

Chapter 9

Acute Appendicitis in Pregnancy: A Review

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Abstract

Acute appendicitis is the most prevalent non-obstetric surgical emergency encountered during pregnancy and continues to be a significant contributor to maternal and fetal morbidity when there is a delay in diagnosis or treatment. Diagnosing appendicitis in pregnant patients presents particular challenges due to the physiological, anatomical, and biochemical changes associated with pregnancy, which may obscure classical clinical symptoms. A delay in diagnosis heightens the risk of appendiceal perforation, which is linked to preterm labor, fetal loss, maternal sepsis, and adverse neonatal outcomes. Imaging techniques, especially ultrasonography and magnetic resonance imaging (MRI), have become integral to the diagnostic process. Surgical intervention remains the cornerstone of treatment. Recent evidence and international guidelines advocate for laparoscopic appendectomy as the preferred surgical method for most pregnant patients, owing to its favorable maternal outcomes, reduced hospital stay, and lower rates of wound complications. Nonetheless, open appendectomy is still suitable in certain clinical scenarios. Emerging literature on non-operative management with antibiotics has garnered interest; however, current evidence indicates that surgery remains the standard of care due to concerns about treatment failure, recurrence, and maternal-fetal complications. Multidisciplinary collaboration among surgeons, obstetricians, anesthesiologists, radiologists, and neonatologists is essential for optimizing outcomes. This chapter explores the diagnostic and current recommendations for managing acute appendicitis during pregnancy.

Keywords: Acute appendicitis, Pregnancy, Imaging, Open appendectomy, Laparoscopic appendectomy, and Non-operative treatment.

Introduction

Acute appendicitis is the most prevalent non-obstetric cause of acute abdominal pain during pregnancy, occurring in approximately one in 500 to one in 800 pregnancies. It is typically characterized by lower abdominal pain. However, the classical presentation is infrequently observed in these patients due to the gravid uterus, which may also result in symptoms such as anorexia, nausea, and vomiting. During abdominal examination, the classical tenderness at McBurney's point is seldom detected, as the gravid uterus displaces the cecum and appendix laterally, potentially causing flank tenderness (De Franca Neto et al., 2015; Yale et al., 2022). Blood investigations, including leukocytosis and elevated inflammatory markers like C-reactive protein (CRP), lack sensitivity as these markers are naturally elevated during pregnancy. Additionally, the presence of leukocytes in the urine, which is common during pregnancy, is insufficiently sensitive for diagnosing acute appendicitis (Pastore et al., 2006).

Imaging modalities are a crucial component of the diagnostic evaluation for pregnant patients with acute appendicitis. Abdominal ultrasound is the most frequently employed first-line imaging technique due to its availability and lack of radiation exposure; however, it exhibits low sensitivity and specificity. Magnetic resonance imaging (MRI) is the second most commonly used modality, offering high sensitivity and specificity for diagnosing acute appendicitis during pregnancy, although it is expensive, time-consuming, and requires specialized interpretation. Computed tomography is seldom utilized in pregnancy because of its reliance on ionizing radiation (Flexer et al., 2014; Orbay et al., 2019). The management of acute appendicitis in pregnancy typically involves an appendectomy, which may be performed as either an open or laparoscopic procedure, contingent upon the trimester. Non-operative treatment may be considered for select patients, but it carries risks such as perforation, as well as maternal risks of pre-term labor and fetal loss (Weston & Moroz, 2015).

The World Society of Emergency Surgeons (WSES), in its 2020 guidelines for diagnosing and managing acute appendicitis, advocates for laparoscopic appendectomy in pregnant patients when expertise is available, explicitly advising against non-operative treatment in such cases (Di Saverio et al., 2020). Conversely, the European Association of Emergency Surgeons (AES) recommends non-operative management for uncomplicated appendicitis during pregnancy. However, they suggest laparoscopic appendectomy up to the 20th week of gestation or when the uterine fundus is below the umbilicus. For both complicated and uncomplicated appendicitis in pregnancy, laparoscopic appendectomy is advised (Adamina, 2022).

Given the lack of consensus on the diagnosis and management of acute appendicitis during pregnancy, this chapter examines the roles of ultrasound and magnetic resonance imaging in diagnosing acute appendicitis in pregnant patients. Additionally, it explores the efficacy of laparoscopic versus open appendectomy for this condition in pregnancy. The potential of non-operative treatment for acute appendicitis in pregnant patients is also evaluated. A comprehensive literature review was conducted using PUBMED, the Cochrane Database of Systematic Reviews, Google Scholar, and Semantic Scholar. The search focused on randomized controlled trials, non-randomized trials, observational and cohort studies, clinical reviews, systematic reviews, case reports, and meta-analyses published between 1990 and 2026. The keywords employed included "Acute appendicitis," "Pregnancy," "Imaging," "Open appendectomy," "Non-operative treatment," and "Laparoscopic appendectomy." All articles were in English and were assessed through manual cross-referencing of the literature. Commentaries and editorials were excluded from this review. The study exclusively included pregnant patients experiencing non-obstetric abdominal pain.

