Original Article

Comparative Evaluation of Laparoscopic and Open Appendectomy During Pregnancy: Maternal and Fetal Outcomes

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Abstract

Background: Acute appendicitis is one of the most common non-obstetric surgical emergencies during pregnancy, and the choice of laparoscopic and open appendectomies depends on the maternal and fetal outcomes. This study compared perioperative, postoperative, obstetric, and fetal/neonatal outcomes in patients with laparoscopic appendectomy and open appendectomy during pregnancy. **Material and Methods:** This study conducted a comparative observational study of 50 pregnant women who underwent laparotomy for the treatment of acute appendicitis in a tertiary care hospital from June 2024 to June 2026. Patients were randomly assigned to the laparoscopic appendectomy group (LA; n = 25) and the open appendectomy group (OA; n = 25). Demographic, clinical, operative, postoperative, maternal obstetric, and fetal/neonatal data were collected. Continuous variables are described as mean ± SD, while categorical variables are presented as counts and percentages. Statistical analyses were performed with appropriate t-tests, chi-square tests, or Fisher's exact tests. A value of $p < 0.05$ was considered statistically significant. **Results:** The mean age and gestational age were 27.50 ± 3.54 years and 18.56 ± 5.21 weeks, respectively. The LA group showed a longer operative time in comparison with the OA group (54.8 ± 11.6 vs 46.2 ± 10.4 minutes) but lower intraoperative blood loss (24.8 ± 8.7 vs 31.6 ± 10.2 mL). The LA group had a lower level of postoperative pain, earlier mobilization and oral intake, and shorter hospital stay (3.4 ± 1.1 vs 5.0 ± 1.4 days). The maternal obstetric and fetal/neonatal outcomes were similar in groups. **Conclusion:** Laparoscopic appendectomy was associated with better postoperative recovery without affecting the maternal and fetal outcomes.

Keywords: Acute appendicitis, Pregnancy, Laparoscopic appendectomy, Open appendectomy, Maternal and fetal outcomes.

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Introduction

Acute appendicitis is a frequent cause of non-obstetric surgical emergencies during pregnancy.[1] The physiology and anatomy of pregnancy could change the presentation of appendicitis and, consequently, delay its diagnosis and treatment.[2] Uterine distension leads to displacement of the appendix, and pregnancy-associated leukocytosis and gastrointestinal symptoms make the assessment difficult.[3] The timely diagnosis and treatment of acute appendicitis is necessary to prevent adverse outcomes for the mother and fetus.[4]

Appendectomy is the surgical procedure of choice in the treatment of acute appendicitis. Both laparoscopic and open appendectomy is used in clinical practice.[5] Traditionally, open appendectomy is considered more preferable due to some concerns about pneumoperitoneum and increased intra-abdominal pressure and their potential adverse influence on uteroplacental perfusion and fetal well-being.[6] However, laparoscopic surgery has certain advantages, such as smaller incisions, lower postoperative pain, earlier mobilization, shorter hospitalization, and fast recovery.[7] Modern progress in the field of laparoscopic surgery, anesthesia, and perioperative monitoring allowed using this surgical approach in pregnant patients.

However, laparoscopic surgery still has some potential disadvantages for the pregnant patient. Such outcomes as operative time, intraoperative blood loss, postoperative pain, postoperative complications, duration of hospitalization, preterm labor, fetal loss, preterm delivery, birth weight, Apgar score, and neonatal intensive care unit admission are important outcomes for pregnant women. Different results in various studies may depend on gestational age, disease severity, surgeon experience, patient selection, and perioperative care.[8,9] The comparison of outcomes could give some valuable information about the safety of both surgical methods for pregnant women.

The aim of the present study was to compare the perioperative outcomes, postoperative recovery, maternal obstetric complications, and fetal/neonatal outcomes in patients with

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laparoscopic appendectomy and open appendectomy during pregnancy.

Materials and Methods

This comparative observational study involved pregnant women who had appendectomy from June 2024 to June 2026 in a tertiary care hospital. The study included 50 patients with a clinical and/or radiological diagnosis of acute appendicitis who underwent laparotomy. These women were assigned to two groups: 25 underwent laparoscopic appendectomy (LA group) and 25 underwent open appendectomy (OA group). The inclusion criteria were pregnant women who underwent laparotomy during the defined period and had a clinical and/or radiological diagnosis of acute appendicitis. The choice of operative approach was based on the clinical assessment, gestational age, disease severity, surgeon preferences, and institutional practices. The exclusion criteria were incomplete clinical or operative data, major surgical disease, or a lack of definitive appendectomy.

