ORIGINAL ARTICLE
Turk J Surg

Surgical outcomes of laparoscopic and open appendectomy in pregnant patients: A single-center retrospective cohort study

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ABSTRACT

Objective: Acute appendicitis is the most common non-obstetric surgical emergency in pregnancy and is associated with increased maternal morbidity and risk of preterm delivery. Diagnostic difficulty rises with advancing gestation, contributing to delayed diagnosis and higher negative appendectomy rates. This retrospective study compared surgical outcomes between laparoscopic and open appendectomy in pregnant patients and assessed trimester-specific trends.

Material and Methods: This retrospective single-center cohort study included pregnant patients who underwent appendectomy between June 2020 and December 2023. The final cohort of 50 cases met the inclusion criteria. Primary outcomes were maternal postoperative complications and preterm birth; secondary outcomes included operative time and length of stay (LOS). Continuous variables were non-normally distributed and are summarized as median (range). Group comparisons were performed using the Mann-Whitney U and Fisher's exact tests.

Results: Appendectomies were performed during the first (26%), second (60%), and third trimesters (14%). Laparoscopic appendectomy accounted for 48% of cases. Operative time was significantly shorter in the laparoscopic group compared with the open approach (47 vs. 58 minutes, p=0.044). No significant differences were observed in postoperative complications, LOS, or preterm birth. The overall negative appendectomy rate was 8%, increasing to 28.6% in the third trimester, consistent with greater diagnostic difficulty in late gestation.

Conclusion: Laparoscopic appendectomy is a safe and feasible option during pregnancy, providing comparable maternal and obstetric outcomes to open surgery while offering shorter operative times. Larger prospective studies are needed to clarify trimester-specific management, particularly in late gestation.

Keywords: Appendicitis, pregnancy, laparoscopic appendectomy, open surgery, maternal outcomes

INTRODUCTION

Acute appendicitis is the most common non-obstetric surgical emergency during pregnancy, with an incidence of 0.05-0.13% (1,2). While the overall incidence is comparable to that of non-pregnant populations, pregnant patients face a significantly higher risk of adverse outcomes, including increased rates of appendiceal perforation and associated maternal and fetal morbidity (3,4). Appendicitis may occur at any gestational age; however, hospitalization rates are highest during the second trimester (5,6).

Diagnosis is frequently challenging due to gestational anatomical displacement, physiological leukocytosis, and the limitations of imaging modalities. Ultrasonography has limited sensitivity and negative predictive value; magnetic resonance imaging (MRI), although more accurate, is not always immediately available; and computed tomography (CT) is generally avoided because of fetal radiation exposure (7).

Laparoscopic surgery has emerged as both a diagnostic and therapeutic option for suspected appendicitis in pregnancy. Nevertheless, real-world comparative data between laparoscopic appendectomy (LA) and open appendectomy (OA), particularly across trimesters, remain limited.

This study aimed to compare perioperative outcomes between LA and OA in pregnant patients and to describe trimester-specific patterns in presentation, diagnostic accuracy, and maternal-fetal outcomes.

Cite this article as: Bekraki A, Aydın O, Yagublu K, Korkmaz YY, Işık AL, Demir Güngör AS. Surgical outcomes of laparoscopic and open appendectomy in pregnant patients: a single-center retrospective cohort study. *Turk J Surg.* [Epub Ahead of Print]

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Received: 29.09.2025
Accepted: 09.02.2026
Epub: 17.02.2026

DOI: 10.47717/turkjsurg.2026.2025-9-33

Available at **www.turkjsurg.com**

MATERIAL and METHODS

Study Design and Patient Selection

This retrospective single-center cohort study included all pregnant patients who underwent appendectomy between June 2020 and December 2023 in University of Health Sciences Türkiye, Başakşehir Çam and Sakura City Hospital, a tertiary care hospital in İstanbul, Türkiye. All patients underwent evaluation by both a general surgeon and an obstetrician. Gestational age at surgery determined trimester classification. Pathology results were categorized as acute appendicitis, phlegmonous appendicitis, complicated appendicitis (gangrenous, perforated, or abscess-forming), or normal appendix.

