

Laparoscopic versus open appendectomy in pregnancy: A single center experience

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ABSTRACT

BACKGROUND: The aim of this study was to compare the obstetric and surgical outcomes of laparoscopic appendectomy (LA) and open appendectomy (OA) performed for pregnant women at a single center. It was the hypothesis of this study that there would be no significant difference in the results.

METHODS: The medical records of 57 consecutive pregnant women who underwent an appendectomy between January 2009 and September 2018 were reviewed retrospectively. The patients were divided into 2 groups: OA and LA. The collected data included age, gestational age, diagnostic modalities used, duration of surgery, length of hospital stay, morbidity, and mortality.

RESULTS: Eighteen (31%) patients underwent LA and 39 (69%) patients underwent OA. There were no significant differences in the demographic data. The duration of surgery was significantly less in the laparoscopic group (37 vs 57 minutes; $p=0.005$). There were no statistically significant differences in the outcomes of deep or superficial surgical site infection, length of hospital stay, pre-term delivery, or loss of the fetus. There was no mortality in either group.

CONCLUSION: The results of this study suggest that LA can be a safe option for both the pregnant patient and the child. Further prospective, randomized studies with a larger group of pregnant patients with appendicitis are needed to fully determine the effects of laparoscopy in these circumstances.

Keywords: Appendectomy; laparoscopy; open appendectomy; pregnancy.

INTRODUCTION

Acute appendicitis (AA) is the most common non-obstetric surgical emergency in pregnant women.^[1] Owing to the physiological changes in pregnancy, such as mild leukocytosis and change in appendix location, diagnosis of appendicitis may be challenging. Surgical treatment is the standard of care in pregnant women with appendicitis. Nevertheless, Carstens et al.^[2] reported that they have successfully treated a pregnant patient with appendicitis non-operatively in a remote area where there is no place for non-operative management of AA during pregnancy because of a higher rate of peritonitis,

fetal demise shock, and venous thromboembolism as compared with operative management.^[3,4] The optimal surgical technique is still controversial in pregnant patients, but during recent years, laparoscopic appendectomy (LA) has become the preferred treatment for pregnant women with AA.^[5,6] Appendectomy in pregnancy may have poor obstetric outcomes when a delay occurs in the diagnosis and/or treatment. The aim of the present study was to compare obstetric and surgical outcomes of LA and open appendectomy (OA) during pregnancy in a single center. We hypothesized that there are no differences between LA and OA according to obstetric and surgical outcomes in pregnancy.

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MATERIALS AND METHODS

The medical records of 57 consecutive pregnant women who underwent appendectomy between January 2009 and September 2018 were reviewed retrospectively. The patients were divided into two groups as OA and LA. Data regarding age, gestational age, diagnostic modalities, duration of surgery, length of stay, pathological results, morbidity, and mortality were collected. The local ethics committee approved the study in accordance with the guidelines of the Declaration of Helsinki (second revision, 2008). Patient characteristics including age, gestational week, admission, white blood cell count, diagnostic modalities, surgical approach, and final pathology report were obtained from the medical records. The study population was divided into two groups according to the surgical approach. The 30-day postdischarge complications were compared between the two groups. Primary outcomes were the loss of the fetus and the preterm delivery. Secondary outcomes were the development of deep and superficial surgical site infections, hospital length of stay, duration of surgery, and readmission.

All patients were evaluated according to the İstanbul University İstanbul Faculty of Medicine, Trauma and Emergency Surgery Unit guideline (Fig. 1). The appendicitis diagnosis was based on the clinical, laboratory, and imaging findings. All patients underwent abdominal ultrasonography (US). Magnetic resonance imaging (MRI) was used to support the appen-

ditis diagnosis if the initial diagnosis could not be definitively diagnosed in the US. All patients were consulted by the Department of Obstetrics & Gynecology to evaluate fetal viability before and after the abdominal surgery. All of them received nifedipine and indomethacin for tocolytic purpose. In addition, they received ampicillin–sulbactam (4 g/day) preoperatively and postoperatively for 24 h.