Demographic and clinical data were collected, including the maternal age, gestational age, trimester, symptoms, clinical examination findings, laboratory parameters, and imaging. Intraoperative variables were the operative approach, the duration of operation, the intraoperative blood loss, complicated and perforated appendicitis, drains insertion, and intraoperative complications. Postoperative outcomes for the mothers were postoperative pain, analgesic use, time to mobilization, time to resumption of oral intake, the duration of hospitalization, wound infection, postoperative ileus, readmission, and reoperation. The obstetric outcomes were preterm labor, preterm delivery, spontaneous abortion, antepartum hemorrhage, mode of delivery, and maternal mortality.

The fetal and neonatal outcomes were assessed after the surgery and in the course of pregnancy where the follow-up data were available. These outcomes were fetal loss, live birth, gestational age at delivery, birth weight, low birth weight, 5-minute Apgar score, NICU admission, and neonatal mortality. The comparison of maternal and fetal outcomes was performed to assess the difference in the recovery and pregnancy outcomes. All the data were collected with the help of a structured data collection pro forma.

The data were entered into Microsoft Excel and analyzed with Statistical Package for the Social Sciences (SPSS), version 26.0. Continuous variables were described as mean ± SD. Categorical variables were described as frequency and percentage [n(%)]. The between-group comparison of the continuous variables was performed using the independent-samples Student's t-test. The categorical variables were analyzed with the chi-square test or Fisher's exact test as appropriate. P-value less than 0.05 was considered statistically significant.

Results

Fifty pregnant women underwent appendectomy, 25 (50.0%) in LA group and 25 (50.0%) in OA group. The mean age was 27.50 ± 3.54 years, and the mean gestational age at surgery was 18.56 ± 5.21 weeks. The majority of the women (66.0%) were in the second trimester of pregnancy, followed by the first trimester (18.0%) and the third trimester (16.0%). [Table 1]

Table 1: Distribution of study participants according to age and gestational age

Variable	Laparoscopic appendectomy (n=25)	Open appendectomy (n=25)	Total (N=50)	p-value
Age (years), mean ± SD	27.16 ± 3.42	27.84 ± 3.67	27.50 ± 3.54	0.507
Gestational age (weeks), mean ± SD	18.24 ± 5.16	18.88 ± 5.31	18.56 ± 5.21	0.666
Trimester				
First trimester	5 (20.0%)	4 (16.0%)	9 (18.0%)	0.904
Second trimester	16 (64.0%)	17 (68.0%)	33 (66.0%)	
Third trimester	4 (16.0%)	4 (16.0%)	8 (16.0%)	

All patients (100.0%) had abdominal pain, and 35 (70.0%) patients had nausea/vomiting, 34 (68.0%) had leukocytosis, 18 (36.0%) had fever, and 47 (94.0%) had right iliac fossa tenderness. Ultrasonography showed appendicitis in 41 (82.0%) women. [Table 2]

Table 2: Comparison of clinical presentation between the study groups

Clinical characteristic	Laparoscopic appendectomy (n=25)	Open appendectomy (n=25)	Total (N=50)	p-value
Abdominal pain	25 (100.0%)	25 (100.0%)	50 (100.0%)	-
Nausea/vomiting	17 (68.0%)	18 (72.0%)	35 (70.0%)	0.758
Fever	8 (32.0%)	10 (40.0%)	18 (36.0%)	0.556
Leukocytosis	16 (64.0%)	18 (72.0%)	34 (68.0%)	0.544
Right iliac fossa tenderness	23 (92.0%)	24 (96.0%)	47 (94.0%)	0.548
Ultrasound suggestive of appendicitis	21 (84.0%)	20 (80.0%)	41 (82.0%)	0.736

The mean operative time was 54.8 ± 11.6 minutes in LA group and 46.2 ± 10.4 minutes in OA group. Mean intraoperative blood loss was 24.8 ± 8.7 mL in LA group and 31.6 ± 10.2 mL in OA group. Complicated appendicitis was observed in 11 (22.0%) women, perforation in 5 (10.0%) women, drains insertion in 8 (16.0%) women, and intraoperative complications in 3 (6.0%). [Table 3]