Inclusion and Exclusion Criteria

Inclusion criteria were confirmed fetal heartbeat before surgery, obstetric consultation, and maternal age ≥18 years. Patients <18 years or without fetal cardiac activity were excluded. A total of 50 cases fulfilled the defined criteria and were therefore included in the final analysis of this work.

Collected Variables

Data included demographic characteristics, laboratory values, imaging findings, operative time, surgical approach, conversions from laparoscopy to open, postoperative complications, length of stay, and obstetric outcomes including preterm birth. Preterm delivery was defined as birth <37 weeks of gestation.

Statistical Analysis

Descriptive statistics are reported as frequencies (percentages) for categorical variables. All continuous variables failed the Shapiro-Wilk test for normality ($p<0.05$ for all variables). Consequently, non-parametric statistics were utilized, and continuous data are reported as median (range). Comparative analyses between the LA and OA groups were performed using the Mann-Whitney U test for continuous variables and the Fisher's exact test for categorical variables. A two-sided p-value <0.05 was predefined as statistically significant.

Ethical Approval

Ethics committee approval was obtained from the Ethics Committee of University of Health Sciences Türkiye, Başakşehir Çam and Sakura City Hospital under the number 2025-241. All procedures complied with the 1964 Declaration of Helsinki and its subsequent revisions. Informed consent was obtained from all participants prior to inclusion in the study.

Declaration of Generative AI

During the preparation of this work, the authors used Google Gemini for English language editing to improve readability. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

RESULTS

Patient Demographics and Baseline Characteristics

During the study period (June 2020-December 2023), 2.466 appendectomies were performed at our institution, of which 50 involved pregnant patients. The median maternal age was 27 years (range: 18-39). Median gestational age at surgery was 18 weeks (range: 5-28) for the LA group and 21.5 weeks (range: 8-33) for the OA group.

Diagnostic Workup

Preoperative imaging was commonly utilized: 32 patients (64%) underwent MRI and 43 patients (86%) underwent ultrasound. Two patients (4%) proceeded to surgery based solely on clinical and laboratory findings, without preoperative imaging. Detailed baseline characteristics and laboratory values are provided in Table 1.

Surgical and Postoperative Outcomes

The cohort was divided into an OA group (n=26, 52%) and an LA group (n=24, 48%), with the operative approach selected according to the attending surgeon's preference. Surgeries were distributed across trimesters: First trimester (n=13, 26%), second trimester (n=30, 60%), and third trimester (n=7, 14%). General anesthesia was used in 33 patients (66%) and spinal anesthesia in 17 patients (34%), based on the anesthesiologist's clinical judgment.

Median operative time was significantly shorter in the LA group compared with the OA group (47 vs. 58 minutes, p=0.044). To exclude the potential confounding effect of gestational age on operative duration, a subgroup analysis was performed for second-trimester (n=30). This confirmed that the median operative time was significantly shorter in the laparoscopic group than in the open group [35 minutes (range 20-95) vs. 58 minutes (range 25-110); p=0.034]. Postoperative complications occurred in five patients (10% overall)—two in the OA group (7.7%) and three in the LA group (13%)—all of which were limited to wound infections. No statistically significant difference was observed between groups (p=0.661). Length of hospital stay was similar between groups (1-5 days vs. 1-4 days).

No fetal loss occurred. Preterm delivery was observed in five patients (10%)—three following LA and two following OA—with no statistically significant difference between groups (p=0.661). In the LA group, preterm deliveries occurred at 23, 28, and 36 weeks of gestation, corresponding to gestational ages at surgery of 21, 25, and 28 weeks, respectively. In the OA group, preterm deliveries occurred at 30 and 31 weeks, with gestational ages at surgery of 25 and 16 weeks, respectively. All preterm infants are currently alive and healthy.

