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Original Article

Perioperative outcomes and ovarian function after laparoscopic versus abdominal myomectomy for uterine fibroids

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Abstract: This retrospective study aimed to evaluate the clinical outcomes and safety of laparoscopic myomectomy (LM) compared with abdominal myomectomy (AM) in patients with uterine fibroids. A total of 150 patients admitted to Shanxi Maternal and Child Health Hospital between March 2021 and March 2023 were included. According to the surgical approach, patients were divided into the AM group (n=75) and the LM group (n=75). Clinical efficacy, perioperative parameters, surgical stress-related indicators, humoral immune indicators, ovarian function-related indicators, and postoperative adverse events were observed and compared between the two groups. The total effective rate in the LM group was 97.33%, significantly higher than 88.00% in the AM group (P<0.05). Compared with the AM group, the LM group had a shorter operative time, less intraoperative blood loss, shorter time to ambulation, shorter time to first anal flatus, and a shorter hospitalization duration (all P<0.05). Postoperative levels of substance P, interleukin-6, ischemia-modified albumin, and cortisol levels were lower in the LM group than in the AM group (P<0.05), whereas postoperative IgG and IgA levels were higher (P<0.05). Significant between-group differences were also observed in postoperative ovarian function-related indicators (P<0.05). The postoperative adverse event rate in the LM group was 2.67%, significantly lower than the 14.67% observed in the AM group (P<0.05). Compared with AM, LM is associated with better clinical outcomes in patients with uterine fibroids, including faster postoperative recovery, lower surgical stress-related marker levels, more favorable postoperative ovarian function-related indicators, and a lower incidence of adverse events.

Keywords: Laparoscopy, myomectomy, uterine fibroids, therapeutic efficacy, safety

Introduction

Uterine fibroids are benign gynecological tumors originating from uterine smooth muscle tissues and are characterized by a high prevalence and hormonal dependence [1]. According to the latest statistics released by National Statistical Pathology, uterine fibroids are common among women aged 30-50 years and account for 51.87% of benign tumors of the female reproductive system [2, 3]. Approximately 25-50% of women develop uterine fibroids of varying sizes and numbers, which are hormone-sensitive growths within the uterine wall [3]. The pathogenesis of uterine fibroids involves a complex interplay of sex steroid hormones, particularly estrogen, which promotes the proliferation and hypertrophy of leiomyoma cells, as well as genetic factors and stem cell dysfunction [4, 5].

In the early stages, uterine fibroids are often asymptomatic due to their slow and insidious growth [6]. However, as the tumors growth, their space-occupying effects can alter the pelvic microenvironment and distort uterine anatomy [7]. This progression may lead to symptoms such as abnormal uterine bleeding, lower abdominal pain, and compression of adjacent organs, resulting in frequent urination or constipation [8]. Furthermore, uterine fibroids may be associated with reproductive complications, including preterm delivery, miscarriage, and degenerative changes, significantly increasing psychological distress and impairing patient's quality of life [9]. Therefore, accurate diagnosis and appropriate interventions are of paramount clinical significance.

Treatment strategies are determined by a comprehensive assessment of patient's age, fibroid

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Table 1. Comparison of baseline characteristics between the two groups

		AM group (n=75)	LM group (n=75)	$t/\chi^2/U$	P
Age (years)		43.28±6.50	44.32±6.33	0.993	0.323
Disease duration (months)		16.17±5.65	15.18±5.46	1.088	0.278
Fibroid diameter (cm)		6.12±0.41	6.21±0.48	1.317	0.190
Number of pregnancies (n)		3 (2, 3)	3 (2, 3)	3115	0.217
Number of deliveries (n)		1 (1, 2)	1 (1, 2)	2922	0.648
Number of fibroids, n (%)	Single	47 (62.67)	49 (65.33)	0.116	0.734
	Multiple	28 (37.33)	26 (34.67)		
Fibroid location, n (%)	Broad ligament (anatomy)	14 (18.67)	14 (18.67)	0.134	0.935
	Intramural	27 (36.00)	25 (33.33)		
	Subserosal	34 (45.33)	36 (48.00)		

Notes: AM, abdominal myomectomy; LM, laparoscopic myomectomy.

characteristics, fertility needs, and menopausal status [10]. Although pharmacologic treatments can alleviate symptoms in some patients, they often fail to control tumor progression effectively and carry risks of osteoporosis, endometrial lesions, and recurrence [11]. Currently, surgery remains the primary therapeutic option for symptomatic uterine fibroids. Abdominal myomectomy (AM) provides direct surgical access for the complete removal of multiple or deeply located fibroids. However, this approach is highly invasive, requiring a prolonged recovery period and potentially compromising ovarian function [12].

