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Original Article

Laparotomy versus laparoscopy for the elective cystectomy of a benign ovarian tumour during pregnancy: a retrospective cohort study

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Abstract: The aim of this manuscript is to compare the pregnancy and surgical outcomes and costs of an elective cystectomy of a benign ovarian tumour during pregnancy treated by laparotomy and laparoscopy. We completed a retrospective cohort study, and the related data was collected and analysed between September 2009 and September 2014 in the Obstetric & Gynecology Hospital of Fudan University. A total of 65 pregnant women were included, 30 cases for laparoscopy and 35 cases for laparotomy. The laparoscopy group had higher costs ($P < 0.001$) and lower postoperative febrile rates ($P = 0.005$), a shorter postoperative hospital length of stay ($P < 0.001$) and a shorter antibiotic prophylaxis ($P < 0.001$). The gestational age at delivery, caesarean delivery rate, preterm delivery rate, length of prophylactic tocolytic therapy, rate of postoperative uterine contractions, newborn weight and rate of neonatal disorders were not significantly different between the 2 groups. Compared with laparotomic surgery for the elective cystectomy of a benign ovarian tumour during pregnancy, laparoscopy had an equal effect on the mothers and foetuses. The costs of laparoscopic surgery were higher, but it is minimally invasive. Further studies are needed to compare the long-term outcomes between the 2 groups.

Keywords: Benign ovarian tumour, cystectomy, laparoscopy, laparotomy, pregnancy

Introduction

Ovarian tumour is a common complication during pregnancy, with a morbidity of 0.19-8.8% [1-3] among pregnant women. The detection rate and the morbidity of ovarian tumours during pregnancy is growing [4-6] because of the widespread use of high-definition ultrasonography and the increasing application of assisted reproductive technology.

The proportion of ovarian tumours that are benign is 97-99%, and only 1-3% of ovarian tumours are malignant [1]. Surgery for malignant ovarian tumour during pregnancy is associated with serious surgical trauma, with a higher rate of complications and a higher rate of pregnancy loss, and the radiotherapy and chemotherapy after surgery has a great influence on the growth of the foetus. A majority of women with malignant ovarian tumours who are pregnant choose to undergo induced abortions for their own safety and then undergo comprehensive treatment, including chemotherapy and surgical treatment [7]. Meanwhile, based on the meta-analysis we performed, the rates of malignant cysts were 7.9%, 8.6%, 11%, and 0% in the four studies we included [7-10]. All of our patients accepted surgery when they were suspected of having a malignant tumour.

Benign ovarian tumours can enlarge into the broader abdominal cavity along with the uterus during pregnancy, which can induce a higher morbidity of ovarian torsion, especially during the first and second trimester, compared to benign tumours in non-pregnant women [2]. A retrospective case-control study by Ginath

[11] reported that the rate of torsion was 56% and 7% in pregnant women and non-pregnant women, respectively. Multi-cyst ovarian tumours had a higher torsion rate than single-cyst ovarian tumours with a rate of 86% versus 31%. The ischemic necrosis caused by ovarian torsion can release inflammatory cytokines and cause pain, and the uterine contractions caused by the inflammatory cytokines may be one of the reasons that spontaneous abortion occurs during early pregnancy. Once ovarian torsion during pregnancy is detected, emergency operation is needed. Ultrasonography is one of the tools that is used to monitor the changes in ovarian tumours, and surgery is suggested for those pregnant women who have complaints and persistent or even enlarged ovarian tumours. Surgery is needed in cases of suspected complications or malignancy [12].

Laparotomy is a traditional surgical procedure applied during pregnancy. At the same time, laparoscopy is reported to be widely used among pregnant women with benign ovarian tumour since the 1990s due to its advantages of less surgical trauma, faster recovery after the operation, and a lower rate of complications, including poor wound healing and postoperative intraperitoneal adhesion. However, laparoscopic surgery has its own risks that are different from those of laparotomy and cannot be ignored. First, the lithotomy position (Trendelenburg position) can influence the blood perfusion to the uterus and placenta, which may have a negative influence on the pregnant women and their foetuses. Second, the consistent CO_2 pneumoperitoneum pressure may increase the pressure on the diaphragmatic muscle of pregnant women and may increase the likelihood of cardiovascular accident in pregnant women [13], and some animal studies have confirmed foetal acidosis with associated tachycardia, hypertension, and hypercapnia during CO_2 pneumoperitoneum [14, 15]. However, at the same time, the Trendelenburg position during an operation can increase the venous return. Thus, cardiorespiratory circulation can be affected to a certain degree [13].

