

Effectiveness of the laparoscopic appendectomy on second half of the pregnancy

 Mehmet Aziret,  Yesim Akdeniz,  Kerem Karaman,  Fatih Altintoprak,  Cengiz Karacaer,  Baris Mantoglu,  Yasin Alper Yildiz,  Metin Ercan

Department of General Surgery, Sakarya University Education and Research Hospital, Sakarya, Turkey

Copyright © 2020 by authors and Annals of Medical Research Publishing Inc.

Abstract

Aim: Although the debate regarding fetal loss and preterm delivery continues, the use of laparoscopic appendectomy (LA) to treat pregnant women has gained legitimacy owing to the advantages it brings, such as less uterine manipulation, less postoperative pain, and an early return to normal daily activity. This present study aims to compare the impact of LA on women in early and late gestation periods with regard to surgical outcomes.

Material and Methods: After scanning the files of 4,295 cases, 29 patients who underwent LA for acute appendicitis during pregnancy were enrolled in the study and were assessed retrospectively. The patients were divided into two groups: women with a gestation period less than 20 weeks (group 1; n=19) and those over 20 weeks (group 2; n=10). Data from these two groups, including patient perioperative characteristics and morbidity, were compared.

Results: The results showed no statistical difference between the two groups. No statistically significant difference was detected in terms of mean age, body mass index, length of hospital stay, operation time or median ASA score ($p > 0.05$). Moreover, mean INR (International normalized ratio), hemoglobin, hematocrit, white blood cell count, neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, red cell distribution width, platelet distribution width and histopathological examination of the appendicitis revealed no statistical difference between the two groups ($p > 0.05$). Most importantly, comparison of surgical site infection (6.8%), intra-peritoneal collection (3.4%), fetal distress and preterm delivery rate (6.8%), and abortus imminens (3.4%) also showed no significant difference ($P > 0.05$). In this study, no fetal loss was recorded.

Conclusion: The results of present study suggest that LA for acute appendicitis in pregnant women can be performed safely during the second half of pregnancy.

Keywords: Acute appendicitis; laparoscopic appendectomy; pregnancy

INTRODUCTION

The last three decades have seen an increase in the use of minimally invasive surgery (MIS) to treat a variety of conditions such as colorectal disorders, appendicitis, and diseases of the gallbladder and pancreas; consequently, endoscopic interventions are increasingly performed in many clinical practices (1,2). Acute appendicitis (AP) is the most common clinical problem requiring emergency surgery (3,4). Nowadays, Laparoscopic Appendectomy (LA) can be carried out safely and easily, bringing reduced postoperative abdominal pain, a relatively short hospital stay and early return to normal activity, as well as patient satisfaction (4,5) and is one of the most frequently performed examples of MIS.

Any surgery during pregnancy brings the risk of complications for the fetus, such as fetal distress,

preterm delivery, abortus imminens and fetal loss; as well as surgical site infections, hematoma, and abscess formation in the mother (5-7). Although the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) indicate that LA may be performed safely in pregnant patients with acute appendicitis, there are certain unavoidable challenges in both the diagnosis and treatment of patients during pregnancy (8).

The aim of the present retrospective study is to compare the effect of LA in early and late gestation periods, according to surgical outcomes.

MATERIAL and METHODS

Methodology and Ethics

This retrospective study was carried out in the Department of Surgery at Sakarya University Education and Research

Received: 11.01.2020 Accepted: 17.03.2020 Available online: 26.08.2020

Corresponding Author: Mehmet Aziret, Department of General Surgery, Sakarya University Education and Research Hospital, Sakarya, Turkey, E-mail: drozgeyuce@gmail.com

Hospital, with reference to patients hospitalized between May 2014 and February 2019. In total, 29 patients who underwent LA for acute appendicitis were eligible for the study. The patients were divided into two sub-groups according to their gestation period (Figure 1):

- First half of pregnancy (<20 weeks) (group 1; n=19)
- Second half of pregnancy (\geq 20 weeks) (group 2; n=10)

Figure 1 shows the flowchart for the study: all patients were assessed according to age, gender, gestation period, laboratory and pathological findings, operation time, hospital stay time and postoperative complications. The pregnant patients diagnosed with acute appendicitis were operated on within 12 hours, after obstetric consultation. Approval for the study protocol was granted by the Ethical Committee of our university.