With the advancement of minimally invasive gynecological surgery, laparoscopic myomectomy (LM) has gained widespread acceptance due to its smaller incisions, reduced surgical trauma, accelerated postoperative recovery, and favorable perioperative outcomes [13, 14]. Although the perioperative advantages of LM over AM have been well established, comparisons of the effects of these two surgical approaches on postoperative stress responses, humoral immune parameters, and short-term indicators of ovarian function remain relatively limited [15]. Most existing studies have focused primarily on conventional perioperative outcomes, such as operative time and intraoperative blood loss. A more comprehensive assessment incorporating surgical stress-related markers, humoral immune indicators, and parameters related to ovarian function may provide further insights into the short-term physiological effects of different surgical approaches in women with uterine fibroids. Accordingly, this retrospective study analyzed the clinical records of 150 patients with uterine fibroids who underwent LM or AM between March 2021 and March 2023. Perioperative outcomes, surgical stress-related markers, humoral immune indicators, ovarian function-related markers, and postoperative adverse events were compared between the two groups. This study aimed to provide a more comprehensive evaluation of the perioperative outcomes and short-term physiological effects associated with LM and AM in patients with uterine fibroids.

Information and methods

General information

This retrospective comparative study included 150 patients with uterine fibroids who were admitted to Shanxi Maternal and Child Health Hospital between March 2021 and March 2023. According to the surgical approach received, the patients were divided into an AM group (n=75) and a LM group (n=75). Baseline characteristics, including age, disease duration, number of pregnancies, number of deliveries, number of fibroids, fibroid diameter, and fibroid location, were collected from the medical records and are presented in **Table 1**. No significant between-group differences were observed in the measured baseline characteristics. The study was reviewed and approved by the Medical Ethics Committee of Shanxi Maternal and Child Health Hospital. Given the retrospective design and the use of de-identified clinical data, the requirement for individual informed consent was waived.

Inclusion and exclusion criteria

Inclusion criteria: meeting the diagnostic criteria for uterine fibroids specified in the *Chinese Expert Consensus on the Diagnosis and Treatment of Uterine Fibroids* [12]; confirmed diagnosis of uterine fibroids based on pathological findings and imaging examinations; age ≥18 years; undergoing myomectomy for the first time and meeting the indications for surgical treatment; absence of cognitive or psychiatric disorders that would interfere with normal communication or study participation; availability of complete clinical data.

Exclusion criteria: concomitant dysfunction of major organs, including the heart, liver, kidneys, or thyroid; concomitant gynecological diseases, such as ovarian cysts, endometrial cancer, endometriosis, or cervical cancer; coagulation dysfunction, endocrine system diseases, or metabolic diseases; pregnancy or lactation; poor compliance; recent use of hormonal therapy, including gonadotropin-releasing hormone (GnRH) agonists, oral contraceptives, progestins, or other medications affecting ovarian endocrine function within 6 months before surgery; incomplete clinical data.

Surgical procedures

Before surgery, patients in both groups underwent imaging examinations to determine the number, size, and location of fibroids. Routine preoperative bowel preparation and vaginal cleansing were performed. All procedures were performed by the same surgical and anesthesia teams.

AM group: Patients in the AM group received general anesthesia with endotracheal intubation. Patients were placed in the supine position, and routine surgical skin preparation and draping were performed. An approximately 10 cm incision was made in the midline, approximately 3 cm above the junction of the lower abdomen and the pubic region. The skin, subcutaneous tissue, anterior rectus sheath, and peritoneum were incised sequentially to reach the abdominal cavity. The location, number, morphology, and distribution of uterine fibroids were assessed. A solution containing 10 U of vasopressin (National Pharmaceutical License H31022751) diluted in 2 mL of saline was injected into the fibroid tissue to reduce intraoperative bleeding. For subserosal fibroids with prominent protrusions, an incision was made at the base of the protruding portion to expose the fibroid. For fibroids without prominent protrusions, the overlying tissue was incised directly to expose the fibroid. The fibroids were then grasped with forceps and bluntly dissected from the surrounding tissues. After removal of the fibroids, electrocoagulation was used to achieve hemostasis. For deeper fibroids, the resulting myometrial defects were closed with layered sutures, using figure-of-eight sutures where appropriate, to obliterate the residual cavities. The uterus was returned to the pelvic cavity, which was then irrigated with normal saline, and hemostasis was confirmed before abdominal closure.

