines set forth by the journal, our data will be made available for independent analysis by a specifically chosen team, as determined by the Editorial Team. This will serve the purpose of conducting additional data analysis or facilitating the reproducibility of our study in other research centers, if such request is made.

2.2 Data Collection and Definitions

The study collected demographic and clinical data from medical records, including age, BMI, history of prior abdominal surgery, year of surgery, type of surgery, procedural characteristics, length of hospital stay, minor complications, and major complications. Age was divided into three groups: ≤ 30 years, 31–60 years, and > 60 years. This study included all laparoscopic procedures performed between January 2005 and October 2021; complex surgeries were carried out by 12 experienced specialists, including two consultants and 10 associate consultants. All operations followed the established guidelines and were followed up for at least five months based on the patients' conditions. Retrospective data indicated changes in the doc-

tors performing gynecological laparoscopic surgery over a span of more than 16 years, with an overall improvement in the competence level of many doctors. The study categorized the year of surgery into two periods: 2005–2011 and 2012–2021. It is important to note that our hospital has been performing laparoscopic surgery since 2001, and complete datasets for patients were available from 2005 onwards. Complications were defined as any adverse events that occurred during the operation or within one week post-operation. The gynecologic laparoscopic surgeries were classified into four types: (1) adnexal surgery, (2) myomectomy or surgery for other uterine lesions (including cesarean scar pregnancy), (3) laparoscopically assisted vaginal hysterectomy (LAVH) or total laparoscopic hysterectomy (TLH), and (4) surgery for malignancy (cervical cancer underwent laparoscopic radical hysterectomy combined with pelvic lymph node dissection, and endometrial cancer underwent total laparoscopic hysterectomy combined with pelvic and para-aortic lymphadenectomy).

Complications arising from laparoscopy were categorized as major and minor. Major complications were defined as those occurring during laparoscopy or the post-operative period that necessitated additional intervention, such as laparoscopy or laparotomy. These included injuries to the intestine, urinary bladder, ureter, or major blood vessels, significant bleeding (with a volume exceeding 600 mL within 24 hours of the perioperative period), severe infective complications, and pulmonary edema. Minor complications encompassed mild bleeding or infection, fever, nerve damage, abdominal wall hematoma, urinary

Table 1. Clinical characteristics of the study participants and procedures.

Parameter	Value (n (%))
Age (years), mean \pm SD	42.25 \pm 15.21
Body mass index (kg/m ²), mean \pm SD	23.62 \pm 6.82
Prior surgery, <i>n</i> (%)	2589 (16.91)
Type of surgery, <i>n</i> (%)	
Adnexal surgery	9812 (64.10)
Myomectomy or surgery for other uterine lesions	3412 (22.29)
LAVH or TLH	1572 (10.27)
Surgery for malignancy	512 (3.34)
Length of hospital stay (days)	8.31 \pm 5.62
5–7 days, <i>n</i> (%)	13,104 (85.60)
8–10 days, <i>n</i> (%)	1560 (10.19)
>10 days, <i>n</i> (%)	644 (4.21)

SD, standard deviation; LAVH, laparoscopically assisted vaginal hysterectomy; TLH, total laparoscopic hysterectomy.

tract infection or retention, paralytic ileus, subcutaneous emphysema, genital edema, uterine perforation, and pain of unknown origin. Postoperative evaluations were conducted for all patients. Diagnostic criteria for serious infective complications included: (1) signs of infection, such as fever; (2) concurrent organ dysfunction, such as hypotension (referred to as shock blood pressure, with systolic blood pressure below 90 mmHg and diastolic blood pressure below 60 mmHg); (3) alterations in mental state; (4) respiratory failure accompanied by rapid breathing; and (5) reduced urine output, indicating poor kidney blood supply and impaired urine excretion [10,11].