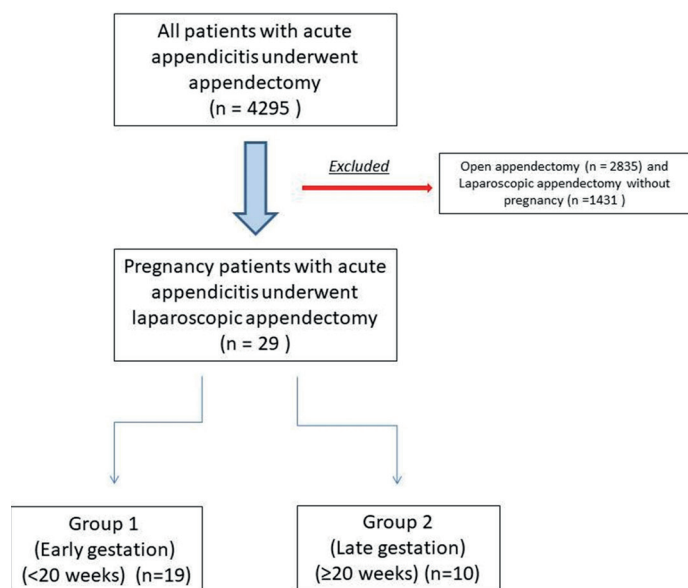


Figure 1. Flow chart of the study

Inclusion criteria

We included patients who -

- were willing to give written informed consent
- were aged between 18 and 40
- were pregnant at the time of diagnosis
- had normal hematological parameters
- underwent Laparoscopic Appendectomy

Exclusion criteria

We excluded patients who:

- were not willing to give informed consent
- were aged <18 or > 40
- had abnormal hemodynamic parameters
- had perforated appendicitis, ruptured ovarian cyst or tubo-ovarian abscess
- underwent open appendectomy

Preoperative and postoperative course of action

Patients were hospitalized following the diagnosis of AP and were referred to the obstetrics/gynecology and anesthesia departments for consultation on preoperative and postoperative care. Progesterone treatment to prevent preterm labor was prescribed both before and after the operation. First-generation cephalosporin was given as prophylaxis, while some patients also took second or third-generation cephalosporin following obstetric and infection consultation. The operation time was established as the time from induction of anesthesia to the point of extubation of the patient. All operations were performed by more than one surgeon. Following the operation, intravenous 10-mg/ml paracetamol was administered to the patients and continued at 8-hour intervals. After 6-8 hours, patients started to receive liquid food and were mobilized. They were discharged from hospital after passing gas and following assessment of 'health and recovery after surgery' by the obstetrics clinic.

Surgical procedure

Laparoscopic Appendectomy

The Veress needle was used in the first trimester, whereas the Hasson technique (open technique) was used for most of the cases performed in the second and third trimester. The lower abdomen was used to the trocar insertion in first and early second trimester whereas; the upper abdomen was used in third trimester and late second trimester. Pneumoperitoneum was established using carbon dioxide, and intraabdominal pressure was fixed at 8-10 mmHg in all patients.

After general anesthesia, a Foley catheter was inserted into the bladder. The patient was given right-sided with Trendelenburg position in the first and second trimester. In patient with third trimester, the partial right-sided with Trendelenburg position was provided. The North American three-port technique was used for all patients. In patient with first trimester and early second trimester, a 10-mm trocar was inserted under to the umbilicus according to the uterine position. A 5-mm trocar was then placed into the left iliac fossa prior to inserting a 10-mm trocar into the upper symphysis pubis under direct vision. In patient with late second trimester and third trimester, a 10-mm trocar was inserted 4-6 cm above the uterus in the midline. A 10-mm trocar was then placed into the under xiphoid bone and a 5-mm trocar into the right upper quadrant or left upper quadrant under direct vision.