Case reports and case series provide a majority of the previous research on the safety of laparoscopy, and only few studies have compared the effectiveness of laparoscopy and laparotomy; these have included different operation options, such as oophorocystectomy, salpingo-ovariectomy, and ovarian torsion reset. Our study aimed to compare the surgical outcomes, pregnancy outcomes and costs between laparotomy and laparoscopy for an elective cystectomy of a benign ovarian tumour during pregnancy.

Materials and methods

Subjects

All of the patients who underwent laparoscopy or laparotomy for benign ovarian tumours at the Obstetrics and Gynecology Hospital of Fudan University between September 2009 and September 2014 were included. All these patients had complete medical files, and their ovarian tumours were diagnosed by pathology. The data were collected from screening the electronic medical record system and the hospital registration book based on the keywords for the admitting diagnosis. The pregnant women were split into 2 research cohorts, depending on whether they had laparoscopy or a laparotomy. We excluded cases with emergency operations, non-oophorocystectomy operations, malignant or borderline ovarian tumours diagnosed by postoperative pathology and elective pregnancy termination in the 2 groups to exclude the effects of acute abdominal pain, ovariectomy and malignant tumour on surgical and pregnancy outcomes. All of the patients signed an informed consent for the surgery, and for the patients in the laparoscopy group, they were informed that laparoscopic surgery might convert to laparotomic surgery according to the specific operation situation.

Surgical procedures

The preoperative preparation included a complete physical examination, blood and biochemical examination, pelvic ultrasonography, and electrocardiogram. Specific anamnesis, surgical history, allergy history and marital history were recorded. The pregnant women accepted antibiotic prophylaxis of cefotiam (Harbin Pharmaceutical Group Holding Company, Product batch number: A1606918-2) i.v. during the 24 hours before and after the surgery if they were evaluated as having a high risk of infection. They were all forbidden to eat or drink starting at 22:00 the day before the operation. The laparotomy and laparoscopy surger-

ies were performed by at least 3 skilled surgeons and 1 experienced anaesthesiologist. A combined spinal-epidural anaesthesia was applied in the laparotomic surgery, and the patients were in the supine position. The incision was made 2 cm above the pubic symphysis or at a previous abdominal scar. The length of the incision was 6 cm to 10 cm, depending on the tumour size. General anaesthesia was applied for the laparoscopy surgery, and the patients were placed in lithotomy. A 2.5 cm incision for the first puncture hole was set at the umbilicus or at a position between the umbilicus and cartilagoensiformis, according to the size of the uterus and the size of the tumour. A 10 mm Trocar was introduced in the abdominal cavity. Then, a celiac lens was placed into the abdominal area through the 10 mm Trocar and CO_2 pneumoperitoneum was established, maintaining the abdominal pressure at 10-12 mmHg. Then, 3 other Trocars were introduced into the abdominal cavity under a constant visualization of the tips. The ovary was carefully exposed, avoiding the uterus, and the ovarian tumour was completely separated and taken out. An ovary suture was performed instead of electric coagulation for haemostasis.

Postoperative observation and follow-up

The pregnant women were observed in the resuscitation room for 1-2 hours, after which they were sent back to the wards and the Bp, P, and R was observed every 0.5 hour by ECG monitors until 8:00 the day after the operation. The foetal heartbeat was observed every 8 hours after the surgery. The first ultrasonography after the surgery was arranged 3 days after the operation, and some patients received a second ultrasonography the day before leaving the hospital. All of the pregnant women were followed up by telephone after their expected due date.