2.3 Statistical Analysis

The analyses were conducted using SPSS 26.0 (SPSS, Inc., Chicago, IL, USA). Statistical significance was defined as *p*-values < 0.05. Normally distributed continuous data were presented as mean \pm standard deviation and compared between groups using Student's *t*-test. Skewed distributed continuous data were presented as median (range) and compared using the Mann-Whitney U test. Categorical data were described as *n* (%) and compared between groups using the chi-squared test. Logistic regression models were constructed to identify factors associated with major and minor complications. Adjusted odds ratios (aORs) and their 95% confidence intervals (95% CIs) were calculated. The final regression model was obtained using stepwise regression of factors with *p* < 0.05 in the univariate analysis. Statistical significance was defined as *p* < 0.05.

3. Results

This study conducted a review of 29,253 gynecological surgeries that took place between January 2005 and October 2021. Out of these surgeries, 15,407 patients underwent gynecological laparoscopic surgery. However, 82 cases involving other surgical procedures and 17 cases involving laparoscopy alone were excluded (Fig. 1) from

the analysis. Ultimately, a total of 15,308 patients who underwent effective gynecological laparoscopic operations were enrolled (a mean age of 42.25 \pm 15.21 years (range: 18–65 years) and a mean BMI of 23.62 \pm 6.82 kg/m²) (Table 1). The laparoscopic procedures performed included adnexal surgery in 9812 patients (64.10%), myomectomy/surgery for other uterine lesions in 3412 patients (22.29%), LAVH/TLH in 1572 patients (10.27%), and surgery for malignancy in 512 patients (3.34%). Among the 512 cases of malignancy, 357 patients had cervical cancer (before 2019) and underwent laparoscopic radical hysterectomy with pelvic lymph node dissection, while 155 patients had endometrial carcinoma and underwent laparoscopic total hysterectomy with pelvic and paraaortic lymphadenectomy. A total of 2589 patients (16.91%) had previously undergone pelvic surgery, and 501 patients received pelvic adhesiolysis during the current operation. The mean length of hospital stay was 8.31 \pm 5.62 days, with the majority of patients (85.60%) being discharged within 7 days (Table 1).

The overall incidence of major complications and minor complications in this study was 0.51% (78/15,308) and 4.64% (711/15,308), respectively. Table 2 summarizes the types of major and minor complications experienced by the patients. The most common major complications were bleeding (71.79% of all major complications), visceral organ injury (12.82%), infection (10.26%), and blood vessel injury (3.85%). Further details of the major complications can be found in Table 3. The most frequent minor complication was bleeding (3.01%). Intraoperative findings led to the conversion of the procedure to laparotomy in four patients (0.03%), including the discovery of an ovarian malignant tumor in two cases and the discovery of a large uterus and extensive pelvic adhesions in two cases. Additionally, one patient (0.01%) required conversion to laparotomy due to bleeding complications (Tables 2,3).

Bivariate analysis revealed several factors associated with major complications. These factors included patient

Table 2. Complications of gynecologic laparoscopic surgery.

Complication	Value (<i>n</i> = 15,308)
Major complications	78 (0.51)
Vascular injury	3 (0.02)
Bladder injury	3 (0.02)
Intestinal injury	3 (0.02)
Ureteral injury	4 (0.03)
Serious bleeding complications	56 (0.37)
Serious infection	8 (0.05)
Acute pulmonary edema	1 (0.01)
Minor complications	711 (4.64)
Severe anemia requiring transfusion	152 (0.99)
Minor bleeding	461 (3.01)
Minor infection	4 (0.03)
Wall abscess	2 (0.01)
Vaginal vault abscess	1 (0.01)
Pelvic abscess	1 (0.01)
Nerve lesion	2 (0.01)
Fever	46 (0.30)
Pain of undetermined cause	6 (0.04)
Subcutaneous emphysema	3 (0.02)
External genitalia edema	2 (0.01)
Paralytic ileus	1 (0.01)
Hernia at trocar site	3 (0.02)
Urinary tract infection	6 (0.04)
Urinary retention	9 (0.06)
Hematoma (postoperative)	10 (0.07)
Postoperative abdominal wall hematoma	8 (0.05)
Postoperative vaginal vault hematoma	2 (0.01)
Uterine perforation	6 (0.04)
Conversion to laparotomy due to intraoperative findings	4 (0.03)
Conversion to laparotomy because of complications	1 (0.01)

Data are presented as *n* (%).

age ($p = 0.027$), year of surgery ($p = 0.035$), prior abdominal surgery ($p = 0.038$), obesity ($p = 0.021$), and type of surgery ($p < 0.001$). Furthermore, bivariate analysis identified year of surgery ($p = 0.029$) and type of surgery ($p < 0.001$) as factors associated with minor complications (Table 4).