After exploration of the peritoneal cavity, the mesoappendix was dissected using a 5-mm abdominal bipolar vessel sealer. When the base of the appendix was exposed, it was ligated with a 2/0 endoloop. The appendectomy specimen was then lifted out using a 10-mm trocar. In one patient with suppurated appendicitis, the appendectomy area was washed with 0.9% sodium-chloride, and then aspirated. Irrigation was not performed routinely, but only in patients with gangrenous appendicitis (Figure 2 and 3).

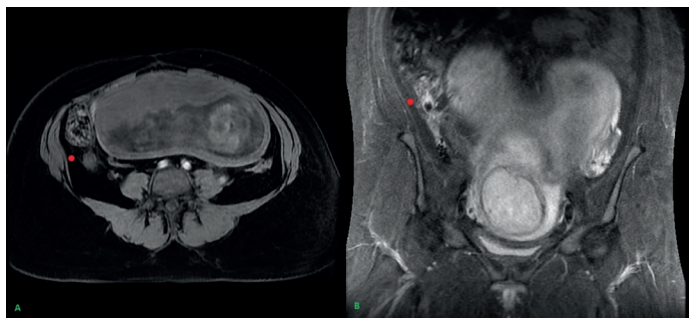


Figure 2. Acute appendicitis in magnetic resonance imaging in a 25-week pregnant woman (Red point: Acute appendicitis)

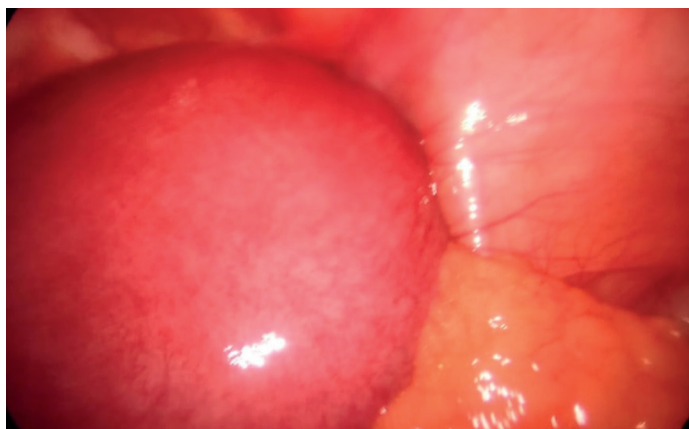


Figure 3. Uterus during laparoscopic appendectomy in a 13-week pregnant woman

Statistical analysis

The data were examined using Statistical Package for the Social Sciences ver. 21.0 (SPSS Inc, Chicago, Illinois, USA). Shapiro-Wilk's was used for the number of units in cases with normal distribution of variables. The Mann-Whitney U test was used in the event normal distribution was absent to measure the differences between the groups. Independent-Samples T test was used for comparison of age, BMI, length of hospital stay, follow up, operation time and biochemical parameters between the groups. Chi-square and Fisher's exact chi-square tests were used for comparison of categorical variables. Complications of the study were measured with the χ^2 or Fisher's exact tests. In the present study, for all sta-tistical analyzes $p < 0.05$ was accepted as significant.

RESULTS

Clinical and perioperative characteristics and pathological examination

Of the 4,295 patients considered, 29 were enrolled in the study, with 4,266 patients excluded for failing to meet the necessary criteria. These patients were divided into two groups according to the length of gestation: gestation period shorter than 20 weeks (Group 1: $n=19$) and gestation period 20 weeks or longer (Group 2: $n=10$). Twelve patients (41.6%) were in their first trimester, fifteen patients (51.6%) in their second, and two patients (6.8%) in their third trimester. Minimal co-morbidities were recorded

(24%); the most common being goiter or hypothyroidism (6.8%), hypertension (3.4%), and bronchial asthma (3.4%) (Table 1).

Table 1. Patients and Comorbidities

	n (%)
Total Pregnancy	29 (100)
Early gestation <20 weeks	19 (65.5)
Late gestation \geq20 weeks	10 (34.5)
Trimester	
First	12 (41.6)
Second	15 (51.6)
Third	2 (6.8)
Co-morbidities	
Goiter or hypothyroid	2 (6.8)
Familial Mediterranean fever	1 (3.4)
Hypertension	1 (3.4)
Beta thalassemia carrier	1 (3.4)
Migraine	1 (3.4)
Smoker	1 (3.4)
Bronchial asthma	1 (3.4)
D vitamin deficiency	1 (3.4)

The mean patient age was 29.6 ± 5.4 years in Group 1 and 26.7 ± 3.6 years in Group 2 ($p=0.141$). The mean body mass index (BMI) for Group 1 was 26.9 ± 3.9 kg/m² and 28.9 ± 3.7 kg/m² for Group 2 ($p = 0.35$) (Table 2), while the median ASA score was 2 (1-2) in Group 1 and 2 (1-3) years in Group 2 ($p=0.09$).