Standard or modified McBurney incision was preferred in open approach according to gestational age. Laparoscopic procedures were performed in all patients with three standard trocars (umbilicus 10 mm, left lower quadrant 10 mm, and suprapubic 5 mm) and HD systems (Karl Storz GmbH & Co. KG, Tuttlingen, Germany). Open incision technique was performed for entering the first trocar that was used for the camera. CO₂ pressure was 14 mm Hg to maintain pneumoperitoneum. The specimens were extracted through the left lower quadrant trocar incision with a plastic bag.

All patients underwent operation with general anesthesia. Heart rate (three-channel electrocardiography), blood pressure, peripheral oxygen saturation, and end-tidal CO₂ (Dräger Infinity Vista XL Monitor) were monitored. For anesthesia induction, 2–3 µg/kg fentanyl, 2–2.5 mg/kg propofol (up to the loss of eyelash reflex), and 0.5 mg/kg rocuronium bromide were used. Patients were intubated with an appropriate endotracheal tube. The fresh gas flow was adjusted to 2–3 l/min (O₂/air mix, 50%/50%) during surgery. The tidal volume was adjusted to 6–8 ml/kg with a ventilatory frequency of 12 beats/min by volume-controlled mechanical ventilation (Dräger Fabius GS). End-tidal CO₂ was maintained at 30–40 mm Hg. During anesthesia maintenance, 50% O₂/50% air mix, sevoflurane (0.5%–2%), and 0.05–0.45 µg/kg/min remifentanyl were used. All patients received 1 g intravenous paracetamol and 1 mg/kg tramadol. For postoperative analgesia, a 500 mg/6 h intravenous paracetamol was used.

Statistical analysis was performed by using the Statistical Package for the Social Sciences software, version 23 for Windows (IBM Corp., Armonk, NY, USA). The chi-squared test or Fisher's exact test was used to compare categorical variables. The Student's t-test was used to analyze normally distributed variables, and the non-parametric Mann–Whitney U test was used to analyze non-normally distributed variables. A p-value <0.05 was considered statistically significant.

RESULTS

During the study period, 57 pregnant patients were admitted with a diagnosis of appendicitis and underwent appendectomy. Of the patients, 18 (31%) underwent LA, and 39 (69%) underwent OA. The overall median age of the patients was 28 (19–41) years. There were no statistically significant differences between the two groups according to age, pregnancy week, and laboratory and pathological findings (Table 1).

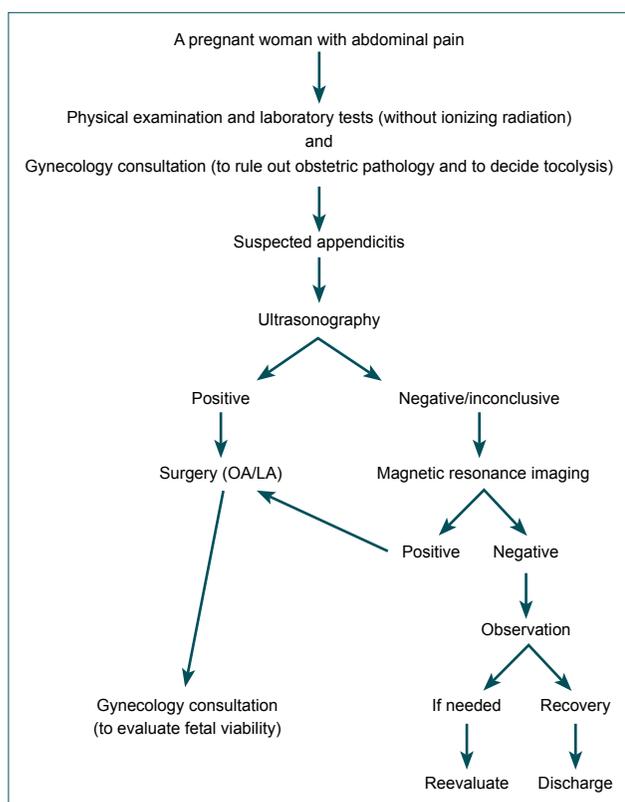


Figure 1. Trauma and Emergency Surgery Unit guideline.