Discussion

Diagnosis of acute appendicitis in pregnancy

Imaging plays a crucial role in diagnosing acute appendicitis during pregnancy, with abdominal ultrasound and magnetic resonance imaging (MRI) being the most frequently employed modalities. Ultrasonography offers the benefits of widespread availability and the absence of radiation exposure; however, it is limited by its operator dependency and relatively low sensitivity and specificity (Katz et al., 2012; Khandelwal et al., 2013). MRI is typically utilized when ultrasonography results are inconclusive, as it provides superior sensitivity and specificity. Segev et al. conducted a case-control study to evaluate the diagnostic performance of ultrasonography for acute appendicitis in pregnant patients, including a total of 67 participants, and reported a positive predictive value of 0.94 (Segev et al., 2016). In a prospective study by Kazemini et al., the accuracy of ultrasonography in diagnosing acute appendicitis during pregnancy was assessed in 58 pregnant patients, yielding sensitivity, specificity, positive predictive value, and negative predictive value of 80%, 75%, 91.4%, and 52.9%, respectively (Kazemini et al., 2017).

Wang et al. conducted a systematic review and meta-analysis to evaluate the diagnostic performance of ultrasonography for acute appendicitis in pregnant patients. This study incorporated four studies comprising 239 patients, revealing that ultrasonography demonstrated a sensitivity of 56% and a specificity of 88%. The positive likelihood ratio was 4.65 (95% CI, 1.42-15.23), and the negative likelihood ratio was 0.50 (95% CI, 0.41-0.62) (Wang et al., 2023). In a separate systematic review and meta-analysis, Moghadam et al. assessed the diagnostic accuracy of ultrasonography for acute appendicitis in pregnancy. This analysis included eight studies with a total of 1593 patients, reporting an overall sensitivity and specificity of 77.6% and 75.3%, respectively. The sensitivity of ultrasonography during the first, second, and third trimesters was 69%, 63%, and 51%, respectively, while the specificity during these trimesters was 85%, 85%, and 65%, respectively (Maryam Nakhaie Moghadam, 2022).

Magnetic resonance imaging (MRI) is the second most frequently employed imaging technique for diagnosing acute appendicitis during pregnancy. Pedrosa et al. conducted a retrospective study to evaluate the efficacy of MRI in this context. The study included 51 patients and reported sensitivity, specificity, positive predictive value, and negative predictive value of 100%, 96.3%, 1.4%, and 100%, respectively (Pedrosa et al., 2006). Additionally, Burke et al. carried out a five-year multicenter study involving 709 patients, of whom 66 exhibited findings of acute appendicitis on MRI. The study demonstrated sensitivity, specificity, positive predictive value, and negative predictive value of 96.8%, 99.2%, 92.4%, and 99.7%, respectively (Burke et al., 2015). Furthermore, Burns et al. conducted a retrospective study on the application of MRI for diagnosing acute appendicitis in pregnancy, reporting sensitivity and specificity of 75% and 100%, respectively (Burns et al., 2017).

Motavaselian et al. conducted a systematic review and meta-analysis to evaluate the diagnostic performance of magnetic resonance imaging (MRI) for diagnosing acute appendicitis during pregnancy. This study incorporated 26 studies, revealing a sensitivity of 0.92 (95% CI, 0.88-0.95), a specificity of 0.98 (95% CI, 0.97-0.98), a positive likelihood ratio of 29.52 (95% CI, 21.90-39.81), and a negative likelihood ratio of 0.10 (95% CI, 0.04-0.25) (Motavaselian et al., 2022). Similarly, Kave et al. conducted another systematic review and meta-analysis focusing on the clinical application of MRI in diagnosing acute appendicitis in pregnant patients. This analysis included 19 studies with a total of 2400 patients, reporting a sensitivity of 91.8% (95% CI, 87.7-94.9%) and a specificity of 97.9% (95% CI, 97.2-100%) (Kave et al., 2019).

Table 1: Sensitivity and Specificity of Ultrasonography and Magnetic Resonance Imaging in the Diagnosis of Acute Appendicitis During Pregnancy

Study	Study type	Imaging Modality	Sensitivity (%)	Specificity (%)
Kave et al	Systematic review Meta-analysis	Magnetic resonance Imaging (MRI)	91.8	97.9
Motavaselian et al	Systematic review Meta-analysis	Magnetic resonance Imaging (MRI)	92	98
Moghadam et al	Systematic review Meta-analysis	Ultrasonography	77.6	75.3
Wang et al	Systematic review Meta-analysis	Ultrasonography	56%	88%

Table showing the sensitivity and specificity of ultrasonography and magnetic resonance imaging in diagnosing acute appendicitis in pregnancy.