Table 3: Intraoperative characteristics in the two groups

Variable	Laparoscopic appendectomy (n=25)	Open appendectomy (n=25)	p-value

Operative time (minutes), mean ± SD	54.8 ± 11.6	46.2 ± 10.4	0.009
Intraoperative blood loss (mL), mean ± SD	24.8 ± 8.7	31.6 ± 10.2	0.015
Complicated appendicitis	5 (20.0%)	6 (24.0%)	0.733
Perforated appendix	2 (8.0%)	3 (12.0%)	0.637
Drain placement	3 (12.0%)	5 (20.0%)	0.439
Intraoperative complication	1 (4.0%)	2 (8.0%)	0.548

The mean postoperative pain score at 24 hours was 3.2 ± 0.9 in LA group and 4.1 ± 1.0 in OA group. Mean times to mobilization and resumption of oral intake were 14.6 ± 4.2 and 12.8 ± 3.7 hours, respectively, after laparoscopic appendectomy compared to 20.8 ± 5.1 and 18.1 ± 4.5 hours after open appendectomy. The mean length of hospital stay was 3.4 ± 1.1 days in LA group and 5.0 ± 1.4 days in OA group. [Table 4]

Table 4: Comparison of postoperative maternal outcomes

Postoperative outcome	Laparoscopic appendectomy (n=25)	Open appendectomy (n=25)	p-value
Postoperative pain score at 24 h, mean ± SD	3.2 ± 0.9	4.1 ± 1.0	0.002
Analgesic requirement (days), mean ± SD	2.1 ± 0.8	3.0 ± 1.0	0.001
Time to ambulation (hours), mean ± SD	14.6 ± 4.2	20.8 ± 5.1	<0.001
Time to oral intake (hours), mean ± SD	12.8 ± 3.7	18.1 ± 4.5	<0.001
Postoperative hospital stay (days), mean ± SD	3.4 ± 1.1	5.0 ± 1.4	<0.001
Wound infection	1 (4.0%)	3 (12.0%)	0.301
Postoperative ileus	1 (4.0%)	3 (12.0%)	0.301
Readmission	1 (4.0%)	2 (8.0%)	0.548

The preterm labor and preterm delivery occurred in 6 (12.0%) women in total, and in a higher number in the OA group. The spontaneous abortion occurred in 3 (6.0%) women and the antepartum haemorrhage was observed in 2 (4.0%) women. Caesarean delivery was done in 22 (44.0%) women and vaginal delivery in 22 (44.0%). Fetal loss was seen in 3 (6.0%) women and 3 (6.0%) were ongoing at the last follow-up [Table 5].

Table 5: Maternal obstetric outcomes

Maternal outcome	Laparoscopic appendectomy (n=25)	Open appendectomy (n=25)	p-value
Preterm labour	2 (8.0%)	4 (16.0%)	0.384
Preterm delivery	2 (8.0%)	4 (16.0%)	0.384
Spontaneous abortion	1 (4.0%)	2 (8.0%)	0.548
Antepartum haemorrhage	1 (4.0%)	1 (4.0%)	1.000
Maternal ICU admission	0 (0.0%)	1 (4.0%)	0.312
Maternal mortality	0 (0.0%)	0 (0.0%)	—
Caesarean delivery	10 (40.0%)	12 (48.0%)	0.571
Vaginal delivery	13 (52.0%)	9 (36.0%)	0.254
Pregnancy ongoing at last follow-up	1 (4.0%)	2 (8.0%)	0.548

Among the fetal and neonatal outcomes 44 (88.0%) had live births and 3 (6.0%) fetal loss. The mean birth weight was 2.86 ± 0.42 kg in LA group and 2.71 ± 0.47 kg in OA group. Low birth weight was seen in 12 (24.0%) neonates, and NICU admission occurred in 8 (16.0%). The mean 5-minute Apgar scores were 8.7 ± 0.6 and 8.4 ± 0.8 in LA and OA groups, respectively [Table 6].

