

Original Research Article

Acute appendicitis in pregnancy, is there a role for conservative management?

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ABSTRACT

Background: Although rare, acute appendicitis is the most common general surgery problem encountered in pregnancy. A chief concern is timely and accurate diagnosis. Traditionally, delayed diagnosis of appendicitis in pregnant patients can quickly lead to appendiceal rupture associated with miscarriage, premature delivery, or even fetal loss. Hence, appendectomy has been the gold standard. However, emerging evidence suggests conservative management may be more effective than previously thought, after accounting for maternal and fetal characteristics.

Methods: This retrospective study included a sample of pregnant women diagnosed with acute appendicitis presenting for treatment to two hospitals in Queens, NY, between Jan 2012 and Dec 2021. The characteristics, presentation, and outcomes of conservatively versus surgically treated patients were compared.

Results: The cumulative incidence of acute appendicitis was 0.11% (n=44/28,000). Forty were treated surgically: 78% underwent laparoscopic appendectomy, 15% open appendectomy, and 8% underwent an initial laparoscopy which was converted to an open appendectomy. Four (14%) patients were managed conservatively with IV antibiotics. Eight percent of patients treated surgically had postoperative complications. Neither surgical nor conservatively treated groups reported any instance of mortality or fetal demise.

Conclusions: Our study adds to the literature on treatment decisions for pregnant patients with acute appendicitis. Although surgical intervention remains the gold standard, it carries the potential risk of peri- and postoperative complications. These findings suggest conservative management with antibiotics can sometimes be used without a negative impact on maternal or fetal outcomes.

Keywords: Acute appendicitis, Pregnant, Pregnancy, Surgery

INTRODUCTION

Acute appendicitis is the most common general surgery problem encountered in pregnancy, occurring in 0.06-0.12% of pregnancies.¹ Acute appendicitis frequently occurs in the second trimester with a median gestational age of 16 weeks, although it can occur at any time during

pregnancy.² A correct and timely diagnosis of acute appendicitis is important to reduce fetal and maternal mortality or morbidity. However, as the gravid uterus expands, the list of differentials for an acute abdomen increases and the clinical diagnosis of acute appendicitis becomes more difficult. The anatomic and physiological changes during pregnancy decrease diagnostic accuracy

based on clinical and laboratory parameters, making imaging studies an important adjunct, albeit with their own limitations.³

Acute appendicitis is generally treated surgically, but there is increasing evidence that conservative management may be safe and effective in certain patients.⁴ Conservative management of appendicitis, often referred to as non-operative or antibiotic therapy, has gained attention in the last decade as an alternative for uncomplicated cases.⁴ It is typically considered for patients with mild symptoms, no signs of perforation, and the absence of complications. Patients placed on conservative management are closely monitored for symptom resolution and potential complications, with surgery reserved for cases where antibiotic therapy proves ineffective or if the condition worsens. This approach is especially relevant for certain patient populations, such as those with underlying medical conditions that make surgery riskier or individuals who prefer a non-surgical option.⁵

The risk of appendicitis recurring after conservative management is relatively low, especially in cases of uncomplicated appendicitis. Studies have shown that the recurrence rate for uncomplicated appendicitis treated with antibiotics ranges from around 10% to 15%, implying only a small percentage of patients may experience another episode of appendicitis within a year or two after the initial episode.⁶ However, it's important to note that the risk of recurrence is generally lower for uncomplicated cases compared to complicated cases (such as those with perforation or abscess formation). In complicated cases, the risk of recurrence may be higher, and appendectomy is often recommended to reduce the chances of further complications.

However, in pregnant patients, the decision to treat conservatively or surgically must be carefully weighed, considering not only maternal factors but also those related to the unborn fetus. Given these considerations but also evidence in support of conservative management, the current study will describe characteristics of pregnant patients with acute appendicitis, including demographics, clinical parameters, laboratory, imaging, treatment, maternal and fetal outcomes. In this retrospective, observational study we aim to highlight differences in the characteristics and outcomes for patients treated conservatively against those treated surgically.