Management of acute appendicitis in pregnancy

The management of acute appendicitis during pregnancy involves performing an appendectomy, which may be executed via either an open or laparoscopic approach. The choice of surgical method is contingent upon factors such as gestational age, the complexity of the appendicitis, and the presence of co-morbidities or prior surgeries. The laparoscopic approach necessitates consideration of the potential risk of uterine injury during trocar placement and the fetus's tolerance to carbon dioxide during pneumoperitoneum (Kirshtein et al., 2009; Miloudi et al., 2012). Aggenbach et al. conducted a retrospective study examining the impact of acute appendicitis in pregnancy, emphasizing the necessity of accurate diagnosis and prompt treatment to avert maternal complications and minimize the risk of fetal loss (Aggenbach et al., 2015). Yang et al. investigated the outcomes associated with different treatment options for acute appendicitis in pregnancy. This study included a total of 10,271 patients, with 57.2% undergoing laparoscopic appendectomy, 13.7% undergoing open appendectomy, and 29.2% receiving non-operative treatment. Laparoscopic appendectomy was correlated with a reduced risk of pre-term labor (Yang et al., 2021).

Walker et al. conducted a systematic review examining the role of laparoscopic appendectomy in cases of acute appendicitis during pregnancy. The study concluded that laparoscopic appendectomy is typically performed before 24 weeks of gestation, with a tendency to avoid the procedure during the third trimester (Walker et al., 2014). Similarly, Walsh et al. conducted a systematic review comparing laparoscopic and open appendectomy in pregnant patients. This review included 28 studies encompassing 637 cases, revealing that laparoscopic appendectomy was associated with a 6% risk of fetal loss and a 27% rate of negative appendectomy (Walsh et al., 2008). Furthermore, Frountzas et al. performed a meta-analysis of observational studies assessing the safety of laparoscopic appendectomy for acute appendicitis in pregnancy. This analysis incorporated 21 studies with a total of 6276 patients, of whom 1963 underwent laparoscopic appendectomy, and 4313 underwent open appendectomy. The findings indicated that laparoscopic appendectomy was linked to a higher risk of fetal loss, although postoperative complications were comparable between the two groups (Frountzas et al., 2019).

Table 2: Sensitivity and Specificity of Ultrasound and MRI for the Diagnosis of Acute Appendicitis in Pregnancy

Study	Study Type	N=numbers	Main findings on Fetal loss	Main findings on pre-term delivery	Maternal/ Surgical outcomes	Conclusion
Walsh et al., 2008	Systematic review	637Lapa- roscopic Append- ectomy (LA) cases	Fetal loss after Laparoscopic Appendectomy =6%, higher than that of Open Appendectomy (OA)	Preterm delivery appeared lower after Laparoscopic Appendectomy than Open Appendectomy	OA appeared safer because of the lower fetal loss risk	Open appendectomy was safer because of lower fetal loss risk
Wilasrusmee et al., 2012	Systematic review and meta-analysis	3,415 women	LA associated with significantly increased fetal loss (RR 1.91, 95% CI 1.31-2.77)	No significant difference (RR 1.44, 95% CI 0.68-3.06)	No significant difference in wound infection, birth weight, operative time, Apgar score, or hospital stay	LA may increase the risk of fetal loss
Walker et al., 2014	Systematic review	N/A	Increased fetal loss associated with LA compared with OA	Similar pre-term delivery rates between groups	LA is associated with minimally invasive benefits	Caution is advised when selecting LA during pregnancy
Frountzas et al., 2019	Meta-analysis	6,276 women	Increased fetal loss risk with LA	No significant difference between techniques	Lower neonatal 5-min Apgar scores were reported after OA; otherwise, outcomes were similar	LA is considered relatively safe when performed by experienced surgeons
Lee et al., 2019	Systematic review and updated meta-analysis	4,694 women	Initial analysis suggested higher fetal loss with LA (OR 1.72), but significance disappeared after sensitivity analysis (OR 1.16, p=0.581)	No significant difference (OR 0.76)	LA had a shorter hospital stay and a lower wound infection risk	Evidence insufficient to conclude that LA increases fetal loss