Specific observation index

Demographic characteristics: Age, BMI, the gestational week when the surgery occurred (calculated by last menstrual period for those who had regular periods), the average diameter of the tumour (defined by ultrasonography within one week before surgery), the rate of the bilateral ovarian tumours and the pathological type of the tumour were all recorded.

Surgical outcomes

Total surgical time, estimated blood loss, postoperative exhaust time, postoperative urinary retention, postoperative maximum temperature, postoperative length of fever, postoperative rate of fever, rate and length of antibiotic prophylaxis, incision length, occurrence of poor wound healing, postoperative length of hospitalization and costs were recorded.

Pregnancy outcomes

Foetal death, postoperative uterine contractions, length of prophylactic tocolytic therapy, gestational age at delivery, caesarean delivery rate, newborn weight, preterm delivery rate and neonatal disorders were recorded.

Statistical analysis

SPSS 18.0 (Chicago, IL, USA) was used for the statistical analyses. A t test or a rank sum test was used for the continuous variables, and a chi square test or Fisher test was used for the frequency data. Two multivariate logistic regression analyses were used to evaluate the association between the surgical approach and postoperative fever and the association between the surgical approach and uterine contraction, controlling for potential confounding factors. $P < .05$ was considered statistically significant.

Results

Basic observation

We retrospectively searched 77 cases in the first step, and 12 cases were excluded according to the indicated criteria. A total of 65 pregnant women were included. They were divided into laparoscopy and laparotomy groups according to the surgical procedure used, and there were 30 laparoscopy cases (43.15%) and 35 laparotomy cases (53.85%). We obtained 56 cases with live delivery information; 26 cases in the laparoscopy group and 30 cases in the laparotomy group. One case of a deceased foetus of idiopathic aetiology was found in the laparoscopy group. Eight pregnant women were lost to follow-up; 3 in the laparoscopy group and 5 in the laparotomy group.

Table 1. Baseline characteristics

Characteristic	Laparotomy	Laparoscopy	*P* Value
Age (years; Mean ± SD)	27.1 ± 3.4	27.2 ± 4.8	.912*
BMI (kg/m^2; Mean ± SD)	22.4 ± 2.9	21.4 ± 2.8	.173*
Gestational week when accepted surgery (weeks)	16.4 ± 3.3	17.7 ± 4.1	.153*
Average tumour diameter (m; range)	0.101 (0.06-0.28)	0.0945 (0.04-0.30)	.218&
Rate of bilateral ovarian tumour (n, %)	9 (25.7%)	3 (10.0%)	.104#

*T-test; &Rank sum test; #Chi square test.

Table 2. Pathology of the ovarian tumours

Pathology type	Laparotomy	Laparoscopy	Total number	*P* Value
Mature cystic teratoma (n, %)	17 (48.6)	7 (23.3)	24 (36.9)	.426*
Endometrioid cyst (n, %)	6 (17.1)	9 (30.0)	15 (23.1)	-
Mucinous cystadenoma (n, %)	7 (20.0)	6 (20.0)	13 (20.0)	-
Luteinizing cysts (n, %)	2 (5.8)	5 (16.7)	7 (10.8)	-
Serous cystadenoma (n, %)	2 (5.7)	2 (6.7)	4 (6.2)	-
Other type of benign tumour (n, %)	1 (2.9)$	1 (3.3)^	2 (3.1)	-

$Simple cyst; ^Leiomyoma with cystic degeneration; *The pathology of the two groups was not significantly different.

Main results

Demographic characteristics of the research subjects: We found no significant difference in the average age, BMI, gestational weeks at the time of surgery, tumour size before operation (tumour size under ultrasound), or the rate of bilateral ovarian tumours between the groups (**Table 1**).

Pathology of the laparotomy and laparoscopy groups: The most common pathological type of ovarian tumour during pregnancy was mature cystic teratoma (36.9%), followed by endometrioid cyst, mucinous cystadenoma, luteinizing cyst, and serous cystadenoma. There were no significant differences in the distribution of the pathological types between the 2 groups (P = 0.426) (**Table 2**). In total, the baseline variables of the research objects of these 2 groups were consistent.