Table 6: Fetal and neonatal outcomes

Fetal/neonatal outcome	Laparoscopic appendectomy (n=25)	Open appendectomy (n=25)	p-value
Live birth	23 (92.0%)	21 (84.0%)	0.384
Fetal loss	1 (4.0%)	2 (8.0%)	0.548
Birth weight (kg), mean ± SD	2.86 ± 0.42	2.71 ± 0.47	0.243
Low birth weight (<2.5 kg)	5 (20.0%)	7 (28.0%)	0.508
Preterm birth	2 (8.0%)	4 (16.0%)	0.384
5-minute Apgar score, mean ± SD	8.7 ± 0.6	8.4 ± 0.8	0.143
NICU admission	3 (12.0%)	5 (20.0%)	0.439
Neonatal mortality	0 (0.0%)	1 (4.0%)	0.312

Discussion

Acute appendicitis during pregnancy presents a unique challenge for clinicians, as it requires the consideration of both maternal and fetal outcomes. The present study revealed that the majority of women underwent appendectomy during the second trimester of pregnancy, and the baseline characteristics, including the maternal age and gestational age, were similar in two groups. These results correspond to the findings of Kabraman et al., which showed that there were no significant differences in age, gestational age, or other baseline characteristics between pregnant women undergoing laparoscopic and open appendectomy.[10] According to the SAGES guidelines, appendectomy is the treatment of choice for acute appendicitis during pregnancy, while the evidence comparing laparoscopic and open procedures is of low

certainty.[11]

In the present study, laparoscopic appendectomy had a longer operative time but lower intraoperative blood loss in comparison with open appendectomy. The most importantly, laparoscopic surgery correlated with a better postoperative recovery, including a lower postoperative pain, earlier mobilization, earlier resumption of oral intake, and shorter hospital stay. These results correspond to the findings of Kabraman et al., which revealed that laparoscopic appendectomy had a longer operative time but shorter hospitalization and mobilization.[10] According to the meta-analysis by Zeng et al. Involving 27 studies and 6,497 pregnant women, similar investigations found that laparoscopic appendectomy had lower wound infection and complication rates and shorter hospitalization.[12] Another systematic review, involving 7,248 pregnant women, found that laparoscopic surgery had a shorter hospital stay and lower wound infection rate.[13]

Maternal and fetal outcomes in the present study were similar in two surgical groups. Numerically less frequent preterm labour and preterm delivery occurred after laparoscopic appendectomy. Fetal loss, NICU admission, birth weight, and Apgar scores were similar in groups. These findings correspond to the results of a meta-analysis by Zeng et al., which found no significant difference in preterm delivery between laparoscopic and open appendectomy, although the overall fetal loss rate was higher in the laparoscopy group in the pooled analysis.[12] The difference in fetal loss was no longer statistically significant when only studies published after 2010 were analyzed, probably due to improvements in the surgery and perioperative care.[12] Also, a systematic review by Lee et al. found no significant difference in preterm delivery, but the fetal loss rate was higher in the laparoscopic group in the pooled analysis.[14]

Interpretation of these findings should take into account the limitations of the existing evidence base, namely the predomination of retrospective studies and the relatively small number of pregnant women in individual comparative studies. The 2018 meta-analysis of 20 studies involving 6,210 pregnant women found shorter hospitalisation and fewer overall complications with laparoscopic appendectomy but higher fetal-loss rate, concluding that the optimal surgical approach remained uncertain.[15] The current SAGES guidelines continue to describe the evidence as having low or very-low certainty and recommend laparoscopic appendectomy if the uterine fundus is below the umbilicus, but allow the use of both approaches if the fundus is above the umbilicus depending on clinical situations and surgeon preferences.[11] Thus, the findings of the present study contribute to accumulating evidence that laparoscopic appendectomy provides favorable maternal postoperative recovery without an increase in major adverse pregnancy outcomes, emphasizing the importance of careful patient selection, gestational age considerations, multidisciplinary obstetric care, and adequate surgical expertise.

Strengths and Limitations

The strengths of the current study include the direct comparison of laparoscopic and open appendectomy with the assessment of operative, postoperative, maternal obstetric, and fetal/neonatal outcomes. The limitation of the study was a relatively small sample size (50 participants) which limited the statistical power for finding the differences in uncommon maternal and fetal complications. Moreover, the non-randomized design of the study increased the risk of selection bias, and the variability in gestational age, disease severity, and surgeon preferences could influence the choice of the surgical approach and subsequent outcomes.

Conclusion

Laparoscopic appendectomy during pregnancy was associated with favourable postoperative recovery, including reduced postoperative pain, earlier ambulation and oral intake, and shorter hospital stay, despite a longer operative duration than open appendectomy. Maternal obstetric and fetal/neonatal outcomes were broadly comparable between the two approaches, with no maternal mortality observed. These findings support laparoscopic appendectomy as a feasible surgical approach for appropriately selected pregnant women with acute appendicitis when performed with suitable surgical expertise and obstetric monitoring.

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Conflicts of interest

There are no conflicts of interest.

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