Wilasrusmee et al. conducted a systematic review and meta-analysis to evaluate the safety of laparoscopic appendectomy versus open appendectomy for acute appendicitis during pregnancy. The study included eleven studies comprising 3,415 patients, with 599 undergoing laparoscopic appendectomy and 2,816 undergoing open appendectomy. The findings indicated that laparoscopic appendectomy was associated with a higher risk of fetal loss (RR 1.91, 95% CI, 1.31-2.77), while no significant differences were observed in postoperative complications and length of hospital stay between the two procedures (Wilasrusmee et al., 2012). Similarly, Lee et al. conducted a systematic

review and updated meta-analysis comparing these surgical approaches. This study included 22 studies with a total of 4,694 patients, of whom 905 underwent laparoscopic appendectomy, and 3,789 underwent open appendectomy. The results demonstrated that laparoscopic appendectomy was linked to a higher risk of fetal loss (OR 1.72, 95% CI, 1.22-2.42), but no significant differences were found in pre-term delivery rates (OR 0.76, 95% CI, 0.51-1.15). Additionally, laparoscopic appendectomy was associated with a shorter hospital stay and reduced wound infection rates compared to open appendectomy (Lee et al., 2019).

Zhang et al. conducted a systematic review and meta-analysis comparing laparoscopic and open appendectomy. This study comprised twenty studies, involving a total of 7,248 patients. The findings indicated that laparoscopic appendectomy was associated with a higher rate of fetal loss (OR, 1.93; 95% CI, 1.39-2.69) and a lower wound infection rate (OR, 0.34; 95% CI, 0.18-0.62). The rates of pre-term delivery were comparable between the two groups (OR, 0.80; 95% CI, 0.48-1.04). Additionally, the length of hospital stay was shorter for patients undergoing laparoscopic appendectomy (Zhang et al., 2021). In a separate systematic review and meta-analysis, Chakraborty et al. examined the safety of laparoscopic appendectomy in cases of acute appendicitis during pregnancy. This analysis included 17 studies, comprising 1,886 patients who underwent laparoscopic appendectomy and 4,261 who underwent open appendectomy. The rate of fetal loss was higher in the laparoscopic group (5.96% vs. 3.73%), with an Odds Ratio of 1.84 (95% CI, 1.31-2.58). Conversely, the rate of pre-term labor was higher in the open appendectomy group (8.99% vs. 2.84%), with an Odds Ratio of 0.39 (95% CI, 0.27-0.55) (Chakraborty et al., 2019).

Table showing the comparison of laparoscopic and open appendectomy for acute appendicitis in pregnancy regarding fetal loss

Non-operative treatment for acute appendicitis in pregnancy

Non-operative management of acute appendicitis during pregnancy is employed for cases of uncomplicated appendicitis in pregnant patients. However, due to the potential for recurrence and the progression to complicated appendicitis, this approach should be adopted with caution. It is imperative to inform patients of these risks, as they are linked to maternal complications and fetal loss (Smolkin et al., 2023). Ceresoli et al. conducted a retrospective study comparing operative and non-operative treatments for acute appendicitis in pregnancy. The study included 349 pregnant patients with acute appendicitis, of whom 38.46% received non-operative treatment. The study found no significant differences in perinatal outcomes between the operative and non-operative treatment groups (Ceresoli et al., 2025).

Candrawinata et al. conducted a systematic review and meta-analysis to compare antibiotic therapy with appendectomy for the treatment of acute appendicitis during pregnancy. The analysis included five studies encompassing a total of 3,562 patients. The findings indicated that antibiotic therapy was associated with a reduced risk of pre-term labor (OR 0.63, 95% CI, 0.43-0.92); however, it was also linked to an increased risk of complications (OR 1.79, 95% CI, 1.19-2.69). The study concluded that antibiotic therapy should be administered with caution in the management of acute appendicitis in pregnant patients (Candrawinata et al., 2023).

Conclusion

Acute appendicitis is the most prevalent non-obstetric surgical emergency during pregnancy, posing considerable diagnostic and therapeutic challenges. The physiological and anatomical changes that accompany pregnancy often obscure classic symptoms, thereby heightening the risk of delayed diagnosis and subsequent appendiceal perforation. Consequently, early recognition is crucial, as disease progression significantly elevates maternal and fetal morbidity. Surgical intervention continues to be the primary approach in managing appendicitis, with appendectomy serving as the definitive treatment to prevent complications such as perforation. Current evidence robustly endorses laparoscopic appendectomy as the preferred surgical technique for most pregnant patients due to its advantageous maternal outcomes, reduced recovery time, and comparable fetal safety. Despite the increasing interest in non-operative management, existing evidence does not yet support the routine use of antibiotic-only therapy during pregnancy. Effective treatment necessitates a multidisciplinary approach, involving surgeons, obstetricians, anesthesiologists, radiologists, and neonatal specialists. Ultimately, prompt diagnosis, timely surgical intervention, and coordinated multidisciplinary care are essential for optimizing maternal and fetal outcomes in the management of acute appendicitis during pregnancy.

Declaration

Conflict of interest: There is no conflict of interest

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