LM group: Patients in the LM group underwent general anesthesia with endotracheal intubation. After induction of anesthesia, patients were placed in the lithotomy position with the head-down tilt, and the hips were elevated as required. Routine surgical skin preparation and draping were performed. A 1-2 cm incision was made below the umbilicus. The abdominal wall was elevated, and a pneumoperitoneum needle was inserted to establish a carbon dioxide pneumoperitoneum, with the intra-abdominal pressure maintained at 10-12 mmHg. After removal of the pneumoperitoneum needle, and a 10-mm trocar was inserted to establish the observation port. Additional approximately 5-mm incisions were made in the right and left lower abdomen, and trocars were inserted to establish accessory operating ports. The laparoscope and surgical instruments were inserted to observe the abdominal and pelvic cavities and determine the location and size of the fibroids. The surgical approach was then formulated according to the intraoperative findings.

A solution containing 10 U of vasopressin diluted in 2 mL of saline was injected into the myometrium adjacent to the fibroid. The overlying tissue was incised to expose the fibroids, which were then bluntly dissected from the surrounding myometrium and removed. Hemostasis was achieved by electrocoagulation. The resulting myometrial defects were closed with absorbable sutures. Larger fibroids were extracted through the 10-mm port using an electric tissue morcellator. The abdominal and pel-

vic cavities were thoroughly irrigated with 0.9% sodium chloride solution to remove residual tissue fragments, and the myometrial defects were sutured in layers.

After operation, patients in both groups received antibiotic therapy. Uterotonic agents were administered when clinically indicated. All patients were followed up for 6 months through telephone interviews, outpatient visits, or other ways.

Observation indicators

(1) Clinical efficacy [13]: Clinical efficacy was classified into three categories. Markedly effective: abdominal mass and associated clinical symptoms (e.g., pain) disappeared; no residue fibroids were detected after surgery; no recurrence occurred during the 3-month follow-up; quality of life improved significantly. Effective: abdominal mass disappeared, occasional pain persisted, a small amount of residue fibroid tissue remained after surgery, with possible recurrence; quality of life improved to some extent. Ineffective: abdominal masses, severe pain, or other symptoms persisted; substantial residue fibroid tissue was detected, with possible recurrence; quality of life did not improve. The total effective rate = (number of markedly effective cases + number of effective cases)/ total number of cases × 100%.

(2) Perioperative parameters: operation time, intraoperative blood loss, time to first ambulation, anal time to first postoperative anal flatus, and hospital days were recorded. Intraoperative blood loss was designated as the primary outcome because it is an objective perioperative measure directly reflecting the extent of surgical trauma.

(3) Pain- and surgical stress-related indicators: fasting venous blood samples (3 mL) were collected from patients in the early morning before surgery and 3 days after surgery. Serum was separated by centrifugation at 2500 r/min for 10 min. The levels of serum substance P (SP) and interleukin-6 (IL-6) were detected using high-performance liquid chromatography. was used to detect Serum ischemia modified albumin (IMA) levels were determined using the albumin-cobalt binding assay, and serum cortisol (Cor) levels were measured using radioimmunoassay.

(4) Immune indicators: Serum immunoglobulin G (IgG) and IgA levels were measured. Before the operation and 3 days after the operation, 3 mL of fasting peripheral venous blood was collected from all patients in the early morning. Serum was separated by centrifugation at 3,000 r/min for 3 min, and the corresponding indicators were measured using the immunoturbidimetric method.

(5) Ovarian function indexes: Serum levels of estradiol (E2), follicle stimulating hormone (FSH), luteinizing hormone (LH), and antimullerian hormone (AMH) were measured by radioimmunoassay preoperatively and at 3 months after surgery. Blood samples for E2, FSH, and LH measurements were collected during the early follicular phase (days 2-4 of the menstrual cycle).