The overall negative appendectomy rate was 8% (n=4). A summary of operative and postoperative characteristics is presented in Table 2. Of the third-trimester patients (n=7), the majority (n=6, or 85.7%) underwent OA appendectomy, while only one patient (14.3%) underwent laparoscopic surgery. This reflects a preference for open surgery in advanced gestation in our cohort.

Trimester-based Analysis

Preterm birth rates demonstrated an upward trend with advancing gestation, occurring in 0% (0/13) of first-trimester cases, 13.3% (4/30) in the second trimester, and 14.3% (1/7) in the third trimester. Postoperative complications were observed in 7.7% (1/13), 10% (3/30), and 14.3% (1/7) of patients in the first, second, and third trimesters, respectively, with all complications being minor and managed conservatively.

Negative appendectomy rates also varied by trimester, rising from 7.7% (1/13) in the first trimester to 3.3% (1/30) in the second trimester and increasing substantially to 28.6% (2/7) in the third trimester, reflecting the growing diagnostic challenges in late pregnancy. Median gestational ages at the time of surgery were 10, 20, and 31 weeks for the first, second, and third trimesters, respectively. Corresponding median operative times were 55 minutes, 45 minutes, and 60 minutes, likely reflecting the technical complexity associated with increasing gestational age. A detailed summary of trimester-specific outcomes is provided in Table 3.

Pathological Findings

Pathology reports revealed acute appendicitis in 35 patients (70%), acute phlegmonous appendicitis in 8 (16%), perforated appendicitis in 2 (4%), appendiceal tumor in 1 (2%), and a normal appendix in 4 (8%). Notably, one patient with perforated appendicitis underwent surgery based solely on clinical findings, while a patient with a normal appendix underwent surgery guided by ultrasound and clinical examination. There was no significant difference in pathological severity between the laparoscopic and open surgery groups. A summary of the pathological characteristics is provided in Table 4.

Table 1. Demographic characteristics and imaging features of patients

	Overall (n=50)	Open surgery (n=26)	Laparoscopic surgery (n=24)
Age (years)	27 (18-39)	28 (19-39)	26 (18-37)
WBC (x10^3/μL)	14.7 (6.8-28.1)	16.1 (7.4-27.9)	13.1 (6.8-22.4)
Lymphocyte count (x10^3/μL)	1.72 (0.6-3.8)	1.72 (0.7-3.69)	1.72 (0.6-3.8)
Platelet count (x10^6/μL)	227 (132-341)	222 (134-345)	233 (150-334)
C-reactive protein count (mg/L)	38.6 (1-210)	39.3 (2-198)	37.8 (1-210)
Ultrasonography - Acute appendicitis - Appendix not visualized - Ultrasound was not performed	43 24 (48%) 19 (38%) 7 (14%)		
Magnetic resonance imaging - Acute appendicitis - Normal appendix - Appendix not visualized - MRI was not performed	32 22 (44%) 7 (14%) 3 (6%) 18 (36%)		

WBC: White blood cell, USG: Ultrasound, MRI: Magnetic resonance imaging.

Table 2. Operative and postoperative features of patients

	n	Open surgery (n=26)	Laparoscopic surgery (n=24)	p
Gestational age - 1st trimester - 2nd trimester - 3rd trimester	 13 30 7	 5 15 6	 8 15 1	 0.034*
Operation time (min)		58 (21-110)	47 (18-95)	0.044*
Hospital stay (day)		1.7 (1-5)	1.6 (1-4)	0.965
Postoperative complication	5	2 (7.7%)	3 (13%)	0.661
Preterm birth	5	2	3	0.661
Fetal loss	0	0	0	

*: $p<0.05$.