Multivariate logistic regression analysis was conducted to investigate the relationship between various factors and the occurrence of major complications. The findings revealed that individuals aged 31–60 years had a significant higher adjusted odds ratio (aOR) of 2.88 (95% CI: 1.89–7.88) for major complications compared to those aged 18–30 years. Similarly, individuals over 60 years had a significantly higher aOR of 2.92 (95% CI: 1.67–5.65) for major complications compared to those aged 18–20 years. Other independent risk factors for major complications included previous abdominal surgery (aOR: 3.58, 95% CI: 1.38–6.54), obesity (aOR: 2.52, 95% CI: 1.39–7.28), and surgical complexity. Specifically, myomectomy or surgery for other uterine lesions had an aOR of 1.56 (95% CI: 1.23–3.45) compared to adnexal surgery. Additionally, LAVH or

TLH had an aOR of 3.87 (95% CI: 1.99–8.23) compared to adnexal surgery. Finally, malignant tumor surgery had an aOR of 7.62 (95% CI: 3.61–13.63) compared to adnexal surgery. The type of surgical procedure was also associated with minor complications: LAVH/TLH had an aOR of 2.21 (95% CI: 1.20–5.42) and surgery for malignancy had an aOR of 4.56 (95% CI: 2.77–9.49) (Table 5).

4. Discussion

4.1 Results in the Context of Published Literature

A previous meta-analysis of 27 prospective randomized clinical trials demonstrated that laparoscopic surgery was associated with several benefits compared to laparotomy, including a significant reduction in pain, with an 80% decrease in the rate of surgical site infection. Additionally, patients who underwent laparoscopic surgery experienced a shorter hospital stay by two days and a faster return to physical activity by two weeks. Furthermore, laparoscopic surgery was found to reduce the rate of postoperative adhesions by 60% when compared to laparotomy [12].

Table 3. Summary of the major complications.

Site of complication (<i>n</i>)	Type of surgery (<i>n</i>)	Diagnosis (<i>n</i>)	Surgical access (<i>n</i>)	Additional information				
Vascular injury (3) Left common iliac vein (1) Right common iliac vein (1) External iliac vein (1)	Radical hysterectomy for cervical cancer (3)	Intraoperative (3)	Laparoscopy (3)	Injury occurred during separation of minor vascular branches (common iliac veins) and adhered tissue (external iliac vein). Vessels successfully repaired by suturing in all cases.				
Bladder injury (3)	Total hysterectomy with adhesiolysis (3)	Intraoperative (3)	Laparoscopy (3)	Intraoperative repair was successful in all three cases.				
Intestinal injury (3) Rectovaginal fistula (1) Colonic injury (2)	Radical hysterectomy for cervical cancer (1) Total hysterectomy for adenomyosis (2)	Postoperative (1) Intraoperative (2)	Transvaginal (1) Laparoscopy (2)	Rectovaginal fistula diagnosed after yellow-green vaginal discharge developed on post-op day 5; transvaginal repair was successful. Colonic injuries were detected and repaired intraoperatively.				
Distal ureteral injury (4)	Radical hysterectomy for cervical cancer (1) Total hysterectomy (2)	Intraoperative (1) Postoperative (1)	Laparoscopy (2) Laparotomy (1)	Repaired by ureterovesicostomy. Diagnosed by CT urography after development of fever and abdominal pain. Repaired by uretero-ureterostomy.				
	Broad ligament myomectomy for 8-cm leiomyoma (1)	Intraoperative (2)	Laparoscopy and laparotomy (1)	Initial repair by laparoscopic uretero-ureterostomy failed. Subsequent repairs carried out via laparotomy at 2 and 5 months. Patient recovered well.				
Serious bleeding (56)	Adnexectomy for endometriosis (4) Myomectomy (10) Total hysterectomy (16) Radical hysterectomy (26)	Intraoperative (56)	Laparoscopy (56)	Most cases occurred in patients undergoing technically difficult operations.				
	Serious infection (8) Wall abscess (6) Vaginal vault abscess (1) Pelvic abscess (1)				Myomectomy (1) Hysterectomy (2) Radical hysterectomy (3) Radical hysterectomy (1) Radical hysterectomy (1)	Postoperative (8)	Wound dressing changes. Vaginal drainage, antibiotics (8)	Most cases were infected abdominal incisions in patients with obesity.
	Acute pulmonary edema (1)				Radical hysterectomy (1)	Intraoperative (1)	Diuretic and other drugs (1)	Operative duration was long, and substantial blood transfusion was needed.