Distribution of the pathological types: There was no significant difference in the distribution of the pathological types of the ovarian tumours between the 2 groups, but we noticed that there was a higher proportion of mature cystic teratoma in the laparotomy group, and the laparoscopy group had a higher proportion of endometrial cyst (**Table 2**). The distribution of the pathological types of the ovarian tumours was similar to that reported by Koo FH in 2013 [16]. The different pathological types of ovarian tumours influence the choice of surgical procedure, operation time and estimated blood loss. The matured cystic teratoma has an intact capsule and clear boundaries, so it is easier to operate on than an endometrial cyst, which is better suited to laparoscopic surgery. With improvements in the pathological diagnostic rate of ultrasonography in our hospital, we propose a general surgical procedure according to the type and size of the ovarian tumour to reduce the surgical damage as much as possible.

Surgical outcomes and costs

The overall costs included anaesthesia, surgery, healthcare, medicine, hospital stay and material costs. Compared to laparotomy, the costs associated with laparoscopy were higher (P < 0.001).

However, laparoscopy had a shorter length of hospitalization (P < 0.001) and was better accepted by the patients. The rate of antibiotic prophylaxis was lower (P < 0.001), and the length of antibiotic prophylaxis (P = 0.000) was shorter. The postoperative rate of fever (P = 0.005), the postoperative maximum temperature of the patients (P = 0.001) and the postoperative length of fever (P = 0.004) were all decreased. The estimated blood loss, total surgical time, postoperative exhaust time, and postoperative urine retention were not significantly different between the 2 groups (P = 0.213). There were 4 patients in the laparotomy

Table 3. Surgical outcomes and costs between the laparotomy and laparoscopy groups

Surgical outcomes and costs	Laparotomy	Laparoscopy	*P* Value
Total surgical time (min; range)	60 (35-140)	53.5 (25-201)	.051&
Estimated blood loss (ml; range)	50 (10-200)	30 (5-400)	.052&
Incision length (m)	0.08 (0.05-0.10)	0.025 (0.025-0.03)	.000&,@
Postoperative			
Exhaust time (hours; range)	42.0 (6-67.5)	24.8 (7.5-47)	.060&
Urine retention (hours; range)	29 (17.5-91.5)	25.8 (17-75.5)	.213&
Maximum temperature (°C; range)	37.6 (36.8-38.6)	37.4 (36.8-38.3)	.001&,@
Length of fever (hours; range)	12 (0-68)	1 (0-39)	.004&,@
Rate of fever (n, %)	29 (82.9)	15 (50.0)	.005#,@
Rate of antibiotic prophylaxis (n, %)	24 (68.6)	4 (13.3)	< .001#,@
Length of antibiotic prophylaxis (days)	3 (0-3)	0 (0-3)	.000&,@
Hospitalization (days)	6.14 ± 1.648	3.97 ± 1.326	< .001*,@
Poor wound healing (n, %)**	4 (13.3)	0 (0.0)	.114¥
Costs (yuan)	6971.82 ± 3095.468	10034.98 ± 3382	< .001*,@

*T-test; &Rank sum test; #Chi square test; ¥Fisher test; @Statistical significance. **Number of follow-up used as the overall number.

Table 4. Multivariate analysis of the factors associated with the risk of fever

	Multivariate analysis		
	95% confidence		
Variable	AdjOR	Interval	*P*-value
Surgical approach			
Laparoscopy Versus Laparotomy	0.224	0.037-1.362	0.104
Bilateral ovarian tumour			
Yes Versus No	3.537	0.342-36.587	0.289
Average tumour diameter	0.935	0.811-1.078	0.354
Total surgical time	1.011	0.986-1.037	0.389
Usage of antibiotic prophylaxis			
Yes Versus No	0.098	0.002-3.728	0.207
Length of antibiotic prophylaxis	1.872	0.494-7.099	0.356
Postoperative hospitalization	1.277	0.828-1.969	0.269

group that showed poor wound healing (**Table 3**).

In the multivariate analysis, there was no significant difference in the postoperative risk of fever after adjusting for confounding factors, including postoperative hospitalization, usage and length of antibiotic prophylaxis, total surgical time, average tumour diameter and bilateral ovarian tumour (**Table 4**).