Table 3. Trimester-based clinical outcomes			
	1st trimester (n=13)	2nd trimester (n=30)	3rd trimester (n=7)
Preterm birth, n (%)	0 (0%)	4 (13.3%)	1 (14.3%)
Postoperative complication, n (%)	1 (7.7%)	3 (10%)	1 (14.3%)
Negative appendectomy, n (%)	1 (7.7%)	1 (3.3%)	2 (28.6%)
Median GA at surgery (weeks)	10	20	31
Median operation duration (min)	55	45	60
GA: General anesthesia.			

Table 4. Pathologic findings of patients			
	n (%)	Open surgery	Laparoscopic surgery
Acute appendicitis	35 (70%)	15	20
Acute phlegmenous appendicitis	8 (16%)	8	0
Perforated appendicitis	2 (4%)	1	1
Tumor	1 (2%)	0	1
Normal appendix	4 (8%)	2	2

DISCUSSION

The main finding of this study is that LA results in a significantly shorter operative time compared to open surgery (median: 47 vs. 58 minutes), without increasing the risk of maternal or fetal complications. Although open surgery has traditionally been favoured for its perceived speed, our results show that laparoscopy is a time-efficient alternative for pregnant patients. Crucially, our subgroup analysis of second-trimester cases indicates that this advantage in operative duration is intrinsic to the laparoscopic technique rather than being a result of patient selection or differences in gestational age. Furthermore, our trimester-specific evaluation revealed that, although surgical safety remains comparable across stages, diagnostic challenges increase significantly in the third trimester, necessitating careful preoperative assessment.

LA was first described by Semm in 1983, but its application in pregnant patients was initially limited; the first documented case in pregnancy was reported by Schreiber et al. in 1990. A major turning point occurred in 2007, when the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) formally endorsed LA as a safe option during pregnancy (1). Despite this, the widespread adoption of laparoscopy in pregnant patients has progressed cautiously, largely due to concerns regarding fetal safety, intraoperative CO_2 insufflation, and technical difficulty in advanced gestation.

Diagnosing acute appendicitis during pregnancy remains challenging. Physiological changes—including displacement of abdominal organs by the enlarging uterus and altered laboratory parameters—can obscure classical symptoms and complicate clinical assessment. In accordance with SAGES recommendations, ultrasound is typically the first-line imaging modality, with MRI reserved for inconclusive cases. The sensitivity and specificity of MRI in suspected cases of acute appendicitis in pregnant patients are reported to be 91.8% and 97.9%, respectively, without exposure of both mother and fetus to ionizing radiation (5). CT is generally avoided due to fetal radiation exposure and employed only in exceptional circumstances. In our cohort, ultrasound was used in 86% of patients and MRI in 64%, reflecting contemporary practice patterns. Importantly, no patient underwent CT imaging. The negative appendectomy rate of 8% aligns with published data and highlights the persistent diagnostic limitations in this population.

Anatomical and technical challenges are amplified as gestational age advances. The gravid uterus reduces available intra-abdominal working space and alters the position of the appendix, often necessitating modifications to port placement (7,8). Prior literature suggested hesitancy among surgeons to perform LA in later trimesters (9,10). More recent studies confirm its feasibility and safety across all gestational stages (11-14). Improvements in laparoscopic technology and surgeon expertise have contributed to the increasing use of this approach in pregnant patients (15,16).

Earlier reports, such as Walsh and Walsh (15), suggested that LA may be associated with higher preterm birth rates when compared with open surgery. However, subsequent meta-analyses and large cohort studies have demonstrated that preterm delivery rates do not significantly differ between laparoscopic and OA (16,17). Being a matter of ongoing debate, some recent single-center and national studies still report

higher baseline preterm delivery rates associated with surgery in pregnancy (18). In our cohort, preterm birth occurred in five patients overall—three after laparoscopic surgery and two after open surgery—without statistical significance. Notably, none of the preterm deliveries occurred during the immediate postoperative period. The substantial latency interval between surgery and delivery (ranging from two to 15 weeks) suggests that these outcomes were probably influenced by the systemic inflammatory response to appendicitis or underlying obstetric risk factors rather than by the surgical technique itself. Maternal and fetal outcomes were comparable between approaches, with operative time being the only variable that differed significantly. Although the open surgery group included more third-trimester patients, our subgroup analysis of second-trimester cases confirmed that the laparoscopic approach resulted in significantly shorter operative times, regardless of the distribution of gestational ages.