CT, computed tomography.

Table 4. Factors associated with major and minor complications of gynecologic laparoscopic surgery.

Factor	Major complications (78) <i>n</i> (%)	Minor complications (711) <i>n</i> (%)
Age		
18–30 years	9 (11.54)	325 (45.71)
31–60 years	58 (74.36)	285 (40.08)
>60 years	11 (14.10)	101 (14.21)
<i>p</i>	0.027	0.142
Period of surgery		
2005–2011	48 (61.54)	420 (59.07)
2012–2021	30 (38.46)	291 (40.93)
<i>p</i>	0.035	0.029
Prior abdominal surgery		
Yes	30 (38.46)	76 (10.69)
No	48 (61.54)	635 (89.31)
<i>p</i>	0.038	0.187
Obesity		
Yes	16 (20.51)	36 (5.06)
No	62 (79.49)	675 (94.94)
<i>p</i>	0.021	0.358
Type of surgical procedure		
Adnexal surgery	4 (5.13)	26 (3.65)
Myomectomy/other uterine lesions	12 (15.38)	257 (36.14)
LAVH/TLH	25 (32.05)	216 (30.38)
Surgery for malignancy	37 (47.44)	212 (29.83)
<i>p</i>	<0.001	<0.001

Data are presented as *n* (%).

However, gynecologic laparoscopic surgery carries a risk of complications. In this study, the incidence of minor complications was found to be 4.64%, which aligns with previous studies [3,4,13]. The rate of major complications was only 0.51%, lower than what has been reported by others [2,3]. One possible explanation for this discrepancy is that the majority of patients in our study underwent adnexal surgery or myomectomy, which are relatively less complex procedures. Notably, the incidence of complications was higher during the period of 2005–2011 compared to 2012–2021, suggesting a progressive improvement in the skill level of our surgeons over time. This finding is consistent with previous research indicating that the surgeon's annual case load influences the rate of complications [8].

In this study, the main factors associated with major complications were older age, prior abdominal surgery, and type of surgical procedure (which was used as an indicator of surgical complexity). Elderly patients, who often experience tissue degeneration and compromised visceral function, along with a history of multiple previous surgeries, face challenges in tissue separation during surgical procedures. These difficulties can lead to an increased risk of bleeding and potential damage to surrounding organs. The above findings agree well with prior research [3,6,8]. Other studies have also suggested that operation type, surgical complexity and degree of pelvic adhesions may affect the incidence of complications [13–17].

In this study, the primary factors associated with major complications were older advanced age, previous abdominal surgery, and the type of surgical procedure, which served as an indicator of surgical complexity. These findings align with previous research studies [3,6,8]. Additionally, other studies have indicated that the type of operation, surgical complexity, and the extent of pelvic adhesions may influence the occurrence of complications [13–17].