METHODS

Sample and data

This retrospective correlational study focused on a population of interest that consisted of all pregnant patients with acute appendicitis seen at either Jamaica hospital medical center or Flushing hospital medical center, both located in Queens, NY. The timeframe for inclusion spanned all encounters between January 2012

and December 2021. Additional inclusion criteria included any pregnant female >18 years of age with confirmed or high suspicion of acute appendicitis. Diagnosis of acute appendicitis was made based on clinical presentation (i.e., abdominal pain, GI symptoms and/ or constitutional symptoms of fevers/ chills) and imaging findings (i.e., dilated appendix, peri-appendiceal fat stranding) consistent with acute appendicitis. Patients not pregnant, patients in active labor, patients with imaging proven normal appendix or those with other imaging-confirmed intraabdominal pathology were excluded.

Of the 28,000 pregnant patients seen during this time, 44 were identified with acute appendicitis and served as the study sample. These patients were grouped by treatment approach (conservative vs surgery). Conservative treatment consisted of antibiotics, bowel rest, and intravenous fluid administration, with monitoring via serial abdominal exams. Surgical treatment consisted of antibiotics, bowel rest, and open, laparoscopic, or laparoscopic converted to open surgery. Patients treated conservatively were not offered surgery; 3/4 patients' condition improved after IV antibiotics, while the remaining patient's condition improved without administration of antibiotics. The treatment offered to the patients managed conservatively was as follows: 2 patients were kept NPO, they received intravenous fluid and antibiotics for 2 days and 3 days respectively (mefoxin 2 g every 8 hours). One patient was discharged home on a week of amoxicillin-sublactam and the 4th conservatively treated patient was kept NPO, hydrated and discharged in 48hrs without any antibiotics. Exclusion criteria included those with suspected appendicitis ruled out via imaging or those with other concurrent disease processes. The current study was approved by the institutional review boards of both hospitals. The study was conducted, and the results reported, according to STROBE guidelines.

Data extracted from the chart included demographic characteristics, presenting symptoms, physical exam findings, laboratory and radiological findings, choice of antibiotic, type of treatment, time to surgical intervention, fetal and maternal complications, intraoperative findings, and final pathology. Physical exam findings included location of pain, laboratory and radiological findings included leukocyte (WBC) count on admission, and imaging findings of dilated (>6 mm) appendix ±peri-appendiceal fat stranding. Complications were identified based on the Clavien-Dindo classification system.

Analytic plan

Descriptive statistics were calculated for the sample as a whole and separately for the conservative and surgical groups. Uniformly distributed variables are described using means and standard deviations while count data or variables which indicated significant skew are described with medians and interquartile ranges (IQR). Bivariate

statistics comparing surgically vs. conservatively treated patients were estimated using Fisher's exact test. All continuous and count variables were examined using ANOVA or Kruskal-Wallis tests of independence, where appropriate. Available case analysis used for all analyses.

RESULTS

Characteristics of the sample

Cumulative incidence of acute appendicitis in our final analytic sample-0.11% (n=44/28,000). Average age was 29.0 years (SD=5.6, range=16-41). Majority of patients identified as Hispanic (66%, n=29), 25% as Asian (n=7),

with remaining patients identifying as black (n=3) or white (n=1). Fifty percent of patients presented during the 2nd trimester and 80% reported RLQ pain (n=35), with a median pain duration of 1 day (IQR=0). Most common symptoms reported were nausea (84%), followed by vomiting (68%) and diarrhea (9%). Table 1 shows full list of univariate and bivariate statistics for the sample.

The most common imaging modality used was ultrasound (US; 82%), compared to MRI and CT, used in 43% and 23% of cases, respectively. Nearly half (47%) of all patients had US and another imaging modality; of these, 76% had a combination of US and MRI with the remaining 24% undergoing US and CT.