(6) Safety assessment: The incidence of postoperative adverse events, including incision infection, pelvic adhesions, intestinal obstruction, abdominal pain, and uterine rupture, were recorded.

Statistical analysis

SPSS 25.0 was used for statistical analyses. The normality of continuous variables was assessed using the Shapiro-Wilk test, and homogeneity of variances was evaluated using Levene's test. Normally distributed continuous variables are presented as mean ± standard deviation, whereas non-normally distributed variables are presented as median (Q1, Q3). For between-group comparisons, independent-samples t tests were used for normally distributed variables with homogeneous variances, Welch's t tests were used when the assumption of equal variances was violated, and Mann-Whitney U tests were used for non-normally distributed variables. For paired preoperative and postoperative comparisons within the same group, paired-samples t tests or Wilcoxon signed-rank tests were used. Categorical variables are presented as numbers and percentages and were compared using the chi-square test or Fisher's exact test, as appropriate. To control the risk of type I errors arising from multiple comparisons, *p*-values were adjusted

Table 2. Comparison of clinical outcomes between the two groups (n, %)

	AM group (n=75)	LM group (n=75)	χ^2	P
Markedly effective	34 (45.33)	46 (61.33)	-	-
Effective	32 (42.67)	27 (36.00)	-	-
Ineffective	9 (12.00)	2 (2.67)	-	-
Overall effective rate	88.00%	97.33%	4.807	0.028

Notes: AM, abdominal myomectomy; LM, laparoscopic myomectomy.

Table 3. Comparison of perioperative parameters between the two groups ($\bar{x} \pm s$)

	AM group (n=75)	LM group (n=75)	t	P
Surgical time (min)	84.52±7.30	61.73±4.27	23.332	<0.001
Intraoperative blood loss (mL)	103.05±15.35	71.47±8.23	15.452	<0.001
Time to first ambulation (h)	29.61±4.66	17.10±2.76	20.000	<0.001
Time to first anal flatus (h)	30.88±3.56	18.09±4.93	18.240	<0.001
Length of hospitalization (d)	10.86±2.17	5.64±1.27	17.970	<0.001

Notes: AM, abdominal myomectomy; LM, laparoscopic myomectomy.

using the Benjamini-Hochberg false discovery rate (FDR) procedure for multiple comparisons within the same outcome domain. Multivariate regression analysis was performed to adjust for potential baseline confounders. A two-sided FDR-corrected P<0.05 was considered statistically significant.

As this was a retrospective study, the sample size was determined by the number of eligible patients identified during the predetermined study period. Intraoperative blood loss was designated as the primary endpoint for the revised analysis. A post hoc power analysis was conducted based on the observed differences in intraoperative blood loss between groups. The standardized effect size was calculated using Cohen's d. With 75 patients per group and a two-sided significance level of 0.05, the calculated statistical power exceeded 99.9%.

Results

Comparison of clinical efficacy

The total effective rate was significantly higher in the LM group than in the AM group (97.33% vs. 88.00%, P<0.05; **Table 2**).

Comparison of perioperative parameters

Compared with the AM group, the LM group had a significantly shorter operative time, less intraoperative blood loss, a shorter time to first ambulation, a shorter time to first anal flatus, and a shorter hospital stay (all P<0.05; **Table 3**).

Comparison of pain- and surgical stress-related parameters

No significant between-group difference were observed in the preoperative SP, IL-6, IMA, or Cor levels (P>0.05). After surgery, both groups exhibited significant increase in the levels of SP, IL-6, IMA, and Cor. However, postoperative SP, IL-6, IMA, and Cor levels were significantly lower in the LM group than in the AM group (all P<0.001). In addition, the postoperative increases in SP, IL-6, IMA, and Cor were significantly smaller in the LM group than in the AM group (P<0.001), and these differences remained significant after FDR correction. The results are presented in **Table 4** and **Figure 1**.