Pregnancy outcomes

All cases were followed up after the expected due date. Eight pregnant women (5 laparotomy and 3 laparoscopy; 12.3%) were lost to follow-up because of loss of contact. We could not evaluate the Apgar scores of the 2 groups because 31 of the 65 pregnant women delivered in other hospitals, and therefore we could not obtain all of the Apgar data we needed. There was not a statistically significant difference between these 2 groups in the rate of loss to follow-up (P = 0.716). There was only one case of foetal death that occurred in the 40 days after the surgery; this was caused by oligohydramnios. There was no statistically significant difference in the gestational age at delivery, preterm delivery rate, caesarean delivery rate, newborn weight, length of prophylactic tocolytic therapy or occurrence of postoperative uterine contractions (P > 0.05) (**Table 5**).

In the multivariate analysis, after adjusting for confounding factors, including bilateral ovarian tumour, average tumour diameter, the gestational week when the surgery occurred, occurrence of postoperative fever and length of prophylactic tocolytic therapy, there was also no significant difference in the risk of uterine contractions between the laparoscopy and laparotomy groups (**Table 6**).

Table 5. Pregnancy outcomes between the laparotomy and laparoscopy groups

Pregnancy outcomes	Laparotomy	Laparoscopy	*P* Value
Foetal death (n, %)**	0 (0.0)	1 (3.7)	.474¥
Postoperative			
Uterine contractions (n, %)	3 (8.6)	0 (0.0)	.243¥
Length of prophylactic tocolytic therapy (days)	7.11 ± 4.739	7.93 ± 5.362	.516*
Gestational ageat delivery (weeks)***	39.25 ± 1.233	39.22 ± 1.064	.923*
Caesarean delivery rate (n, %)***	12 (40.0)	8 (30.8)	.472&
Newborn weight (g)***	3393.43 ± 369.281	3202.12 ± 430.442	.079*
Premature delivery (< 37 weeks)***	1 (3.3)	1 (3.8)	> .050¥
Neonatal disorders***	0 (0.0)	0 (0.0)	-

**Number of follow-up used as the overall number; ***Number of live birth deliveries used as the overall number; *T-test; &Rank sum test; #Chi square test; ¥Fisher test.

Table 6. Multivariate analysis of the factors associated with the risk of uterine contractions

	Multivariate analysis		
	95% confidence		
Variable	AdjOR	Interval	*P*-value
Surgical approach			
Laparoscopy Versus Laparotomy	0.000	0.000-+∞	0.998
Bilateral ovarian tumour			
Yes Versus No	2.374	0.131-43.118	0.559
Average tumour diameter	1.014	0.807-1.274	0.908
Gestational week when accepted surgery	1.084	0.702-1.672	0.717
Postoperative			
Fever			
Yes Versus No	0.314	0.011-8.661	0.494
Length of prophylactic tocolytic therapy	1.028	0.746-1.417	0.868

Discussion

Surgical results

Our study showed no significant difference in the total surgical time between these 2 study groups (P = 0.051, 60 (35-140) for laparotomy versus 53.5 (25-201) for laparoscopy). Previous comparative studies [7, 8, 17] found that compared to laparotomy during pregnancy, laparoscopy had outstanding surgical outcomes, including a shorter hospitalization, less blood loss during the operation, and less pain after surgery. In our research, the difference in the postoperative length of hospitalization between these 2 groups was statistically significant (P < 0.001, 6.14 ± 1.648 for laparotomy versus 3.97 ± 1.326 for laparoscopy). As for the estimated blood loss, the difference was not large, but the amount of blood loss was slightly lower in the laparoscopy group (P = 0.052, 50 (10-200) for laparotomy versus 30 (5-400) for laparoscopy). The rate of poor wound healing between the 2 study groups was not significantly different, although the incision length was significantly shorter in the laparoscopy group (P < 0.05, 0.08 (0.05-0.10) for laparotomy versus 0.025 (0.025-0.03) for laparoscopy). A total of 4 patients had poor wound healing in our study, and all belonged to the laparotomy group. Three of them had a cracked superficial layer of the wound after the operation, which healed well after anti-infection treatment. One of these patients had no complaints of discomfort but found a sinus in the original caesarean scar that was full of purulent fluid. Laparoscopic surgery might reduce the risk of poor wound healing from a clinical point of view, but further and larger studies are needed.