Table 1: Descriptive statistics for the sample overall and by treatment group.

Variables	Overall, (n=44)	Surgery, (n=40)	Conservative treatment, (n=4)	P value
Patient characteristics				
Age (mean) (In years)	29.0 (SD=5.6)	28.9 (SD=5.8)	29.3 (SD=4.57)	0.9 ^a
Ethnicity				
Asian	25%	28%	0	1.00 ^b
Hispanic	66%	63%	100%	
Other	9%	10%	0	
Trimester				
1 st	32%	33%	25%	0.81 ^b
2 nd	50%	48%	75%	
3 rd	18%	20%	0	
Clinical presentation				
RLQ	80%	78%	100%	0.57 ^b
RUQ	11%	13%	0	1.00 ^b
Duration of pain (days, median)	1 (IQR=0)	1 (IQR=0)	1 (IQR=0.8)	0.35 ^c
WBC (mean)	16.1 (SD=3.8)	16.4 (SD=3.5)	13.2 (SD=5.8)	0.4 ^c
Nausea	84%	85%	75%	0.51 ^b
Vomiting	68%	68%	75%	1.00 ^b
Diarrhea	9%	10%	0	1.00 ^b
Assessment and treatment				
MRI	43%	40%	75%	0.3 ^b
US	82%	80%	100%	1.00 ^b
CT	23%	25%	0	0.56 ^b
Outcomes				
Complications	7%	8%	0	
LOS (days, median)	2 (IQR=2)	2 (IQR=2)	2 (IQR=0.5)	0.8 ^c
Perforation	9%	10%	0	1.00 ^b

^at-test, ^bFisher's exact test, ^cWilcoxon Rank test.

Ninety-one percent of patients (n=40) were treated surgically with the remaining 10% (n=4) undergoing conservative management. Seventy-eight percent of surgical patients underwent laparoscopic appendectomy, 15% open appendectomy, and 7.5% underwent laparoscopic converted to open. Eighty-seven percent of laparoscopic appendectomies were performed during the 1st and 2nd trimesters, 50% of open appendectomies were performed during the 3rd trimester, and 66% of laparoscopic converted to open appendectomies were performed during the 2nd trimester. Seven percent (n=3) of patients experienced complications, all of whom had

undergone surgery. Appendiceal perforation was found in 9% of cases. No fetal or maternal demise was reported.

Conservative versus surgical patients

All patients treated conservatively presented in the 2nd trimester or earlier and 100% reported RLQ pain. Two patients treated conservatively had leukocytosis. All conservatively managed patients were treated with cefoxitin. The length of stage was 2 days in both the conservatively managed and surgical groups. No differences were found between conservatively treated

patients and those undergoing surgery in terms of reported symptoms, trimester of presentation, WBC levels, duration of pain, or length of stay.

Ultrasound was used in 80% and 100% of surgical and conservative cases, respectively. Three-fourths of patients treated conservatively received multiple imaging assessments, compared to 45% of surgical patients. Three of four patients (75%) who underwent conservative management had both US and MRI. Their appendices measured 6.2 mm, 8 mm, and 1 cm respectively. One conservatively treated patient had US only. No significant differences were found in type and number of imaging modalities nor in complication rates between groups.

Outcomes and complications

Of the patients treated conservatively, one presented the following year with another pregnancy after an uneventful first pregnancy. At this follow-up, the patient reported RLQ pain and was assessed via ultrasound which did not visualize the appendix. The patient was again treated conservatively and went on to have a successful delivery. One other conservatively treated patient had a successful delivery, while the last was lost to follow up. It is unknown if any patients went on to have an appendectomy. Among the patients in the surgical group, Clavien-Dindo 1, 2, and 3 complications were found in 8% (n=3) patients and included postoperative ileus, premature contractions not resulting in birth, and intra-abdominal abscess requiring drainage by interventional radiology.