Mean follow-up time for all patients was 20.9 ± 14.2 months. The mean length of hospital stay was 2 (1-5) days in Group 1 and 2.5 (1-5) days in Group 2 ($p= 0.839$) while the mean operation time was 68.4 ± 19.4 minutes in Group 1 and 83 ± 23 minutes in Group 2 ($p=0.083$). Mean rates for INR (International Normalized Ratio), hemoglobin, hematocrit, white blood cell, neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), red cell distribution width (RDW) and platelet distribution width (PDW) were 1.01 ± 0.11 , 11.8 ± 1.1 mg/dl, $35.6 \pm 3\%$, 15.1 ± 4.9 K/uL, 8.58 ± 5.2 , 168.5 ± 72.3 , $16,28 \pm 2.7$, 17.6 ± 1 in Group 1; ($p > 0.05$) and 1 ± 0.07 , 11.7 ± 1.2 mg/dl, $34.4 \pm 3.3\%$, 16.2 ± 4.6 K/uL, 9.14 ± 4.2 , 162.7 ± 52.1 , 16.2 ± 1.9 , 17.8 ± 0.83 in Group 2; ($p < 0.05$), respectively. Median C-reactive protein (CRP) scores were 11.7 (3-112) in Group 1 and 10.9 (5-67) mg/L in Group 2, ($p < 0.05$).

After histopathological examination of appendectomy specimens, a diagnosis of appendix vermicularis or lymphoid hyperplasia was made in six patients (20.6%) (Table 2).

Table 2. Characteristics, biochemical and pathological examination findings

	Total (n=29)	Group 1 (Early gestation) (<20 weeks) (n=19)	Group 2 (Late gestation) (≥20 weeks) (n=10)	P
Age	28.6±5	29.6±5.4	26.7±3.6	0.141†
Body mass index (kg/m ²)	27.6±3.9	26.9±3.9	28.9±3.7	0.221†
ASA	2 (1-3)	2 (1-2)	2 (1-3)	0.09 *
Length of hospital stay	2 (1-5)	2 (1-5)	2.5 (1-5)	0.839¶
Operation time	73.4±21.5	68.4±19.4	83±23	0.083†
Follow up	20.9±14.2	20,2±15.8	22.4±11.2	0.704†
Twin or triple pregnancies	2 (6.9%)	0	2 (20%)	0.111*
Hematological parameters				
INR	1.01±0.1	1.01±0.11	1±0.07	0.814†
Hemoglobin	11.7±1.1	11.8±1.1	11.7±1.2	0.886†
Hematocrit	35.2±3.2	35.6±3	34.4±3.3	0.359†
WBC	15.5±4.7	15.1±4.9	16.2±4.6	0.548†
NLR	8.7±4.8	8.58±5.2	9.14±4.2	0.780†
PLR	166.4±64.9	168.5±72.3	162.7±52.1	0.826†
RDW	16.2±2.4	16,28±2.7	16.2±1.9	0.928†
PDW	17.7±0.99	17.6±1	17.8±0.83	0.603†
CRP	9.6 (1-112)	11.7 (3-112)	10.9 (5-67)	0.808 ¶
Histopathological diagnosis of appendicitis				
No	6 (20.6%)	3 (15.7%)	3 (30%)	0.633 *
Yes	23 (79.1%)	16 (84.2%)	7 (70%)	

ASA: American society of anesthesiologist INR: International normalized ratio, NLR: Neutrophil-to-lymphocyte ratio, PLR: Platelet-to- lymphocyte ratio, RDW: Red cell distribution width, PDW: Platelet distribution width, CRP: C-reactive protein, WBC: White blood cell