Both the rate and length of antibiotic prophylaxis in the laparoscopy group were significantly lower than those in the laparotomy group, and at the same time, the postoperative maximum temperature and the postoperative rate and length of fever were also significantly lower in the laparoscopy group in the univariate analysis. The postoperative infection risk was somewhat lower in the laparoscopy group. Moreover, the minimally invasive surgery and the shorter postoperative hospitalization in the laparoscopy group might also reduce the risk of nosocomial infection. Laparoscopy might have more

advantages than laparotomy based on the reduced utilization of antibiotics and the lower risk of postoperative infection for pregnant women, which are beneficial for both the mothers and foetuses. In the multivariate analysis, we found that surgical approach was not an independent risk factor for postoperative fever after adjusting for several confounding factors.

An analysis of the overall costs of these 2 groups showed that the cost of laparoscopy was ¥3000-¥4000 higher than for laparotomy, and the difference was statistically significant ($P < 0.001$, 6971.82 ± 3095.468 of laparotomy versus 10034.98 ± 3382 of laparoscopy). Despite the shorter hospitalization duration and less utilization of analgesic drugs, the higher cost of surgical instruments and procedures made the laparoscopic surgery costs significantly higher than those of laparotomy. Most of our patients come from economically developed areas, and they prefer the cosmetic advantages and reduced pain after laparoscopic surgery to saving money.

In summary, laparoscopic surgery during pregnancy might have a better surgical outcome than laparotomy, according to the present research.

Pregnancy outcomes

Compared with surgery in non-pregnant women, surgery during pregnancy places more value on the pregnant women and foetal outcomes. Both laparotomy and laparoscopy had unique advantages and disadvantages. Compared to laparotomy, laparoscopic surgery avoids the direct stimulation of the uterus and theoretically reduces the risk of uterine contractions caused by the operation. However, the influence of carbon dioxide pneumoperitoneum and abdominal pressure on the placental blood supply can cause foetal acidosis. Previous research has shown that the rate of spontaneous abortion during surgery was not significantly different between laparotomy and laparoscopy. In three studies [7, 9, 10] only 2 of 160 pregnant women (84 receiving laparoscopy, 76 receiving laparotomy) in the laparotomy group had pregnancy loss, and another RCT article [8] reported no pregnancy losses in 69 pregnant women (33 receiving laparoscopy), with no statistically significant difference between the groups. These findings were consistent with our research.

The gestational age at delivery, caesarean delivery rate, premature delivery, newborn weight, postoperative uterine contractions, and length of the prophylactic tocolytic therapy were not significantly different between the laparotomy and laparoscopy groups, which are consistent with previous multicentre retrospective cohort studies [18].

Based on a previous study, surgical approach, emergency surgery and gestational age at surgery might be risk factors for preterm labour [19]. In our study, we ruled out cases of emergency surgeries. In the univariate analysis, there was no significant difference in the uterine contractions between the laparoscopy and laparotomy groups. In the multivariate analysis, we found that the surgical approach was not a risk factor for uterine contractions.

There was one case of an unexplained foetal death in the laparoscopy group in our study, and there was no pregnancy loss in the laparotomy group. We tracked this case as followed: the patient found a left ovarian cyst in the ultrasound test at the 8th week without any recorded complaints and accepted left-oophorocystectomy via laparoscopy at week 18.2. The surgery went well and lasted 40 minutes, and the pathology after surgery showed a goiter type of ovarian tumour. No abdominal pain or unusual vaginal bleeding after surgery was mentioned, and the obstetrics examination, thyroid function and ultrasonography test 2 weeks and 4 weeks after the surgery showed no abnormal outcomes. The mother became aware of a disappearance of foetal movement 41 days after the surgery, and oligohydramnios and the absence of the foetal heartbeat were observed through an ultrasonography test 42 days after the surgery. The patient accepted labour induction, and the pathology of the foetus and placenta were normal. The reason for the pregnancy loss was foetal asphyxia caused by oligohydramnios, and there was no relevant proof that the surgery was a cause of the pregnancy loss, because the foetal heartbeat and movement 2 weeks after the surgery were normal.