Gynecologic laparoscopic procedures have been identified as the cause of over half of all iatrogenic injuries to the ureters [18]. The incidence rate of gastrointestinal injury during gynecologic laparoscopic surgery has been estimated to range from 0.13% to 1% [19,20]. Among these injuries, the small intestine is the most commonly affected site (55.8%), followed by the large intestine (38.6%) and the stomach (3.9%) [20]. A study involving 12,354 patients undergoing laparoscopic surgery reported 15 cases of rectal injury [21]. In our study, one patient who had undergone two previous surgeries required transvaginal repair of a rectovaginal fistula, resulting in a yellow-green vaginal discharge. Two additional patients experienced colonic injuries during total hysterectomy. Common strategies for managing rectal injuries include laparotomic or laparoscopic colostomy, one-stage repair, low anterior resection, and partial rectal resection [4,22–24]. To minimize the risk of injury during laparoscopic surgery, it is crucial to ensure that the separation of the intestine is performed as close to the uterus as possible.

Table 5. Multivariate logistic regression analysis of factors associated with major and minor complications of gynecologic laparoscopic surgery.

Factor	Adjusted odds ratio (95% confidence interval)	
	Major complications	Minor complications
Age		
18–30 years	1	1
31–60 years	2.88 (1.89–7.88)	0.66 (0.35–0.92)
>60 years	2.92 (1.67–5.65)	0.72 (0.47–1.21)
Period of surgery		
2005–2011	1	1
2012–2021	0.52 (0.27–1.09)	0.71 (0.32–1.31)
Prior abdominal surgery	3.58 (1.38–6.54)	0.86 (0.43–2.12)
Obesity	2.52 (1.39–7.28)	0.95 (0.43–2.28)
Type of surgical procedure		
Adnexal surgery	1	1
Myomectomy/other uterine lesions	1.56 (1.23–3.45)	1.26 (0.38–4.65)
LAVH/TLH	3.87 (1.39–8.23)	2.21 (1.20–5.42)
Surgery for malignancy	7.62 (3.61–13.63)	4.56 (2.77–9.49)

Three cases of vascular injury were observed in this study. Blood vessels can sustain damage during the separation of adhesions or trocar insertion [25]. Only five patients (0.03%) necessitated conversion to laparotomy in this study. Two cases were due to the intraoperative discovery of an ovarian malignant tumor, one case was due to extensive hemorrhage from a cesarean scar pregnancy, and two cases were attributed to a large uterus and extensive pelvic adhesions. The rate of conversion to laparotomy in this series was significantly lower than the previously reported value of 5% for patients undergoing hysterectomy for benign gynecologic disease [15]. The lower rate observed in this study may be attributed to the majority of operations being technically straightforward procedures such as adnexal surgery or myomectomy.

4.2 Strengths and Weaknesses

This study encompassed a substantial number of patients who received consistent treatment and management within the same hospital. However, it is important to acknowledge several limitations of this study. Firstly, being a retrospective study, there is a possibility of selection bias or information bias affecting the findings. Secondly, the generalizability of the results is uncertain due to the study being conducted at a single center. Lastly, there may be additional parameters not considered in the analysis that could have acted as confounding factors influencing the results.

4.3 Implications for Practice and Future Research

The findings suggest that meticulous separation of adhesions and regular examination of the bladder, ureter, bowel, blood vessels, and other vital organs may effectively mitigate the risk of complications. These results contribute valuable data on the risk factors associated with major com-

plications in gynecologic laparoscopic surgery among Chinese patients. Furthermore, these findings could aid in the appropriate selection of patients for preventive measures.

5. Conclusion

The occurrence of minor and major complications following gynecologic laparoscopic surgery is relatively low. Moreover, increased surgical difficulty and a history of previous surgeries are identified as risk factors that contribute to a higher incidence of major complications. Additionally, older age, prior abdominal surgeries, and the complexity of the surgical procedure are associated with an increased likelihood of major complications.

Availability of Data and Materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Author Contributions

AL carried out the studies, participated in collecting data, and drafted the manuscript. YX and JC participated in acquisition, analysis, or interpretation of data. AL participated in reviewing and proofreading papers. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This work has been carried out in accordance with the Declaration of Helsinki (2000) of the World Medical Association and approved by Huazhong University of Science

and Technology Union Shenzhen Hospital (approval number: LW-2023-005). All patients were aware of the potential risks of this clinical study and agreed to offer the data and the information.

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Conflict of Interest

The authors declare no conflict of interest.

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