† Student's t test, ¶ Mann Whitney U test, * Chi-square test or Fisher's exact test

Characteristics of patients during the second half of pregnancy

Ten pregnant patients with acute appendicitis underwent LA during the second half of their pregnancy. The median age, BMI, ASA score and length of hospital stay for these patients was 26.5 (22-34) years, 28.88 (22-35,1) kg/

m², 2 (1-3) and 2.5 (1-5) days, respectively. The median durations for operation time and follow-up period were 79.5 (60-140) minutes and 2.9 (5.8-40) months, respectively. The median timings related to pregnancy were 21 (20-36) weeks gestation for laparoscopic appendectomy and 39 (32-39) weeks gestation for delivery time (birth time). The negative appendectomy rate was 30% (3 cases) (Table 3).

Table 3. Characteristics of patients with second half of pregnancy

No	Age	BMI (kg/m ²)	Comorbidity	Twin or triple pregnancy	Trimester pregnancy	Operation time in pregnancy (week)	Operation Time (min)	Length of hospital stay (day)	Complication	Pathology of peritonitis	Follow-up (month)	Delivery time (birth) (week)	Weight and gender of baby	APGAR score
1	27	30.9	No	No	3	36	140	3	No	AA	40	39	4050gr / ♂	10
2	22	30.75	No	No	2	20	72	1	No	Appendix vermiformis	30.7	40	3350gr / ♀	9-10
3	24	29.72	No	No	3	30	88	1	No	AA	30.6	39	3520gr / ♂	9-10
4	28	28.04	No	Twin	2	20	90	2	No	AA	24.2	37	2750 / ♀ 2560 / ♂	NA
5	26	25.71	No	No	2	20	90	3	No	AA	21.7	40	3420gr / ♂	9-10
6	29	26.92	Hashimoto disease	No	3	28	85	5	No	AA	15.2	37	NA / ♂	
7	30	35.15	No	No	2	25	71	5	No	AA	14.4	32	1220gr / ♀	NA
8	23	27.33	No	Triple	2	20	60	3	Fetal distress and preterm delivery	Lymphoid hyperplasia	8.5	32	1060gr / ♀ 1490gr / ♀ 1410gr / ♂	8-9 8-9 8-9
9	34	32.53	D vit. deficiency	No	2	22	60	2	Preterm delivery	Lymphoid hyperplasia	5.8	40	3740gr / ♀	9-10
10	24	22	No	No	2	20	74	1	No	AA	32.8	39	3850gr / ♂	9-10

AA: Acute appendicitis, BMI: Body mass index, min: minute, vit: vitamin, NA: Not available

Complications

In this study, we compared morbidity between the two groups for the duration of the pregnancy, continuing after discharge from hospital. There was no mortality during this period. Superficial surgical site infection was recorded in two patients from Group 1 ($p = 0.53$). In these patients, wound cultures were taken, and after removal of the sutures, surgical site care was administered until completely healed. An accumulation of intraperitoneal fluid was found in one patient, appearing in CT scan as ascites, 19x12mm in size, in the appendectomy area. In consultation with the interventional radiologist, antibiotics were administered and no percutaneous drainage was necessary.

Two patients with multiple pregnancies in Group 2 had

preterm deliveries ($p = 0.11$). The first, a 32-week pregnant patient, exhibited signs of fetal distress and delivered twins preterm, 18 days postoperatively. After suitable treatment, the mother and children have no health issues. The second case was a triplet pregnancy that proceeded uneventfully after LA at the 20th week, culminating in a preterm cesarean section delivery at 32 weeks. The patient and her children are all healthy and thriving.

One abort imminens occurred during diagnosis of acute appendicitis in a 6-week pregnant patient ($p > 0.99$) from Group 1. The patient was followed closely and treated with Tocolytics. The clinical course of the patient and her child proceeded uneventfully after delivery (Table 4).

In the present study, no instances of stump appendicitis, leakage or massive hemorrhage occurred in either group.