Overall, laparoscopic surgery had the same pregnancy outcomes as laparotomic surgery. It remains unclear whether laparoscopy has long-term adverse effects on the foetus or if there was a relationship between the one case of pregnancy loss in the laparoscopy group and the laparoscopic surgery itself. Larger and longer studies are needed.

Laparoscopy management during pregnancy and advice

When women find benign ovarian tumours during pregnancy with complications, should they accept surgery? Benign ovarian tumours during pregnancy without complications are advised to accept the elective operation. The procedure for the surgery is same as that for non-pregnant women.

As for the choice of operating time, Wang [20] thought that an operation beyond 7 weeks of pregnancy was safe, but considering the side-effects discussed above, most experts thought that the second trimester was the safest trimester for the operation [21]. During the first trimester, 71% of the ovary mass can disappear [22], and operation during this trimester is associated with a higher risk of abortion. The uterus in the third trimester is too large to perform a pelvic operation, which can cause adverse effects on the pregnancy, such as a higher rate of preterm birth [23]. It is safer to perform the operation in the second trimester [24, 25] because the sensitivity of the uterus is lower, the uterine size leaves adequate space for the surgery, and the progesterone secreted by the well-developed placenta can adequately maintain the pregnancy. An operation on the ovary has less influence on the level of progesterone, which creates a lower risk of abortion and fewer complications [26].

As for the safety of the anaesthesia, in previous studies, Steinbrook considered that the use of anaesthesia during pregnancy was safe and feasible with the appropriate precautions, including close monitoring and pneumoperitoneum pressure control [27]. The use of local anaesthesia could avoid the failure of tracheal intubation and the risk of inhalation anaesthetics, which could theoretically induce foetal malformation. However, one of Hong's studies [28] showed a higher rate of preterm birth associated with laparotomic surgery with local anaesthesia than with general anaesthesia when treating adnexal tumours during pregnancy. There is no evidence to indicate [29] which of the 2 types of anaesthesia methods is better for surgery during pregnancy. A study of ovarian surgery during pregnancy showed that none of the anaesthesia methods, for example general anaesthesia or spinal anaesthesia, showed a negative impact on the pregnancy outcomes [16]. Thus, the influence of anaesthesia during pregnancy remains controversial. In our study, the anaesthesia for laparoscopy was carried out and monitored by experienced anaesthetists, and none of the 65 women mentioned any complications.

There was one case report of laparoendoscopic single-site surgery (LESS) for cystectomy of an ovarian tumour during pregnancy. No perioperative or postoperative complications developed, and the patient was discharged on postoperative day 2 [30]. We believe that more LESS might be applied in the future with the development of this surgical technique and increases in aesthetic requirements. More research should be done to confirm the safety of LESS.

Limitations

First, our research was a retrospective study with no random assignment. Although the baseline characteristics of the 2 groups were not significantly different, we could only control for some of the common confounding factors, and those that could not be controlled might affect the results. Second, because of the short follow-up time, we used relevant short-term indicators and were unable to analyse and compare the long-term effects. Finally, newborn Apgar scores were missing because only a small proportion of research subjects delivered their babies in our hospital.

Conclusion

Compared with laparotomic surgery for the elective cystectomy of benign ovarian tumours during pregnancy, laparoscopy had an equal effect on the mothers and the foetuses. The costs of laparoscopic surgery were higher, but it is minimally invasive. Further studies are needed to compare the long-term outcomes between the 2 groups.

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Disclosure of conflict of interest

None.

Authors' contribution

Y-XL contributed to the conception and design of the study, performed the literature search, and extracted the study data, YZ was responsible for the data analysis, contributed to the interpretation of the analyses, and wrote the manuscript. LW was responsible for the overall study planning, contributed to the interpretation of the analyses, and participated in the revision of the manuscript. All of the authors approved the final version of the article.

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