Table 1. Demographic, laboratory, and pathological findings

	Overall n=57 (100%)	Open appendectomy n=39 (69%)	Laparoscopic appendectomy n=18 (31%)	p
Age (years)	28 (19–41)	27 (19–41)	29 (21–41)	0.606
Gestational age (weeks)	16 (4–36)	17 (5–36)	15 (4–26)	0.078
Pregnancy trimester				
1	18 (32.0%)	11 (28.2%)	7 (38.9%)	0.258
2	29 (51.0%)	19 (48.7%)	10 (55.6%)	
3	10 (17.0%)	9 (23.1%)	1 (5.6%)	
Leukocyte count (range: 4300–10300)	13106 (7600–23700)	12500 (7600–27300)	12550 (8800–19600)	0.491
Neutrophil count (range: 2800–10000)	9800 (5270–22800)	9800 (5900–22800)	9810 (5270–17700)	0.712
CRP level (mg/L, range: 0–5)	21 (1–160)	21 (1–160)	22 (2–139)	0.711
Pathology				
Normal appendix	4 (7.0%)	3 (7.7%)	1 (5.6%)	0.323
Acute appendicitis	52 (91.0%)	36 (92.3%)	16 (88.8%)	
Perforated appendicitis	1 (2.0%)	0 (0.0%)	1 (5.6%)	

Table 2. Outcomes

	Overall n=57 (100%)	Open appendectomy n=39 (69%)	Laparoscopic appendectomy n=18 (31%)	p
Primary outcomes				
Preterm delivery	2 (5.0%)	2 (5.1%)	0 (0.0%)	1.000
Fetal loss	1 (2.5%)	1 (2.6%)	0 (0.0%)	1.000
Secondary outcomes				
Readmission	3 (12.5%)	2 (5.1%)	1 (5.6%)	1.000
SSSI	2 (5.0%)	1 (2.6%)	1 (5.6%)	0.536
DSSI	2 (5.0%)	2 (5.1%)	0 (0.0%)	1.000
LoS (days)	1 (1–7)	1 (1–7)	1 (1–3)	0.243
DoS (min)	50 (25–110)	57 (25–110)	37 (23–95)	0.005
Mortality	0			

SSSI: Superficial surgical site infection; DSSI: Deep surgical site infection; LoS: Length of stay (days); DoS: Duration of surgery (minutes).

All patients underwent abdominal US (n=57, 100%). MRI was obtained to clarify the diagnosis for 10 (17.5%) patients with an unclear diagnosis of appendicitis. Sensitivity and specificity of US were 84.9% and 50%, respectively. Sensitivity and specificity of MRI were 66.7% and 100%, respectively.

There were no statistically significant differences between the two groups according to preterm delivery, fetal loss, and other complications. The duration of surgery was significantly shorter in the LA group than in the OA group (Table 2).

DISCUSSION

The aim of the present study was to compare obstetric and surgical outcomes of LA and OA in pregnant women in a single center. The findings from our study showed that there were no differences between LA and OA in pregnancy in terms of obstetric and surgical complications. There was no evidence of a statistically significant negative effect of laparoscopy on obstetric and surgical outcomes. On the other hand, the duration of surgery was significantly shorter in the LA group (57 vs. 37 min, p=0.005) (Table 2). There was a pronounced trend for OA in late gestational age, but there was no statistical significance.

Somewhat surprisingly, the length of stay was not different in two groups. We were expecting that the length of stay of the LA group might be shorter than that of the OA group. In a systematic review of 20 studies, Prodromidou et al.^[7] reported that the length of stay of LA is 1 day shorter than that of OA.^[7] We think that our result might be due to preoperative and postoperative consultations to assess the mother and fetus regardless of the surgical intervention. In addition, the diagnostic tools that we used to ensure the diagnosis of appendicitis, such as US and MRI, take some time. In the same study, they found that there is no difference in the incidence of intra-abdominal abscesses or wound infection among the two groups. This result is similar to our results according to surgical site infections, despite the surgical site infection rate would be expected to be lower in laparoscopic cases. We think that our result might be due to pre- and postoperative antibiotic treatments.