Comparison of immune function indicators

As shown in **Table 5**, no significant between-group differences were observed in preoperative IgG and IgA levels (P>0.05). On postoperative day 3, IgG levels decreased significantly in both groups, with a significantly smaller reduction in the LM group than in the AM group (P<0.001). IgA levels decreased significantly after surgery in the AM group (P<0.001), whereas no significant preoperative-to-postoperative change was observed in the LM group

Table 4. Comparison of pain- and surgical stress-related parameters between the two groups ($\bar{x} \pm s$)

		AM group (n=75)	LM group (n=75)	t/U	P
SP (μg/mL)	Pre-surgery	3.95 (3.71, 4.41)	3.99 (3.67, 4.27)	2621	0.472
	Post-surgery	6.95±0.84*	5.42±0.57*	13.016	<0.001
IL-6 (pg/mL)	Pre-surgery	5.45±0.67	5.37±0.65	0.687	0.493
	Post-surgery	8.00±0.97*	6.39±0.74*	11.44	<0.001
IMA (U/L)	Pre-surgery	67.55±4.53	66.59±4.85	1.252	0.212
	Post-surgery	76.01 (73.36, 78.13)*	69.04 (66.57, 71.86)*	951.5	<0.001
Cor (ng/mL)	Pre-surgery	127.28±14.58	125.02±16.49	0.889	0.376
	Post-surgery	164.44±19.34*	139.43±16.17*	8.590	<0.001

Notes: *P<0.05 vs pre-surgery in the same group; SP, Substance P; IL-6, interleukin-6; IMA, ischemia modified albumin; Cor, cortisol; AM, abdominal myomectomy; LM, laparoscopic myomectomy.

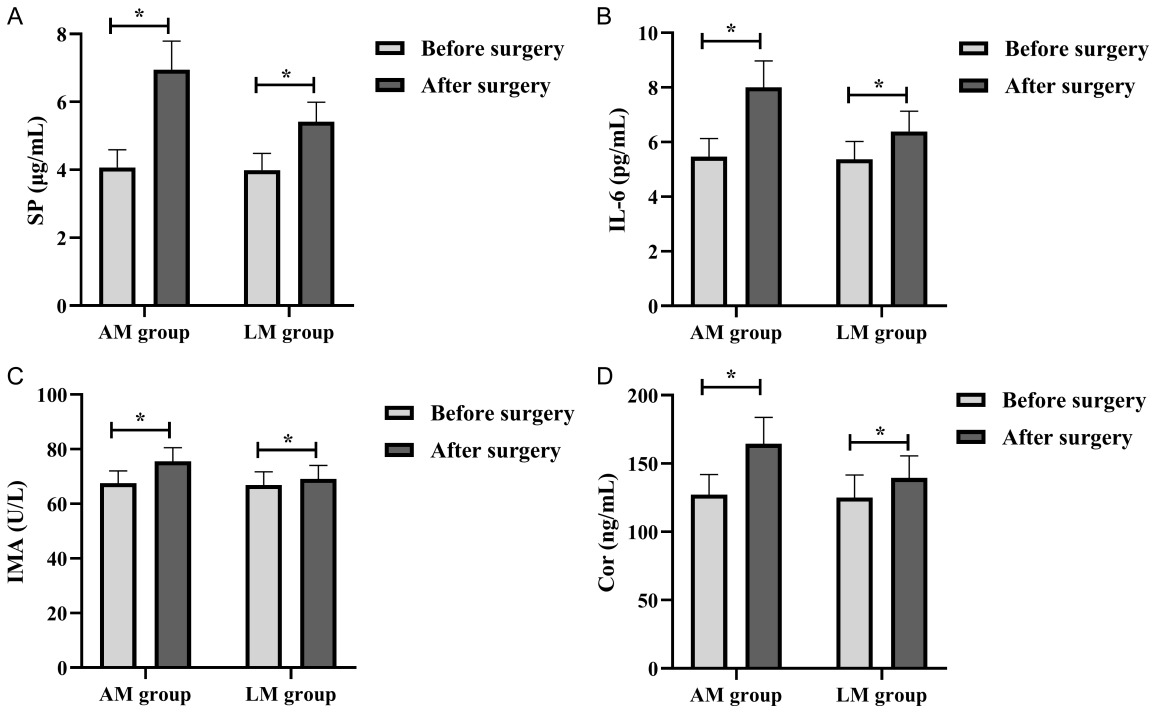


Figure 1. Comparison of pain- and surgical stress-related markers between the two groups. A. SP; B. IL-6; C. IMA; D. Cor. Notes: *P<0.05, compared with before surgery levels. SP, Substance P; IL-6, interleukin-6; IMA, ischemia modified albumin; Cor, cortisol; AM, abdominal myomectomy; LM, laparoscopic myomectomy.