DISCUSSION

The results of the current study add to a growing literature supporting the use of conservative management for acute appendicitis during pregnancy. Consistent with previous estimates, we found a cumulative incidence of 0.11% among the pregnant patient populations of two hospitals over a 10-year period. While the majority of patients were treated surgically, we did not find evidence that conservative management was associated with worse patient outcomes compared to surgical management. Neither group experienced maternal mortality nor fetal demise. No complications occurred among patients treated conservatively, compared to a complication rate of 11% among patients treated surgically. At least in our sample, these results were not explained by differences in demographic, clinical, or procedural characteristics, although limited by a small sample size. However, our findings highlight several factors relating to diagnosis, assessment, and intervention that should be considered.

Diagnosis and assessment

The diagnosis of acute appendicitis in pregnancy has been historically challenging. The classic clinical signs of appendicitis such as right lower quadrant tenderness to palpation, guarding, and rebound are not as commonly

seen in pregnant patients. As the gravid uterus expands, especially in the last trimester of pregnancy, it displaces or overlies the appendix.⁷ The upward displacement of the appendix is believed to relieve irritation of the parietal peritoneum, causing the pain to settle in the right middle quadrant or the right upper quadrant of the abdomen. However, most of our patients had RLQ pain (80%), with only 11% reporting pain in the RUQ. Notably, all patients reporting RUQ pain presented during the 2nd trimester or later, while 83% of patients reporting RLQ pain presented during the 1st or 2nd trimesters. This suggests that differences in the location of pain may vary over the course of pregnancy, likely due to gravid uterine expansion. Given that all patients treated conservatively presented in the 1st or 2nd trimesters and all reported RLQ pain, this may indicate a specific presentation for which conservative treatment may be appropriate.

In our sample, the majority of patients underwent US, however over half of all patients and ¾ conservatively treated patients received multiple imaging modalities. While needed for diagnosis, consideration should be taken regarding the strengths and weaknesses of each modality. Ultrasound remains the initial choice for suspected appendicitis during pregnancy due to its near-universal availability, non-invasive nature, lower cost, and its lack of ionizing radiation and need for a contrast medium. However, barriers to its use include the inability to compress the uterus as the pregnancy progresses, obesity or intestinal gas, and operator dependence. Furthermore, sensitivity of 36-100% and specificity of 33-100% for US are reported for acute appendicitis in pregnancy, calling its reliability into question. Therefore, given the low yield of the US, it has been recommended that second-line imaging should be considered with an inconclusive US before proceeding to surgery.³

While multimodal assessments show some promise, the benefits and risks of MRI and CT should be weighed. On the one hand, combining US and CT significantly reduced the rate of negative appendectomy from 36% to only 8% in one study.⁸ However, ionizing radiation is a significant disadvantage of CT because of a potential hazard to fetal development. When the exposure to radiation during a CT scan is less than 500mGy, no increase in adverse pregnancy outcomes is seen, but childhood cancer is estimated to rise by 0.1% following a fetal radiation dose of 100mGy.⁹ Therefore, given the potential teratogenic and carcinogenic effects of ionizing radiation on the fetus, CT imaging should be avoided whenever possible in pregnant patients and used only when necessary.

MRI has a reported sensitivity of 90-100% and specificity of 94-98% with studies showing 100% negative predictive value when the appendix is visualized.¹⁰ Previous studies have shown that 61% of patients who did not have an MRI had operative exploration, compared to only 39% of those who underwent an MRI.¹¹

Clinicians should consider performing an MRI as the first choice of additional investigation when appendicitis is suspected during pregnancy.

Surgery versus conservative management

Increasing evidence points to the safety of conservative management for acute appendicitis during pregnancy in patients deemed low risk.⁴ Studies have shown low rates of recurrence and low risk of maternal mortality, morbidity, and fetal demise.¹² However, the optimal surgical technique for acute appendicitis during pregnancy is yet to be established.