The risk of preterm delivery is associated with perforated appendicitis. Some studies reported that the risk of preterm delivery is between 8% and 33%.^[8,9] In our study, we observed that the perforated appendicitis rate was 2%, and the preterm delivery rate was 5% (Tables 1 and 2).

In a large population-based study, the negative appendectomy rate is 17.4%.^[10] Bhandari et al.^[11] reported that the negative appendectomy rates are 21.4% and 21.3% ($p=0.52$) in their pregnant and non-pregnant cohorts, respectively. In our study, we observed the negative appendectomy rate in 4 (7%) patients. This could be explained by the accuracy of our diagnostic tools. Appropriate imaging in the diagnosis of appendicitis has resulted in a decreased negative appendectomy rate from as high as 25% to approximately 1% to 3%.^[12] Some series reported that US was found to be 78% to 83% sensitive and 83% to 93% specific for the diagnosis of AA.^[13,14] The use of MRI during the work-up of suspected appendicitis during pregnancy reduces the unnecessary operation rate by 50%.^[15] Avcu et al.^[16] reported that the sensitivity and specificity of MRI are 84.9% and 50%, respectively. In our study, the sensitivity and specificity of US were 84.9% and 50%, respectively, and the sensitivity and specificity of MRI were 66.7% and 100%, respectively.

LA was preferred in the first and second trimesters. Owing to the technical difficulties of LA, OA was preferred more often in the third trimester. Some studies showed that LA can be used in all trimesters, whereas Kirshtein et al. recognized the third trimester as a contraindication for LA.^[17-19] A systematic review stated that there is no difference in fetal loss or preterm delivery for LA managed in the first and third trimesters.^[20] In our study, only one patient underwent LA in the third trimester, whereas nine patients underwent OA (Table 1).

Before this, laparoscopy was considered as a risk factor for fetal loss due to the pneumoperitoneum. Increased intra-abdominal pressure and Trendelenburg position during la-

paroscopy may cause maternal hypercapnia and hypoxemia that affect the fetus.^[21] Some studies suggested low pressure during laparoscopy to prevent fetal loss.^[22,23] On the contrary, in our study, the pressure was maintained at 14 mm Hg as our standard laparoscopic pressure, and there were no statistically significant differences between the two groups according to preterm delivery and fetal loss. Safe abdominal access for laparoscopy can be accomplished using either an open or a closed technique when used appropriately. The concern for the use of closed access techniques, such as Veress needle or optical entry, has largely been based on the potentially higher risk for injury to the uterus or other intra-abdominal organs in pregnant patients.^[24,25] In the present study, always open incision technique was performed for initial port placement to avoid the aforementioned complications. An increasing number of studies have suggested that laparoscopic surgeries are safe during pregnancy.^[22,23,26,27]

In our study, we tried to summarize our institution's experience on pregnant women with appendicitis, but the study has some limitations. These limitations include small sample size, retrospective design, only 30-day outcomes, and not well documented physical examination findings.

Conclusion

Overall, the present study suggests that LA is safe for pregnant patients and their infants. It must be kept in mind that our study was only conducted on a small group of patients retrospectively. Further prospective randomized studies are needed to determine the effects of laparoscopy on a larger group of pregnant patients.

Conflict of interest: None declared.