(P=0.818). Postoperative IgG and IgA levels were significantly higher in the LM group than in the AM group (both P<0.001).

Comparison of ovarian function-related indicators

As shown in **Table 6** and **Figure 2**, there was no significant difference in the levels of E2, FSH, LH, or AMH between the two groups before surgery (all P>0.05). At postoperative 3 months, there were no significant between-group differences in the absolute postoperative levels of E2, FSH, LH, or AMH (P>0.05). Within-group comparisons showed that E2 and AMH levels decreased, whereas FSH and LH increased after surgery. However, the magnitudes of these postoperative changes were significantly smaller in the LM group than in the AM group (all P<0.05).

Comparison of postoperative adverse events

The incidence of postoperative adverse events was significantly lower in the LM group than

Table 5. Comparison of immune function indicators between the two groups ($\bar{x} \pm s$)

		AM group (n=75)	LM group (n=75)	t/U	P
IgG	Pre-surgery	11.86±2.03	10.91±2.02	1.798	0.074
	Post-surgery	8.82±1.35*	9.99±1.73	4.596	<0.001
IgA	Pre-surgery	1.66±0.69	1.48±0.69	1.600	0.112
	Post-surgery	1.24 (1.12, 1.38)*	1.44 (1.21, 1.69)	1880	<0.001

Notes: *P<0.05 vs pre-surgery in the same group; AM, abdominal myomectomy; LM, laparoscopic myomectomy.

Table 6. Comparison of ovarian function-related indicators between the two groups

		AM group (n=75)	LM group (n=75)	t/U	P
E2 (pmol/L)	Pre-surgery	285.03±11.33	284.48±11.63	0.291	0.771
	Post-surgery	283.41±13.44*	280.12±13.25*	1.507	0.134
	Δpre-post	-4.36±7.37	-1.62±5.59	2.563	0.011
FSH (U/L)	Pre-surgery	18.37±1.37	18.35±1.43	0.111	0.912
	Post-surgery	19.17±1.64*	18.77±1.41	1.596	0.113
	Δpre-post	0.74 (0.26, 1.24)	0.48 (0.12, 0.74)	3618	0.002
LH (U/L)	Pre-surgery	17.98±1.51	18.12±1.60	0.525	0.600
	Post-surgery	18.82±1.77*	18.40±1.56	1.542	0.125
	Δpre-post	0.70 (0.38, 1.23)	0.34 (0.04, 0.59)	4094	<0.001
AMH (ng/mL)	Pre-surgery	1.69 (1.44, 1.85)	1.65 (1.45, 1.87)	2928	0.664
	Post-surgery	1.38 (1.20, 1.67)*	1.51 (1.26, 1.72)	2567	0.358
	Δpre-post	-0.17 (-0.30, -0.05)	-0.11 (-0.19, -0.01)	2143	0.012

Notes: *P<0.05 vs pre-surgery in the same group; E2, estradiol; FSH, follicle stimulating hormone; LH, luteinizing hormone; AMH, antimullerian hormone; AM, abdominal myomectomy; LM, laparoscopic myomectomy.