Table 4. Complications

	Total (n=29)	Group 1 (Early gestation) (<20 weeks) (n=19)	Group 2 (Late gestation) (\geq 20 weeks) (n=10)	p*
Surgical site infection	2 (6.8%)	2 (10.5%)	-	0.53
Intra-peritoneal fluid collection	1 (3.4%)	1 (5.3%)	-	>0.99
Aborts imminence	1 (3.4%)	1 (5.3%)	-	>0.99
Fetal distress	1 (3.4%)	-	1 (10%)	0.34
Preterm delivery **	2 (6.8%)	-	2 (20%)	0.11
Fetal loss	-	-	-	

* Fisher's exact test, **with multiple pregnancy

DISCUSSION

This is the first study in the literature to evaluate the effectiveness of LA on pregnant women during the second half of the gestation period. We found that LA is not associated with a higher fetal loss in this period than in the first half. Secondly, although the rate of fetal distress and preterm delivery was higher in the second half of the pregnancy, this difference was not significant ($p = 0.11$).

Acute appendicitis is one of the most common non-obstetric causes of acute abdomen during pregnancy, and LA, which like other minimally invasive procedures has become more popular, is now an accepted treatment in pregnant women (1-5). Nevertheless, with LA during pregnancy, certain problems may occur in the postoperative period such as fetal hypoxia due to pneumoperitoneum; fetal acidosis from carbon-dioxide (CO₂) gas absorption; fetal or uterine injury owing to port or Veres needle insertion; and preterm delivery due to preterm membrane rupture or uterine perforation (6,7). Recently, most studies have emphasized the safety and efficacy of minimally invasive surgical techniques during pregnancy; however, results are contradictory (5,6,8). Furthermore, there are

few prospective studies focusing on the feasibility of laparoscopic surgery in pregnant woman. One such study by Pearl et al., reported that laparoscopic procedures generate less morbidity in terms of maternal and fetal life in every trimester of the gestation (8). On the other hand, other studies report the concern that LA is associated with a higher chance of fetal loss and preterm delivery (9-11). In a meta-analysis incorporating 11 studies on a total of 3,415 pregnant women by Wilasrusmee et al (10), there was a higher fetal-loss rate with LA than in open appendectomy. In another study, Walker et al reported fetal loss rates for LA and OA to be 7% compared to 3% (11). However, although LA may increase the risk of fetal loss during pregnancy, this risk is not high enough to warrant prohibiting that surgical technique (12). In contrast, similar to non-pregnant patients, LA offers certain advantages to women who are pregnant such as less postoperative pain, better bowel motility resulting in a shorter duration of postoperative ileus, early discharge from hospital and a quicker return to normal activity (13). In addition, LA gives optimal opportunity to visualize and assess the organs and tissues, while requiring less uterine manipulation. The need for postoperative analgesia is also reduced, and

cosmetic results are usually satisfactory (12, 14). A meta-analysis by Frountzas et al. encompassing 6,276 pregnant women, suggests that when LA is indicated, it appears to be relatively safe in pregnancy. Nonetheless, the need for new prospective large clinical studies to corroborate this idea is critical (15). Lee et al. considers it irrational to assume that LA in pregnant women might be associated with a greater risk of fetal loss (16). Moreover, Gök et al. reports that LA in pregnant women can be a safe option, from both the maternal and fetal perspective, in the light of prospective, randomized studies with large sample sizes (17).

Diagnosing acute appendicitis during the later gestational period can be problematic, so there is an increase in the risk of negative appendectomy. The main reasons for negative appendectomy are: abnormal findings from the anamnesis and physical examination; a change in the normal uterine localization from pelvis to epigastrium; insufficient ultrasound evidence with respect to colonic or intestinal gas; the contraindication of computed tomography in case of damage to the fetus; an absence of high-field magnetic resonance imaging and alterations in the hematological or biochemical parameters. Despite advances in imaging techniques, the negative appendectomy rate varies from 0% to 43% (5,10,16,18,19). Our negative appendectomy rate is 20.6%, and this is in line with the literature.

There are two main limitations to the present study. First, it is retrospective and the sample size is small. Secondly, although preterm delivery and fetal distress were recorded during the second half of the gestation period, it is likely that these complications are not directly associated with LA, since the patients concerned had twin or triple pregnancies.

CONCLUSION

The results of the present study indicate that LA for acute appendicitis can be safely performed during the second half of pregnancy. Further prospective randomized studies with large patient populations are needed to reach more definite conclusions.