REFERENCES

- Andersen B, Nielsen TF. Appendicitis in pregnancy: diagnosis, management, and complications. *Acta Obstet Gynecol Scand* 1999;78:758-62.
- Carstens AK, Fensby L, Penninga L. Nonoperative Treatment of Appendicitis during Pregnancy in a Remote Area. *AJP Rep* 2018;8:e37-8.
- Cheng HT, Wang YC, Lo HC, Su LT, Soh KS, Tzeng CW, et al. Laparoscopic appendectomy versus open appendectomy in pregnancy: A population-based analysis of maternal outcome. *Surg Endosc*. 2015;29:1394-9. [[CrossRef](#)]
- Abbasi N, Patenaude V, Abenhaim HA. Management and outcomes of acute appendicitis in pregnancy-population-based study of over 7000 cases. *BJOG* 2014;121:1509-14. [[CrossRef](#)]
- Korndorffer JR Jr, Fellinger E, Reed W. SAGES guideline for laparoscopic appendectomy. *Surg Endosc* 2010;24:757-61. [[CrossRef](#)]
- Cox TC, Huntington CR, Blair LJ, Prasad T, Lincourt AE, Augenstein VA, et al. Laparoscopic appendectomy and cholecystectomy versus open: a study in 1999 pregnant patients. *Surg Endosc* 2016;30:593-602.
- Prodromidou A, Machairas N, Kostakis ID, Molmenti E, Spartalis E, Kakkos A, et al. Outcomes after open and laparoscopic appendectomy during pregnancy: A meta-analysis. *Eur J Obstet Gynecol Reprod Biol* 2018;225:40-50. [[CrossRef](#)]
- Kazim SF, Pal KM. Appendicitis in pregnancy: experience of thirty-eight

- patients diagnosed and managed at a tertiary care hospital in Karachi. *Int J Surg* 2009;7:365–7. [CrossRef]
9. Aggenbach L, Zeeman GG, Cantineau AE, Gordijn SJ, Hofker HS. Impact of appendicitis during pregnancy: no delay in accurate diagnosis and treatment. *Int J Surg* 2015;15:84–9. [CrossRef]
 10. Zingone F, Sultan AA, Humes DJ, West J. Risk of acute appendicitis in and around pregnancy: a population-based cohort study from England. *Ann Surg* 2015;261:332–7. [CrossRef]
 11. Bhandari TR, Shahi S, Acharya S. Acute Appendicitis in Pregnancy and the Developing World. *Int Sch Res Notices* 2017;2017:2636759.
 12. Garcia EM, Camacho MA, Karolyi DR, Kim DH, Cash BD, Chang KJ, et al; Expert Panel on Gastrointestinal Imaging. ACR Appropriateness Criteria® Right Lower Quadrant Pain-Suspected Appendicitis. *J Am Coll Radiol* 2018;15:S373–87. [CrossRef]
 13. van Randen A, Bipat S, Zwinderman AH, Ubbink DT, Stoker J, Boormeester MA. Acute appendicitis: meta-analysis of diagnostic performance of CT and graded compression US related to prevalence of disease. *Radiology* 2008;249:97–106. [CrossRef]
 14. Doria AS, Moineddin R, Kellenberger CJ, Epelman M, Beyene J, Schuh S, et al. US or CT for Diagnosis of Appendicitis in Children and Adults? A Meta-Analysis. *Radiology* 2006;241:83–94. [CrossRef]
 15. Rapp EJ, Naim F, Kadivar K, Davarpanah A, Cornfeld D. Integrating MR imaging into the clinical workup of pregnant patients suspected of having appendicitis is associated with a lower negative laparotomy rate: single-institution study. *Radiology* 2013;267:137–44. [CrossRef]
 16. Avcu S, Çetin FA, Arslan H, Kemik Ö, Dülger AC. The value of diffusion-weighted imaging and apparent diffusion coefficient quantification in the diagnosis of perforated and nonperforated appendicitis. *Diagn Interv Radiol* 2013;19:106–10.
 17. Chung JC, Cho GS, Shin EJ, Kim HC, Song OP. Clinical outcomes compared between laparoscopic and open appendectomy in pregnant women. *Can J Surg* 2013;56:341–6. [CrossRef]
 18. Lyass S, Pikarsky A, Eisenberg VH, Elchalal U, Schenker JG, Reissman P. Is laparoscopic appendectomy safe in pregnant women? *Surg Endosc* 2001;15:377–9. [CrossRef]
 19. Kirshtein B, Perry ZH, Avinoach E, Mizrahi S, Lantsberg L. Safety of laparoscopic appendectomy during pregnancy. *World J Surg* 2009;33:475–80. [CrossRef]
 20. Walsh CA, Tang T, Walsh SR. Laparoscopic versus open appendectomy in pregnancy: a systematic review. *Int J Surg* 2008;6:339–44.
 21. O'Rourke N, Kodali BS. Laparoscopic surgery during pregnancy. *Curr Opin Anaesthesiol* 2006;19:254–9. [CrossRef]
 22. Jeong JS, Ryu DH, Yun HY, Jeong EH, Choi JW, Jang LC. Laparoscopic appendectomy is a safe and beneficial procedure in pregnant women. *Surg Laparosc Endosc Percutan Tech* 2011;21:24–7. [CrossRef]
 23. Park SH, Park MI, Choi JS, Lee JH, Kim HO, Kim H. Laparoscopic appendectomy performed during pregnancy by gynecological laparoscopists. *Eur J Obstet Gynecol Reprod Biol* 2010;148:44–8. [CrossRef]
 24. Friedman JD, Ramsey PS, Ramin KD, Berry C. Pneumoamnion and pregnancy loss after second-trimester laparoscopic surgery. *Obstet Gynecol* 2002;99:512–3. [CrossRef]
 25. Halpern NB. Laparoscopic cholecystectomy in pregnancy: a review of published experiences and clinical considerations. *Semin Laparosc Surg* 1998;5:129–34. [CrossRef]
 26. Rollins MD, Chan KJ, Price RR. Laparoscopy for appendicitis and cholelithiasis during pregnancy: a new standard of care. *Surg Endosc* 2004;18:237–41. [CrossRef]
 27. İlhan M, İlhan G, Gök AFK, Günay K, Ertekin C. The course and outcomes of complicated gallstone disease in pregnancy: Experience of a tertiary center. *Turk J Obstet Gynecol* 2016;13:178–82. [CrossRef]