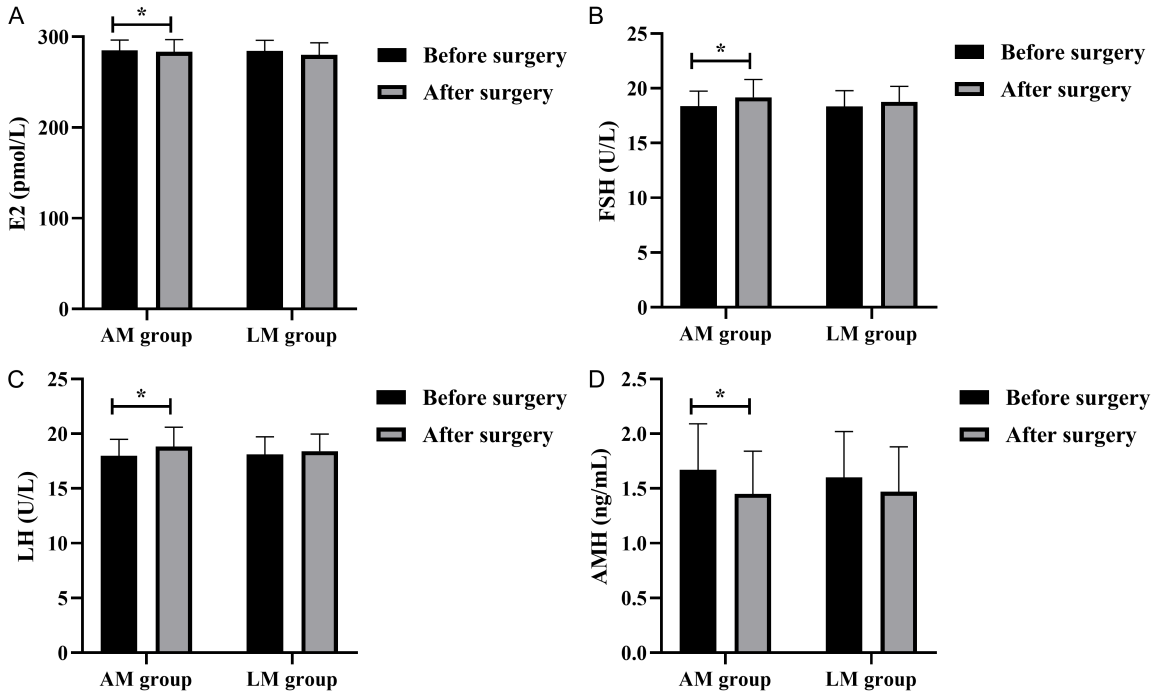


Figure 2. Comparison of ovarian function-related markers between the two groups. A. E2; B. FSH; C. LH; D. AMH. Notes: *P<0.05, compared with before surgery. E2, estradiol; FSH, follicle stimulating hormone; LH, luteinizing hormone; AMH, antimullerian hormone; AM, abdominal myomectomy; LM, laparoscopic myomectomy.

Table 7. Comparison of the incidence of adverse events between the two groups (cases, %)

	AM group (n=75)	LM group (n=75)	*P*-value
Cutaneous infection	3 (4.00)	1 (1.33)	-
Pelvic adhesion	2 (2.67)	0 (0.00)	-
Intestinal obstruction	1 (1.33)	0 (0.00)	-
Abdominal pain	3 (4.00)	1 (1.33)	-
Uterine rupture	2 (2.67)	0 (0.00)	-
Overall incidence	14.67%	2.67%	0.017

Notes: AM, abdominal myomectomy; LM, laparoscopic myomectomy.

in the AM group (2.67% vs. 14.67%; Fisher's exact test, P=0.017) (**Table 7**).

Multivariable analysis of intraoperative blood loss

In multivariate linear regression analysis (**Table 8**), the surgical procedure remained independently associated with intraoperative blood loss even after adjustment for age, disease duration, fibroid diameter, number of pregnancies, number of deliveries, number of fibroids, and lesion location. This model explained 63.8% of the variance in intraoperative blood loss. No substantial multicollinearity was detected, with all variance inflation factor (VIF) values <1.2.

Discussion

Uterine fibroids are hormone-sensitive benign solid tumors that are highly prevalent among women of reproductive age, particularly those aged 30-50 years [16]. Their pathogenesis is associated with sex steroid hormones; specifically, estrogen promotes the proliferation and hypertrophy of leiomyoma cells and the accumulation of extracellular matrix [17]. As fibroids enlarge, their space-occupying effects can distort uterine anatomy and affect the surrounding pelvic environment, leading to clinical manifestations such as abnormal uterine bleeding and mechanical compression of adjacent organs [8]. Therefore, the goal of surgical intervention is not only to excise fibroids but also to preserve uterine function and improve patients' quality of life.

Currently, surgery remains the primary therapeutic strategy for symptomatic uterine fibroids, with AM and LM being two commonly utilized modalities [18]. Our results showed that the total effective rate in the LM group was significantly higher than that in the AM group. The LM group also had a shorter operative time and faster postoperative recovery, consistent with previous findings [19, 20]. Furthermore, multivariable analysis showed that LM remained independently associated with lower intraoperative blood loss after adjustment for potential baseline confounders, supporting the robustness of the observed association. A critical difference between these two procedures may lie in their effects on the systemic stress response and humoral immune parameters. Surgical trauma can initiate a cascade of inflammatory responses and transient immunosuppression [21, 22]. In this study, while both groups exhibited postoperative fluctuations in stress-related markers, the postoperative levels of SP, IL-6, IMA, and Cor were significantly lower in the LM group than in the AM group. In addition, postoperative changes in IgG and IgA were less pronounced in the LM group than in the AM group, suggesting a smaller alteration in humoral immune parameters. Surgical stress can lead to a transient alterations in circulating immunoglobulin levels, including reductions in serum IgA and IgG levels [23]. Compared with AM, LM is associated with fewer tissue manipulations and smaller surgical incisions, which may help reduce the postoperative stress response and thereby limit changes in humoral immune markers [24]. However, since this study assessed only IgG and IgA, these findings should be interpreted as reflecting changes in selected humoral immune markers rather than overall immune protection. Cellular immune parameters, such as T-cell subsets and cytokine profiles, were not evaluated.