The trimester-based analysis of our cohort provides additional insight into the influence of gestational age on clinical outcomes. Although complication and preterm birth rates did not differ significantly across trimesters, the markedly higher negative appendectomy rate in the third trimester reflects the increasing diagnostic complexity as pregnancy progresses. This finding is consistent with known limitations of late-gestation ultrasound visualization and the reduced availability or feasibility of MRI in urgent settings. The prolonged median operative time in the third trimester further reflects the technical demands imposed by reduced intra-abdominal space and altered anatomical landmarks.

Regardless of surgical approach, evidence indicates that the risk of preterm delivery in the third trimester is approximately double that of other trimesters (19). Importantly, existing literature has not demonstrated teratogenic or developmental risks associated with general anesthesia (19,20). Both SAGES and the World Society for Emergency Surgery reaffirm that laparoscopic and OA are appropriate options during pregnancy (1).

Given that LA is more frequently performed in the first trimester, a period naturally associated with higher fetal loss rates, the choice of surgical technique appears to have minimal impact on fetal mortality (16). While a study by Cite Sugai et al. (21) suggests that conservative management may be an option in select cases, our institution maintains a policy of operative management for all pregnant patients with suspected acute appendicitis. For patients with low clinical suspicion, close monitoring and repeated evaluation are employed as alternatives to immediate surgery.

Laparoscopic surgery offers several potential advantages—including reduced postoperative pain, lower wound infection rates, and faster recovery (22). In our study, postoperative complications occurred at similar rates in both groups and consisted solely of superficial wound infections managed conservatively.

Notably, a histopathological evaluation revealed an appendiceal tumour in one patient in our cohort. Incidental appendiceal neoplasms, which are most commonly neuroendocrine tumours, are rare findings in appendectomy specimens (typically occurring in fewer than 1% of cases), but they can occur in pregnant patients (23). This finding highlights the importance of routinely examining all resected specimens histopathologically, regardless of the obstetric context, to ensure appropriate oncological follow-up when necessary.

Study Limitations

This study has several limitations. The retrospective design introduces the inherent risk of selection bias, and the small number of third-trimester laparoscopic cases limits the ability to draw definitive conclusions regarding outcomes in late pregnancy. Additionally, infant follow-up was not standardized, as neonates were subsequently monitored at various institutions, precluding detailed long-term comparison of neonatal outcomes between surgical approaches.

CONCLUSION

LA is a safe and effective surgical option during pregnancy, offering outcomes comparable to open surgery and the advantage of shorter operative time. Although diagnostic challenges—particularly in the third trimester—contribute to higher negative appendectomy rates, laparoscopy can be performed safely across all gestational stages.

Although limited by its retrospective design and small third-trimester sample, this study supports the safety of minimally invasive surgery in pregnancy. Larger prospective studies are needed to define trimester-specific risks and guide management.

Ethics

Ethics Committee Approval: Ethics committee approval was obtained from the Ethics Committee of University of Health Sciences Türkiye, Başakşehir Çam and Sakura City Hospital under the number 2025-241.

Informed Consent: Informed consent was obtained from all participants prior to inclusion in the study.

Footnotes

Author Contributions

Surgical and Medical Practices - A.B., O.A., Y.Y.K., A.L.I.; Data Collection or Processing - K.Y.; Analysis or Interpretation - O.A., K.Y., A.S.D.G.; Literature Search - O.A., A.S.D.G.; Writing - A.B., O.A., Y.Y.K., A.S.D.G.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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