ORIJİNAL ÇALIŞMA - ÖZET

Gebelikte laparoskopik ve açık apendektominin karşılaştırılması: Tek merkez deneyimi

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AMAÇ: Bu çalışmanın amacı tek bir merkezde apandisit nedeniyle ameliyat edilen gebe kadınlarda laparoskopik ve açık apendektominin (OA) obstetrik ve cerrahi sonuçlarını karşılaştırmaktır. Bu çalışmadaki ana hipotezimiz bahsedilen sonuçlar açısından açık ya da laparoskopik apendektomi (LA) arasında fark olmadığıdır.

GEREÇ VE YÖNTEM: Ocak 2009 ile Eylül 2018 arasında apendektomi yapılan 57 ardışık gebe kadının tıbbi kayıtları geriye dönük olarak incelendi. Hastalar açık ve laparoskopik apendektomi olmak üzere iki gruba ayrıldı. Toplanan veriler yaş, gebelik yaşı, tanı yöntemleri, ameliyat süresi, kalış süresi, morbidite ve mortaliteyi içermektedir.

BULGULAR: On sekiz (%31) hastaya LA ve 39 (%69) hastaya OA uygulandı. Demografik veriler arasında fark yoktu. Laparoskopik grupta cerrahinin süresi anlamlı olarak daha kısaydı (37 ve 57 dakika, $p=0.005$). Derin ve yüzeysel cerrahi alan enfeksiyonları, yatış süresi, erken doğum ve fetal kayıp gibi sonuçlarda istatistiksel olarak anlamlı bir fark bulunmadı. Her iki grupta da mortalite yoktu.

TARTIŞMA: Genel olarak, bu çalışma LA'nın gebe hasta ve fetus için güvenli olduğunu düşündürmektedir. Apandisitli gebe hastalar üzerinde laparoskopinin etkilerini belirlemek için, daha geniş sayıda olguda ileriye yönelik randomize çalışmalara ihtiyaç vardır.

Anahtar sözcükler: Açık apendektomi; apendektomi; gebelik; laparoskopik.

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