# Appendicitis in pregnancy: New information that contradicts long-held clinical beliefs

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**OBJECTIVE:** Our purpose was to elicit a better understanding of the presentation of acute appendicitis in pregnancy and to clarify diagnostic dilemmas reported in the literature.

**STUDY DESIGN:** We retrospectively reviewed 66,993 consecutive deliveries from 1986 to 1995 by a computer program. Selected records were reviewed for gestational age; signs and symptoms at presentation; complications including preterm contractions, preterm labor, and appendiceal rupture; and histologic diagnosis of appendicitis.

**RESULTS:** Of 66,993 deliveries, 67 (0.1%) were complicated by a preoperative diagnosis of probable appendicitis. Acute appendicitis was confirmed histologically in 45 (67%) of the 67 cases, for an incidence of 1 in 1493 pregnancies in this population. Distribution of suspected appendicitis in pregnancy was as follows: first trimester, 17 cases (25%); second trimester, 27 (40%); and third trimester, 23 (34%). Right-lower-quadrant pain was the most common presenting symptom regardless of gestational age (first trimester, 12 [86%] of 14 cases; second trimester, 15 [83%] of 18 cases; and third trimester, 10 [78%] of 13 cases). The mean maximal temperature for proven appendicitis was 37.6°C (35.5°C-39.4°C), in comparison with 37.8°C (36.7°C-38.9°C; not significant) for those with normal histologic findings. The mean leukocyte count in patients with proven appendicitis was $16.4 \times 10^9$/L ($8.2\text{-}27.0 \times 10^9$/L), in comparison with $14.0 \times 10^9$/L ($5.9\text{-}25.0 \times 10^9$/L) for patients with normal histologic findings. At the time of surgery, perforation had occurred in 8 cases. Of 23 patients at ≥24 weeks' gestational age, 19 (83%) had contractions and an additional 3 patients (13%) had preterm labor with documented cervical change. One patient was delivered in the immediate postoperative period because of abruptio placentae.

**CONCLUSION:** Pain in the right lower quadrant of the abdomen is the most common presenting symptom of appendicitis in pregnancy regardless of gestational age. Fever and leukocytosis are not clear indicators of appendicitis in pregnancy and preterm labor is a problem after appendectomy, but preterm delivery is rare. (Am J Obstet Gynecol 2000;182:1027-9.)

**Key words:** Appendicitis in pregnancy, pain location, leukocytosis, fever, preterm labor

Acute appendicitis occurs in approximately 1 in 1700 pregnancies[1] and is the most frequent extrauterine indication for laparotomy in pregnancy.[1, 2] Although it can occur in any trimester,[3, 4] there appears to be a slight predominance in the second trimester, with incidences of approximately 30%, 45%, and 25% in the first, second, and third trimesters, respectively.[5-8] There is an urgency in making the diagnosis of appendicitis because it is a potentially life-threatening process for the mother and may also affect the fetus with preterm labor and delivery.

Typical diagnostic criteria for appendicitis in a nonpregnant individual are confusing in the setting of the anatomy and physiologic characteristics of the pregnant woman. Signs and symptoms common to both normal pregnancy and appendicitis include anorexia, nausea and vomiting, mild to moderate leukocytosis, and pain.

Obstetrics teaching for ~70 years has been that the pain of appendicitis migrates upward with the growing uterus; thus pain in the right upper quadrant of the abdomen would be expected in the third trimester. This concept was based on an article by Baer et al,[9] published in 1932, that described changes in appendiceal location as pregnancy progresses. Their barium studies, performed in 78 women, showed that the growing uterus pushes the appendix upward and with a counterclockwise rotation of the tip. Theoretically, this would change the location of perceived pain toward the right upper quadrant or right flank with advancing gestational age.

Uncertainty in making the diagnosis can contribute to delay in surgical intervention with increased maternal and fetal morbidity and mortality rates. We performed a retrospective review of all cases of suspected appendicitis in our institution during a 10-year period in an attempt to validate the landmark publication by Baer et al[9] re-

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**Table I.** Pain location by gestational age in histologically proven cases

| Estimated gestational age (wk) | Patients (No.) | Location of pain | | |
|---|---|---|---|---|
| | | Right upper quadrant | Right lower quadrant | Other |
| 0-12 | 14 | 0 | 12 | 2 |
| 12-24 | 18 | 1 | 15 | 2 |
| >24 | 13 | 2 | 11 | 0 |
| TOTAL | 45 | 3 | 37 | 5 |

**Table II.** Pain location by histologic diagnosis in all cases

| Pathologic finding | Patients (No.) | Location of pain | | | |
|---|---|---|---|---|---|
| | | Right upper quadrant | | Right lower quadrant | |
| | | No. | % | No. | % |
| Normal | 22 | 1 | 4 | 16 | 73 |
| Abnormal | 45 | 3 | 7 | 37 | 82 |

garding the change in pain location with advancing gestational age.

## Methods

All pregnant patients delivered at Good Samaritan Medical Center in Phoenix, Arizona, from January 1, 1986, to December 31, 1995, were reviewed. Records that were coded as "rule out appendicitis" or "appendicitis" were selected. In addition, all patients who had an exploratory laparotomy performed were screened to ensure the greatest possible data accuracy.

Data gathered from these records included the presenting complaint, gestational age at presentation and delivery, history, physical examination, laboratory evaluation, and temperature. Outcome variables included preterm labor, preterm delivery, abruptio placentae, sepsis, appendiceal rupture, and neonatal death.