Acknowledgments

The study was presented as an oral presentation at the 7th national congress of gastroenterological surgery.

Competing interests: The authors declare that they have no competing interest.

Financial Disclosure: There are no financial supports.

Ethical approval: The study was approved by the Ethics Committee of the Medical Faculty at the Sakarya University Education and Research Hospital (71522473/050.01.04/4112).

REFERENCES

1. Semm K. Endoscopic appendectomy. *Endoscopy* 1983;15:59-64.
2. Hansen JB, Smithers BM, Schache D, et al. Laparoscopic versus open appendectomy: prospective randomized trial. *World J Surg* 1996;20:17-20.
3. Aziret M, Palabiyik O, Karaman K, et al. Effectiveness of transversus abdominis plane block for laparoscopic appendectomy in non-perforated acute appendicitis. *Laparosc Endosc Surg Sci* 2018;25:133-9.
4. Aziret M, Çetinküner S, Erdem H, et al. Comparison of open appendectomy and laparoscopic appendectomy with laparoscopic intracorporeal knotting and glove endobag techniques: A prospective observational study. *Turk J Surg* 2017;33:258-66.
5. Li X, Zhang J, Sang L, et al. Laparoscopic versus conventional appendectomy - a metaanalysis of randomized controlled trials. *BMC Gastroenterol.* 2010;10:129.
6. Cox TC, Huntington CR, Blair LJ, et al. Laparoscopic appendectomy and cholecystectomy versus open: a study in 1999 pregnant patients. *Surg Endosc* 2016;30:593-602.
7. Kulhan M, Kulhan NG, Uluğ P. Laparoscopic Surgery in Pregnant Women. *Van Med J* 2017;24:404-9.
8. Pearl JP, Price RR, Tonkin AE, et al. SAGES guidelines for the use of laparoscopy during pregnancy. *Surg Endosc* 2017;31:3767-82.
9. Walsh CA, Tang T, Walsh SR. Laparoscopic versus open appendectomy in pregnancy: a systematic review. *Int J Surg* 2008;6:339-44.
10. Wilasrusmee C, Sukrat B, McEvoy M, et al. Systematic review and metaanalysis of safety of laparoscopic versus open appendectomy for suspected appendicitis in pregnancy. *Br J Surg* 2012;99:1470-8.
11. Walker HG, Al Samaraee A, Mills SJ, et al. Laparoscopic appendectomy in pregnancy: a systematic review of the published evidence. *Int J Surg* 2014;12:1235-41.
12. Stepp K, Falcone T. Laparoscopy in the second trimester of pregnancy. *Obstet Gynecol Clin North Am* 2004;31:485-96.
13. Panin AV, Dubrovsky AV, Petrov DY et al. The results of open and laparoscopic appendectomy in pregnant women with acute appendicitis. *Hirurgiia (Mosk)* 2016;4:21-5.
14. Levy T, Dicker D, Shalev J, et al. Laparoscopic unwinding of hyperstimulated ischaemic ovaries during the second trimester of pregnancy. *Hum Reprod* 1995;10:1478-80.
15. Frountzas M, Nikolaou C, Stergios K, et al. Is the laparoscopic approach a safe choice for the management of acute appendicitis in pregnant women? A meta-analysis of observational studies. *Ann R Coll Surg Engl* 2019;101:235-48.
16. Lee SH, Lee JY, Choi YY, et al. Laparoscopic appendectomy versus open appendectomy for suspected appendicitis during pregnancy: a systematic review and updated meta-analysis. *BMC Surg* 2019;19:41.
17. Gök AFK, Soydaş Y, Bayraktar A, et al. Laparoscopic versus open appendectomy in pregnancy: A single center experience. *Ulus Travma Acil Cerrahi Derg* 2018;24:552-6.
18. McGory ML, Zingmond DS, Tillou A, et al. Negative appendectomy in pregnant women is associated with a substantial risk of fetal loss. *J Am Coll Surg* 2007;205:534-40.
19. Won RP, Friedlander S, Lee SL. Management and outcomes of appendectomy during pregnancy. *Am Surg* 2017;83:103-7.