For women with fertility needs, the preservation of ovarian function is an important clinical consideration. The ovaries are vital reproductive and endocrine organs and may be affected by surgical intervention and alterations in blood supply [25]. In the present study, no significant between-group differences were observed in the absolute levels of E2, FSH, LH, or AMH at 3 months after surgery. However, the magnitudes of postoperative changes in all four ovarian function-related indicators were significantly smaller in the LM group than in the AM group. Specifically, E2 and AMH levels decreased, whereas FSH and LH levels

Table 8. Multivariable linear regression analysis of factors associated with intraoperative blood loss

	B	SE	Standardized β	t	P	95% CI
Surgical approach (0=AM, 1=LM)	-31.870	2.093	-0.793	15.225	<0.001	-36.008- (-27.731)
Age (years)	0.208	0.172	0.066	1.212	0.228	-0.131-0.547
Disease duration (months)	0.046	0.198	0.013	0.230	0.818	-0.345-0.436
Fibroid diameter (cm)	-1.022	2.356	-0.023	0.434	0.665	-5.679-3.636
Number of pregnancies	-0.830	1.361	-0.033	0.610	0.543	-3.522-1.862
Number of deliveries	-2.169	1.628	-0.070	1.332	0.185	-5.387-1.049
Multiple fibroids (vs. single)	3.642	2.177	0.087	1.672	0.097	-0.663-7.946
Intramural (vs. subserosal)	0.385	2.329	0.009	0.165	0.869	-4.220-4.990
Broad ligament (vs. subserosal)	-0.879	2.830	-0.017	0.311	0.757	-6.747-4.716

Notes: R^2=0.638, adjusted R^2=0.615, F=27.47, P<0.001; AM, abdominal myomectomy; LM, laparoscopic myomectomy.

increased after surgery, with less pronounced changes observed in the LM group. These findings suggest that LM was associated with smaller short-term disturbances in ovarian function-related markers than AM. Compared with AM, LM may allow more targeted fibroid removal with less extensive tissue manipulation and surgical trauma, potentially contributing to the smaller postoperative changes observed in these ovarian function-related indicators. However, these biochemical findings should not be interpreted as direct evidence that LM preserves or improves ovarian reserve. Longer follow-up incorporating additional ovarian reserve measures and reproductive outcomes is required to determine the long-term clinical significance of these findings [24].

This study has several limitations. First, its single-center retrospective design and relatively limited sample size may have introduced potential selection bias and residual confounding. Second, only a limited number of markers related to surgical stress, humoral immunity, and ovarian function were evaluated. Cellular immune markers, such as T-cell subsets and cytokine profiles, were not evaluated. Third, patient satisfaction, postoperative quality of life, or reproductive outcomes were not systematically evaluated. Fourth, the follow-up period was insufficient to assess long-term fibroid recurrence, sustained changes in ovarian function, or fertility-related outcomes, including pregnancy and live birth. Moreover, standardized long-term ultrasound surveillance was not uniformly available for all patients. Future large-scale, prospective, multicenter studies with standardized imaging assessments and extended follow-up periods are warranted to evaluate fibroid recurrence, long-term ovarian function, quality of life, patient satisfaction, and fertility-related outcomes.

Conclusion

Compared with AM, LM is associated with better perioperative outcomes, lower postoperative levels of surgical stress-related markers, less pronounced postoperative changes in humoral immune- and ovarian function-related markers, and a lower incidence of short-term postoperative adverse events. These findings support LM as an effective minimally invasive surgical option for appropriately selected patients with uterine fibroids.

Disclosure of conflict of interest

None.

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