## Results

There were 66,993 deliveries during the 10-year study period; 67 of the women (0.1%) had a preoperative diagnosis of probable appendicitis. Acute appendicitis was confirmed histologically in 45 (67%) of the 67 women, for a true incidence of 1 in 1493 women in our population. Suspected appendicitis occurred in 17 cases (25%) in the first trimester, 27 cases (40%) in the second trimester, and 23 cases (34%) in the third trimester. The false-positive rate was 33% and varied slightly by trimester: 3 (18%) of 17 diagnoses in the first trimester, 10 (37%) of 27 diagnoses in the second trimester, and 9 (39%) of 23 diagnoses in the third trimester were falsely positive.

**Table III.** Mean maximal temperature

| Histologic finding | Maximal temperature (°C) | | Patients with temperature >37.8°C | |
|---|---|---|---|---|
| | Mean | Range | No. | % |
| Normal | 37.8 | 36.7-38.9 | 10/22 | 45 |
| Abnormal | 37.6 | 35.5-39.4 | 20/45 | 44 |

**Table IV.** Mean leukocytosis in all cases

| Histologic finding | Leukocyte count ($\times 10^9$/L) | | Band forms (No., mean) | Patients with leukocyte count >15 × $10^9$/L | |
|---|---|---|---|---|---|
| | Mean | Range | | No. | % |
| Normal | 14.0 | 6-25 | 6 | 13/22 | 60 |
| Abnormal | 16.4 | 8-27 | 4 | 18/45 | 40 |

Pain in the right lower quadrant of the abdomen was the most common presenting symptom regardless of gestational age: 12 (86%) of 14 cases, 15 (83%) of 18 cases, and 11 (85%) of 13 cases in the first, second, and third trimesters, respectively (Table I), were histologically proven appendicitis. If the appendix was normal on pathologic analysis, right lower quadrant pain was also the predominant symptom: 3 (100%) of 3 cases, 5 (50%) of 10 cases, and 7 (78%) of 9 cases in the first, second, and third trimesters, respectively. Other locations of pain included the left lower quadrant, mid abdomen, epigastric region, and a combination of locations.

Pain location in all cases is presented in Table II. The mean maximal temperatures (Table III) did not show a statistically significant difference and therefore did not help in distinguishing true appendicitis. A slightly higher mean leukocyte count was obtained in cases of appendicitis, but the number of bands was not helpful (Table IV).

At exploratory laparotomy, 8 cases of appendiceal rupture (12%) were noted. Preterm contractions developed in 19 (83%) of 23 patients in the third trimester, and an additional 3 patients (13%) had preterm labor with documented cervical change. One delivery occurred in the postoperative period because of abruptio placentae.

## Comment

In our pregnant population the incidence of appendicitis is slightly higher than in an age-matched group of nonpregnant women described in the surgery literature. The proven incidence of acute appendicitis is similar in pregnant and nonpregnant women. The acceptable false-positive rate in pregnancy is 30%, which is very similar to our findings.

The classic signs and symptoms of acute appendicitis are abdominal pain, nausea and vomiting, low-grade temperature elevation, and leukocytosis. The diagnosis of ap-

pendicitis in nonpregnant patients can be difficult, with an accepted false-positive rate of ~15%. In pregnancy the diagnosis is made even more difficult by the growing uterus, which can cause inappropriate delay in making the correct diagnosis, leading to an unacceptable increase in maternal and fetal morbidity and mortality rates.

The objective of this study was to assess the classic signs and symptoms of acute appendicitis in nonpregnant patients and to determine their applicability in pregnancy. We also attempted to validate the original study (1932) by Baer et al[9] regarding change in pain location with advancing gestational age. We were unable to find any reliable sign or symptom that could aid in the diagnosis of acute appendicitis in pregnancy.

There was no distinguishing temperature that separated true appendicitis from suspected cases that turned out to be falsely positive. The incidence of leukocytosis was slightly higher in acute appendicitis, but the overlap was substantial and negates the value of this laboratory test in reducing false-positive cases and possibly avoiding laparotomy. An elevated count of band forms was also not diagnostic.

We were unable to corroborate the hypothesis of Baer et al[9] that would suggest a right-upper-quadrant location for the pain of appendicitis in the third trimester. Rather, our data support the concept that the majority of patients with acute appendicitis have pain in the right lower quadrant in all trimesters. We could not demonstrate a difference between the histologically proven cases of appendicitis and the "pretenders" without proven appendicitis. As the appendix becomes obstructed by a coprolith, it distends and visceral afferent nerves are stimulated, causing constant poorly localized pain starting near the umbilicus and eventually migrating to McBurney's point, which overlies the location of the appendix in most nonpregnant patients. As the full thickness of the appendiceal wall becomes necrotic and the serosa is damaged, the somatic neurons are stimulated, which localizes the pain to the right lower quadrant.[10, 11] This process appears to remain similar in pregnancy, contrary to the Baer theory and classical obstetric teaching.

This collection of cases of suspected appendicitis in pregnancy represents the largest case series reported to date. Although other studies have suggested that right-lower-quadrant pain is frequent with appendicitis in pregnancy, our data demonstrate that pain in this location is the most common symptom of appendicitis in pregnancy regardless of gestational age. Temperature is not reliably elevated in pregnant patients, and leukocytosis is present but cannot be used to rule out acute appendicitis. A high clinical suspicion is necessary to make the diagnosis, and because of overlap with normal pregnancy symptoms, a higher false-positive rate (30%) is not only acceptable but necessary to avoid unacceptable delay, with the possibility of increased morbidity and mortality rates.

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