Burcu et al recommended that surgeons who are experienced in laparoscopy should not refrain from performing laparoscopy to be more careful in pregnant patients.² The decision on which surgical approach to use is possibly based upon the trimester of pregnancy and the surgeon's preference. In Aggenbach et al both laparoscopic and open procedures were performed in the first and second trimesters, whereas only open appendectomies were performed during 3rd trimester.¹³ Furthermore, laparoscopic appendectomy does not increase risk of preterm labor, miscarriage, or maternal complications, and also results in fewer wound site infections when compared with conventional open appendectomy.^{14,15} However effect of pneumoperitoneum on pregnancy is an important consideration as increased intra-abdominal pressure reduces venous return and cardiac output, potentially causing maternal hypotension and hypoxia.¹⁶ Carbon dioxide pneumoperitoneum can also lead to fetal acidosis.¹⁷ Therefore, SAGES guidelines recommend intraabdominal access using the Hasson/Veress needle technique with initial entry location dependent on trimester and insufflation pressures between 10-15 mmHg.¹⁸

Majority of surgical patients underwent laparoscopic appendectomy (78%) with additional 15% starting laparoscopically but later converting to open exploration due to poor pneumoperitoneum insufflation or concern for unsafe port placement. There were no complications/increased risk of preterm labor associated with use of laparoscopy itself. In terms of timing of these procedures, our results mirror those found in previous studies. Most patients underwent laparoscopic appendectomies during 1st and 2nd trimesters, while open appendectomies-most likely to occur during 3rd trimester.

Post-operative course and complications

Fear of fetal demise and maternal complications have historically led to a lower threshold for operative exploration in pregnant patients.¹⁹ The risk of operative exploration resulting in negative appendectomy should be carefully balanced with the risk of delayed or no treatment resulting in perforated appendicitis and potential fetal loss. Thompson et al reported a fetal loss rate 1.88 times higher in negative appendectomies.²⁰

There were no fetal demise, no maternal mortality, and no negative appendectomy reported in our sample, among either patients treated surgically or conservatively. While the small sample size in the current study limits what inferences may be drawn, the absence of these outcomes is notable.

In our study, surgical exploration was performed within a median of 12 hours of presentation, and 4 (9%) patients had perforated appendicitis without preterm labor or fetal demise. Timely interventions for these patients are of paramount importance, as delayed diagnosis of appendicitis, especially in pregnancy, can quickly lead to appendiceal rupture which is associated with miscarriage, premature delivery or even fetal loss.¹³ During pregnancy, perforated appendicitis occurs in 14.9%-43% of patients.¹³ Fetal mortality is 1.5% in the presence of uncomplicated appendicitis, increasing to 37% with perforation.²⁰ The enlarged uterus prevents movement of the omentum towards the area of inflammation which may be considered as the causative factor for free perforation.² Pregnant women are also in a state of immunosuppression, altering normal inflammatory response.²¹ This can also increase the risk of premature delivery with rates as high as 40% compared to 13%.

Limitations

The primary limitation of the present study is its retrospective design and relatively small sample size from a single institution. However, the results are in agreement with both sample sizes from similar studies, and expected rates of appendicitis in pregnancy. Nevertheless, while this accurately reflects real-world treatment in community-based settings, it limits the generalizability of findings and interpretability of the results. Given the observational nature of the extant literature and the current study, future research is needed that studies this problem using a prospective, randomized, and balanced design.

CONCLUSION

Acute appendicitis is an uncommon and sometimes difficult condition to diagnose in pregnancy. Physical exam and laboratory values that would normally guide diagnosis of appendicitis lack sensitivity in pregnant patients, thereby necessitating the use of imaging. While ultrasound remains the initial imaging modality of choice, MRI/CT should be utilized when appropriate. Diagnostic laparoscopy should still be considered with equivocal imaging findings but high clinical suspicion. Surgical intervention remains the gold standard, but conservative management with antibiotics can sometimes be used without a negative impact on maternal or fetal outcomes.

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